TEXTE
16/2017

Definition of Best Available Techniques (BAT) in Europe: BAT for Air Emission Reduction in the Chemical Industry Sector in Germany

Final Report

For our Environment

Umwelt Bundesamt

TEXTE 16/2017

Environmental Research of the
Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Project No. (FKZ) 3714 43 312 4
Report No. (UBA-FB) 002442/ENG

Definition of Best Available Techniques (BAT) in Europe: BAT for Air Emission Reduction in the Chemical Industry Sector in Germany

by

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On behalf of the German Environment Agency

Imprint

Publisher:
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Study performed by:
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Nernstweg 32 – 34
22765 Hamburg

Study completed in:
November 2016

Edited by:
Section III 2.1 General Aspects, Chemical Industry, Combustion Plants
Birgit Brahner

Publication as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4804

Dessau-Roßlau, March 2017

The Project underlying this report was supported with funding from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear safety under project number FKZ 3714 43 312 4. The responsibility for the content of this publication lies with the author(s).

Abstract

In September 2016, the European Commission started an information exchange with member states, industry associations and NGOs on best available techniques for waste gas treatment in the chemical sector. Aim of the information exchange is the development of a Best Available Techniques (BAT) Reference Document on Common Waste Gas Treatment in the Chemical Sector (WGC BREF).

With this research report, the German Environment Agency (UBA) contributes to the information exchange. The objective of the project was the compilation and assessment of air emission values from installations of the chemical industry sector in Germany, considering related waste gas treatment. The report analyses 2 972 measurements from 1 209 emission sources of the chemical industry sector.

For this purpose, 550 measurement reports on periodic measurements were compiled and assessed (aproximately every forth of about 2 000 installations of the chemical industry). Most measurements originate from 2012 to 2015. The assessment is based on normalized mean values (1013 hPa, 273 K), in most cases based on three single measurements, conducted subsequently on the same day during normal operating conditions at production conditions generating the maximum emission level. Measurement reports on periodic measurements include information about the context of the measurement, e.g. description of the waste gas abatement system, connected processes and partly information on substances involved. Continuous measurements were not compiled and assessed in this project.

The project has revealed the following key environmental indicators of the Chemical sector because they offer potential for European-wide emission reduction when applying best available techniques:

Table 1: Key Environmental Issues of the Chemical Sector

Character	Parameter
Sum parameter	Dust, TOC, NOx, SO2, PCDD/F, other CMR substances, non-CMR halogenated organic compounds, more harmful organic substances, metals (three classes)
Single substances	Ammonia, methanol, acetic acid, ethylene oxide, formaldehyde, hydrogen chloride, hydrogen fluoride, hydrogen bromide, chlorine, chloromethane, propylene oxide, toluene, benzene, vinyl chloride, phenol, dichloroethane

The assessment of the parameters showed that emission concentration values should always be linked with the mass flow of the emission. Elevated emission concentrations may have a negligible environmental impact if they are linked with small waste gas volumes, resulting in low mass flows. However, when determining maximum mass flows as an alternative of maximum concentration values, workers protection and protection of the neighbourhood have to be considered.

The study results show that dust emissions from fabric filters are generally associated with mean concentrations below 5 mg/Nm^3. Scrubbers are generally associated with dust mean concentrations below 10 mg/Nm^3. Where no dust abatement was installed, the mean mass flow was below 150 g/h.

For emissions of total organic compounds (TOC) the study shows that thermal oxidation systems are generally associated with mean concentrations below 5 mgC/Nm^3. Scrubbers are associated with mean values below 40 mgC/Nm^3. Where no waste gas treatment is installed, mass flows were below 150 g/h. Emissions of individual CMR substances were generally below 0.5 mg/Nm^3.

For nitrogen oxide emissions few data with SCR systems showed concentrations below 80 mg/Nm^3. A NOx level of 100 mg/Nm^3 is associated with thermal oxidation where TOC values are < 5 mgC/Nm^3 and corresponding CO values are kept below 60 mg/Nm^3. Ammonia slip can be limited to 3 mg/Nm^3.

Besides these essential parameters, all other emission values of Table 1 are assessed in the report. Additionally to concentration levels associated with specific abatement techniques, mass flow thresholds are proposed.

Kurzbeschreibung

Die Europäische Kommission hat im September 2016 einen Informationsaustausch mit den Mitgliedstaaten sowie den Industrie- und Umweltverbänden über die besten verfügbaren Techniken zur Abgasbehandlung in der chemischen Industrie begonnen. Ziel des Informationsaustausches ist die Erarbeitung eines prozessübergreifenden BVT-Merkblattes zur Abgasbehandlung in der chemischen Industrie, auf Englisch „BREF on Common Waste Gas Treatment in the Chemical Sector" (WGC BREF).

Mit diesem Forschungsbericht trägt das Umweltbundesamt zum Informationsaustausch bei. Ziel des Vorhabens war es, luftseitige Emissionswerte aus den Anlagen der chemischen Industrie in Deutschland zu ermitteln und in Verbindung mit der eingesetzten Minderungstechnik zu bewerten. Der vorliegende Bericht analysiert 2.972 Messungen aus 1.209 Emissionsquellen der chemischen Industrie.

Dazu wurden 550 Messberichte zu Einzelmessungen erhoben und ausgewertet, so dass etwa jede vierte der rund 2000 Anlagen der chemischen Industrie im Bericht ausgewertet wird. Die Messungen stammen überwiegend aus den Jahren 2012 bis 2015. Es wurden Mittelwerte ausgewertet, die meistens auf drei Einzelmessungen beruhen und in der Regel nacheinander am selben Tag unter normalen Betriebsbedingungen im Zustand der höchsten Emissionen durchgeführt wurden. Messberichte zu wiederkehrenden Kurzzeitmessungen beinhalten Informationen zum Kontext der Messung, z.B. zum Abgasreinigungssystem, den angeschlossenen Prozessen und teilweise zu eingesetzten Stoffen. Informationen zu kontinuierlichen Messungen wurden in diesem Projekt nicht erhoben und betrachtet.

Das Projekt ermittelte folgende Umweltindikatoren als wesentlich für die chemische Industrie, da sie bei Anwendung von besten verfügbaren Techniken ein europaweites Minderungspotenzial aufweisen:

Table 2: Wesentliche Umweltindikatoren der chemischen Industrie

Charakter	Parameter
Summenparameter	Staub, TOC, NOx, SOx, PCDD/F, weitere CMR-Stoffe, halogenierte nicht als CMR eingestufte Stoffe, besonders schädliche organische Stoffe, Metalle (drei Klassen)
Einzelsubstanzen	Ammoniak, Chlorwasserstoff, Chlor, Fluorwasserstoff, Bromwasserstoff, Methanol, Toluol, Benzol, Formaldehyd, Essigsäure, Ethylenoxid, Chlormethan, Propylenoxid, Vinylchlorid, Phenol, Dichlorethan

Die Auswertung zeigte, dass Konzentrationswerte stets zusammen mit dem Massenstrom betrachtet werden sollten. Erhöhte Konzentrationen können geringe Umweltauswirkungen haben, wenn sie mit geringen Abgasvolumina verbunden sind und somit nur kleine Massenströme verursachen. Bei der Festlegung von maximalen Massenströmen als Alternative zu maximalen Konzentrationswerten müssen jedoch der Arbeitsschutz und der Schutz der Nachbarschaft mit berücksichtigt werden.

Im Ergebnis zeigt die Studie, dass Gewebefilter im Allgemeinen mittlere Staubkonzentrationen unter 5 mg/Nm^3 erreichen. Wäscher bewirken i.A. Staubkonzentrationen < 10 mg/Nm^3. Wenn keine Abgasreinigung für Staubemissionen installiert war, lagen mittlere Massenströme unter 150 g/h. Für die Emissionen von Gesamt-C zeigt die Studie, dass mit thermischer Oxidation (TNV, RNV) im Allgemeinen mittlere Konzentrationswerte unter 5 mgC/Nm^3 erreicht werden. Wäscher erreichen im Allgemeinen mittlere Werte unter 40 mgC/Nm^3. Wenn keine Abgasreinigung für Gesamt-C installiert war, lagen die Massenströme unter 150 g/h. Emissionen von CMR-Einzelstoffen lagen i. A. unter 0,5 mg/Nm^3.

Für Stickstoffoxid-Emissionen lagen nur wenige Werte nach SCR-Anlagen vor, deren Konzentrationsmittelwerte lagen unter 80 mg/Nm^3. NOx-Werte nach thermischen Abgasreinigungen betragen 100 mg/Nm^3; gleichzeitig sind CO-Konzentrationen < 60 mg/Nm^3 und Gesamt-C-Konzentrationen < 5 mgC/Nm^3 erreichbar. Der Ammoniak-Schlupf lässt sich im Allgemeinen auf 3 mg/Nm^3 begrenzen.

Der Bericht diskutiert alle in Tabelle 2 genannten Emissionswerte. Zusätzlich zu den mit einer Abgasreinigungstechnik erreichbaren Konzentrationswerten werden Massenstromschwellen vorgeschlagen.

Index

Index of Figures

Index of Tables

Abbreviations

AB	Absorber
AC	Activated carbon filter
AD	Adsorber
AISV	Bund/Länder-Arbeitsgemeinschaft für Immissionsschutz
BAT	Best available techniques
BATAEL	BAT associated emission level
BF	Biofilter
BU	Burner
BREF	BAT Reference Document
C	(Waste gas treatment system): Condenser; (Type of system): Centralized waste gas treatment system
CAK	Chlor-alkali Manufacturing Industries
CART	Cartridge system for waste gas treatment
CAT	Catalyst for waste gas treatment
CMR	Cancerogenic, mutagenic, reproduction toxic
CO	Carbon monoxide
COM	European Commission
COX	Catalytic oxidation
CWW	Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector
CY	Cyclone
DeNOx	Facility to convert nitrogen oxide (NOx) to nitrogen (N_2)
DeDiox	Facility to convert dioxins and furans into carbon dioxide (CO_2)
DS	Droplet separator
DT	Dip tank
EC	European Commission
ESP	Electrostatic precipitator
EU	European Union
F	Filter for waste gas treatment (type not specified)
FF	Fabric filter
GW	Glow wire

HCl	Hydrogen Chloride
HE	Heat exchanger
HF	Hydrogen Fluoride
IED	Industrial Emissions Directive
LOD	Limit of detection
LVIC-AAF	Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilisers Industries
LVIC-S	Large Volume Inorganic Chemicals - Solids and Others Industry
LVOC	Large Volume Organic Chemicals
MF	Membrane filter
NDIR	Non-dispersive Infrared Detector
NFM	Non Ferrous Metals
NGO	Non-Governmental Organisation
NH_3	Ammonia
NOx	Nitrogen Oxides (nitrogen monoxide and nitrogen dioxide)
NO_2	Nitrogen Dioxide
OC	Organic Compounds
OC Class I	Group of more harmful organic compounds class I, see Annex 1
OC Class II	Group of more harmful organic compounds class II, see Annex 1
OFC	Organic Fine Chemicals
PCDD/F	Polychlorinated Dibenzodioxins and Dibenzofurans
PDF	Portable Document Format
PM Class I	Group of toxic metals in dust with very high risk potential: mercury, thallium
PM Class II	Group of toxic metals in dust with very high risk potential: lead, cobalt, nickel, selenium, telluric
PM Class III	Group of metals in dust with risk potential: antimony, chromium, copper, manganese, vanadium, tin
POL	Polymers
PVC	Polyvinylchloride
RNV	Regenerative Nachverbrennung (regenerative thermal oxidation)
RTO	Regenerative thermal oxidation
RU	Recovery system (not specified)
S	(Waste gas treatment system): Scrubber; (Type of system): Stand-alone treatment

SCR	Selective Catalytic Reduction
SIC	Speciality Inorganic Chemicals
SNCR	Selective Non-Catalytic Reduction
SOx	Sulphur Dioxides (sulphur dioxide and sulphur trioxide)
SP	Special waste gas treatment (e.g. combined flows with different pre-treatments)
SR	Solvent recovery system (type not specified)
TOC	Total organic carbon
TO	Thermal oxidation
TNV	Thermische Nachverbrennung (thermal oxidation)
VOC	Volatile Organic Compounds
UBA	Umweltbundesamt (Environment Agency)
WGC	Common Waste Gas Treatment in the Chemical Sector

Summary

For industrial sectors with relevant environmental impacts, the Industrial Emissions Directive of the European Union (2010/75/EU) requires a European-wide information exchange („Sevilla Process“) for determination of best available techniques (BAT) in BAT Reference Documents (BREFs). BAT Conclusions of the BAT Reference Documents are determined by representatives of the European Commission, Member States, industry and environmental NGOs. They are published in the EU's Official Journal in all EU official languages. The BAT Reference Documents determine European-wide standards for prevention and reduction of emissions as well as for energy efficiency and sustainable production. BAT Reference Documents and BAT Conclusions also attract international attention.

The BAT Reference Documents provide guidance regarding concentration and load limitations. For plants of environmental concern and covered by the Industrial Emissions Directive, European Member States have to ensure by permitting and inspection that compliance is ensured with emission values associated with BAT and documented in the BAT Conclusions.

The objective is the creation of a European-wide harmonized permitting system based on BAT Conclusions. By this, EU Member States shall achieve an approximation of standards for environmental protection on a high level. Germany participates in the information exchange to disseminate its own high standards for environmental protection.

In September 2016, the European Commission started an information exchange with member states, industry associations and NGOs on best available techniques for waste gas treatment in the chemical sector. Aim of the information exchange is the development of a Best Available Techniques (BAT) Reference Document on Common Waste Gas Treatment in the Chemical Sector (WGC BREF).

With this research report, the UBA contributes to the information exchange. The objective of the project is a compilation and assessment of air emission data from installations of the chemical industry sector in Germany under the scope of the European Industrial Emissions Directive.

This final report describes the results of the project. The report analyses 2 972 measurements from 1 209 emission sources of the chemical industry sector in Germany. Data were compiled and assessed from 550 measurement reports on periodic measurements (about every forth of ~2 000 installations of the chemical industry in Germany, see Annex 55). Most measurements originate from 2012 to 2015. The measurement reports were delivered by the competent authorities and a few companies. The focus of the project was on periodic measurement reports because these reports comprise information about the context of the emission like the waste gas abatement system, the process and partly on major substances involved. Continuous measurement data was not compiled and assessed in this project.

The assessment is based on normalized mean values (dry gas, 1013 hPa, 273 K), in most cases averaged with three single measurements of 30 minutes each, conducted subsequently on the same day during normal operating conditions at production conditions generating the maximum emission level. Measurement uncertainty was neither added nor subtracted from the data assessed.

In cases where measurement results were reported as originating from other than normal conditions (OTNOC), the results were excluded from the assessment. OTNOC that occurred during the measurement period were e.g. malfunctions of the waste gas abatement system or malfunctions of the measurement equipment. Measurement values not in compliance with the permit were considered as originating from OTNOC; they were also excluded from the data assessment.

The assessment of each parameter starts with a graph showing mean concentration values and mean mass flow values. The graph provides an overview of the general emission levels of the parameter including outliers. The subsequent graphs present data associated with a specific abatement technique. Usually, a specific level can be observed in each graph that is achieved in most cases except for outliers and for small mass flows. In most graphs, small mass flows are linked with high concentrations.

The share of data with low mass flow and high concentration varies for each parameter. For example, all dust data show low concentrations with few exemptions whereas TOC data shows a much larger share of data with high concentrations and small mass flows; these result e.g. from measurements of TOC emissions from storage tank ventilation or displacement air during filling of reactors.

The project has revealed the following key environmental indicators of the chemical industry sector as they offer potential for European-wide emission reduction when applying best available techniques:

Table 3: Key Environmental Issues of the chemical sector

Character	Parameter
Sum parameter	Dust, TOC, NOx, SOx, PCDD/F, other CMR substances, non-CMR halogenated organic compounds, more harmful organic substances, metals (three classes)
Single substances	Ammonia, methanol, acetic acid, ethylene oxide, formaldehyde, hydrogen chloride, hydrogen fluoride, hydrogen bromide, chlorine, chloromethane, propylene oxide, toluene, benzene, vinyl chloride, phenol, dichloroethane

The assessment of the parameters showed that emission concentration values should always be linked with the mass flow of the emission. Elevated emission concentrations may have a negligible environmental impact if they are linked with small waste gas volumes, resulting in low mass flows. However, when determining maximum mass flows as an alternative of maximum concentration values, workers protection and protection of the neighbourhood have to be considered.

Main results of the data assessment are summarized below. In the report, detailed information can be found on each parameter and on each measured data set (chemical installation category, type of waste gas treatment system, measurement method as well as results of mean emission concentration and mean mass flow).

The draft final report was presented on a workshop and discussed with stakeholders. After the workshop, stakeholder comments were discussed with the UBA and considered for the final report.

This final report serves as a contribution of Germany to the information exchange in the European Union for determining best available techniques (BAT) and associated emission levels for the general waste gas cleaning in the chemical industry sector.

Recommendations for the elaboration of a WGC BREF

The report shows that the following priority pollutants are key environmental issues (KEI) of the chemical industry sector:

- Dust (from chemical processes or from combustion processes)
- TOC (from chemical processes or from combustion processes, the later requiring consideration of associated NOx and CO emissions);
- NOx (from chemical processes or from combustion processes, the later requiring consideration of associated TOC and CO emissions)
- NH_3 (from chemical processes and combustion processes where SCR or SNCR are applied)
- SOx (from chemical processes or from combustion processes with sulphur-containing fuels)
- Halogens and their compounds (from chemical processes or from combustion of certain fuels)
- CMR substances (formaldehyde, etylene oxide, PCDD/F, toluene, benzene, phenol, toluene diisocyanate, 1,2-dichloroethane, benzyl chloride, epichlorohydrin)
- Non-CMR individual organic substances, e.g. methanol, acetic acid (from chemical processes)
- Metals (from chemical processes)

The data assessment shows that BATAEL should be defined as emission concentrations [mg/Nm³] in combination with mass flow thresholds, expressed as gram per hour [g/h]. For each parameter, these mass flow thresholds should refer to the entire installation in order to avoid increasing emissions by increasing the number of point sources.

It is recommended to define BATAEL for some individual substances in addition to sum parameters where substances are of special concern due to hazardous properties and/or are often used in the sector, e.g. formaldehyde, toluene, methanol.

Throughout the data assessment, outliers (exceptionally high concentrations or mass flows) have been identified for several parameters. These data were regularly identified from certain processes of the chemical sector like the production of polymers (IED Annex 1 no. 4.1.h) or the production of large volume inorganic chemicals, in particular of acids (IED Annex 1 no. 4.2.b) and fertilizers (IED Annex 1 no. 4.3). For more outlier data see chapter 2.7 (page 78) and chapters analysing individual parameters.

In the future Reference Document for Waste Gas Treatment in the Chemical Sector (WGC BREF), emissions from these processes cannot be included in the scope of general BAT associated emission levels (BATAEL). These processes will need the elaboration of sector-specific BAT associated emission levels.

Based on the assessment of TOC emissions, it is recommended to establish a selection system for an appropriate abatement, driven by technique-related BATAEL, one for thermal oxidation systems and one for other abatement techniques; the selection criteria should take into account the energy consumption of the abatement and the toxicity of the emitted substances. An example of a decision tree with selection criteria for TOC from the production of organic fine chemicals is presented in chapter 4.8 on page 95.

For several parameters, the data assessment shows examples for mass flows where waste gas abatement was generally not considered necessary. Table 4 shows results for some mass flow thresholds. It has to be considered that these threshold values always need to be applied in combination with an assessment of emissions to guarantee workers health and neighbourhood protection at the installation.

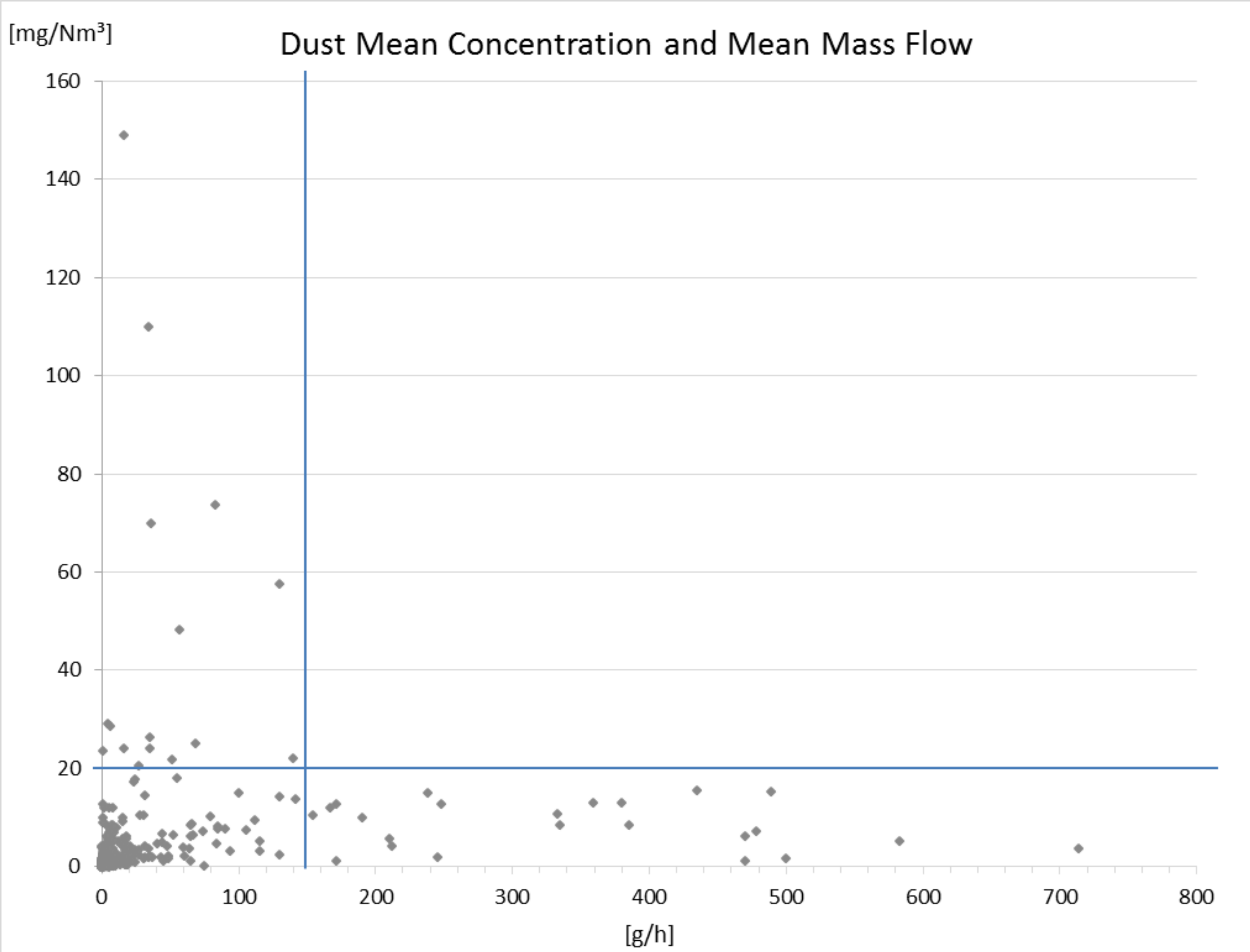
Table 4: Installation-related thresholds (where no waste gas treatment was installed, mass flows were generally below these thresholds)

Parameter	Mass flow threshold [g/h]	Parameter	Mass flow threshold [g/h]
Dust	100	HCl	10
TOC	150	HF	3
NOx	500	Methanol	30
NH_3	100	Ethylen oxide	0.5
SOx	1 500	Toluene	80
Cl_2	5	Benzene	1.5

Dust emissions – chapter 3

For dust, 682 emission data sets have been assessed. Figure 1 shows that dust concentrations are generally below 20 mg/Nm³ (98 % of data sets); most values are also below 10 mg/Nm³ (94 % of data sets). Where mean concentration of 20 mg/Nm³ is exceeded, mass flows are below 150 g/h (all data).

Figure 1: Dust mean concentration and mean mass flow

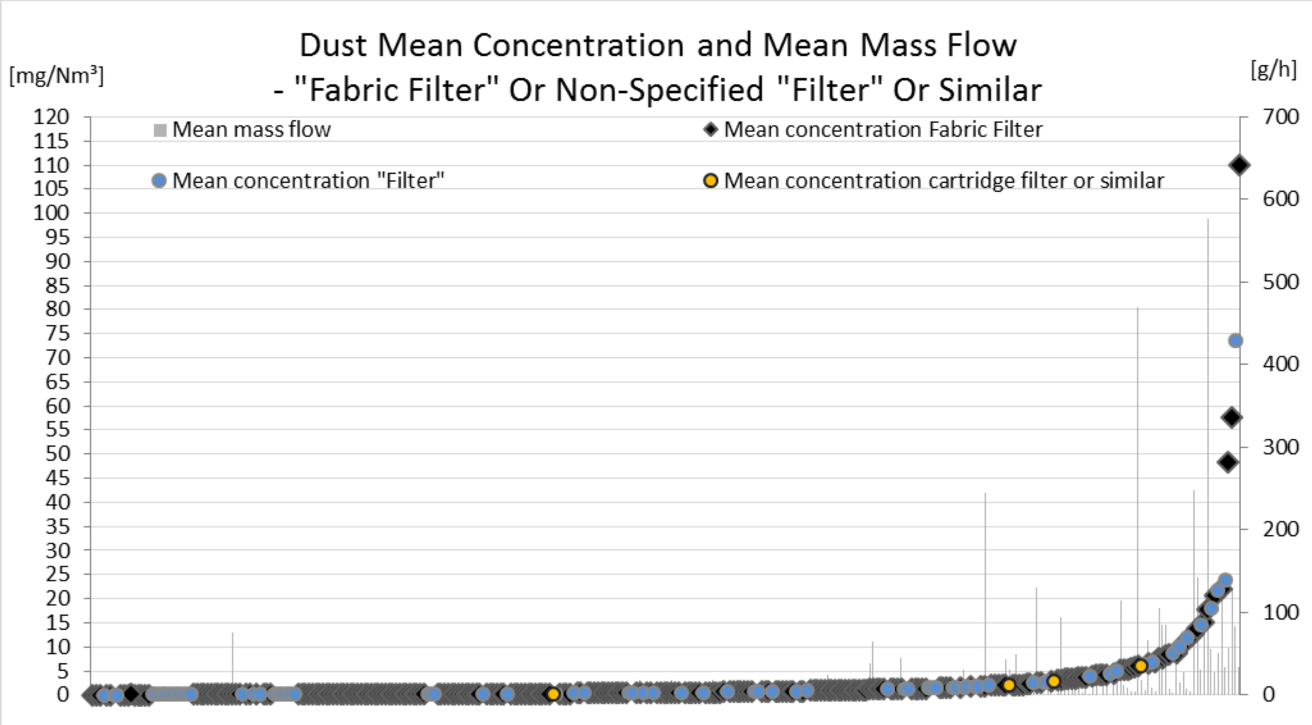


(Ökopol 2016)

Fabric and similar filter systems (478 data) are generally associated with mean dust emissions below 5 mg/Nm³ (90 % of data). Where concentrations are higher, mean mass flows (indicated in the graph as grey bars) are generally below 150 g/h, except two data. These higher mass flows of 248 - 470 g/h originate from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e) and from the production of special inorganic chemicals (IED Annex 1 no. 4.2).

Figure 2 shows fabric filters indicated as black rhombus. Where "filters" were reported (without further specification), fabric filters are assumed (plotted as blue dots in the graph). Cartridge filters or sinter plate filters are plotted as orange dots.

Figure 2: Dust emissions from sources with fabric filters and similar systems



(Ökopol 2016)

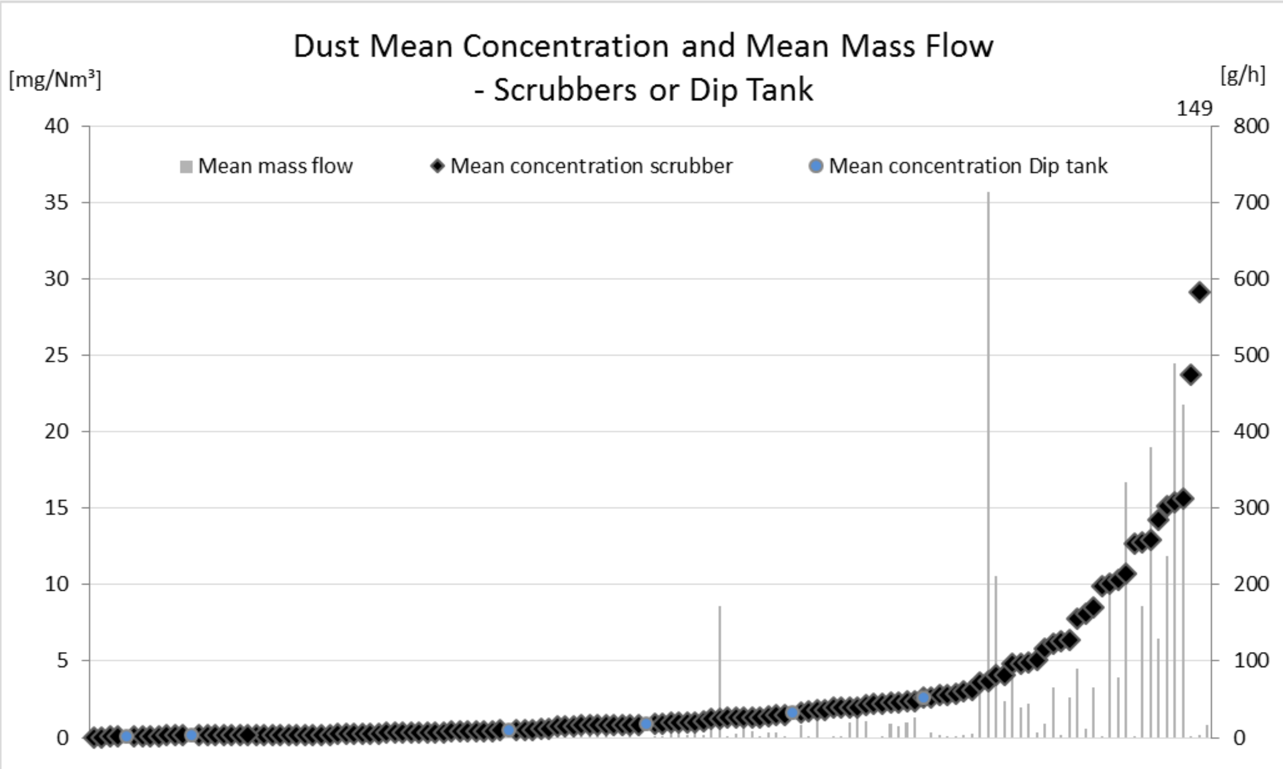
Scrubbers and dip tanks are generally associated with dust concentrations below 10 mg/Nm³ (92 % of 155 data). Where concentrations are higher, six data has mass flows below 150 g/h, another six below 500 g/h.

Figure 3 shows concentrations from sources with scrubbers (black rhombus, 149 data sets) and dip tanks (blue dot, 6 data sets) and the corresponding mass flows (grey bars).

Highest mass flows originate in two cases from the production of plastic materials (IED Annex 1 no. 4.1.h), in another two cases from the production of of oxygen-containing hydrocarbons (IED Annex 1 no. 4.1.b) and in two cases from other production of organic chemicals (IED Annex 1 no. 4.1).

The highest concentration value (149 mg/Nm³) is out of range but indicated in the graph. It has a low mass flow of 16 g/h and originates from a production of organic chemicals (IED Annex 1 no. 4.1.a).

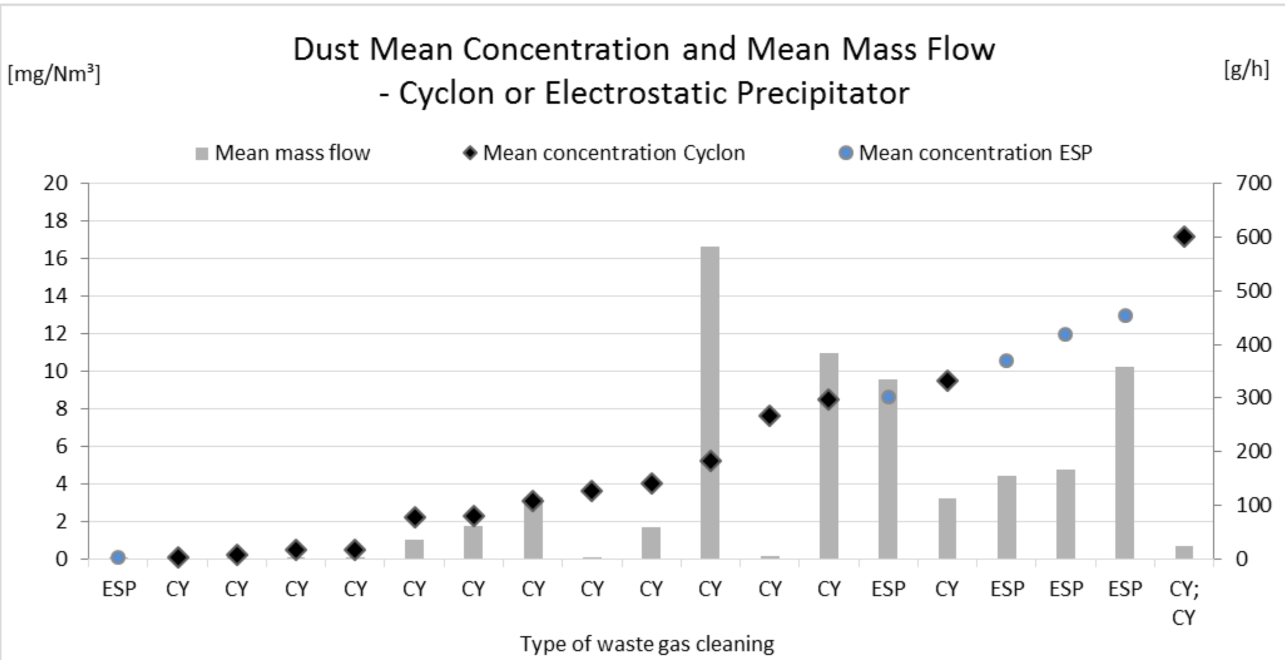
Figure 3: Dust emissions from sources with scrubbers or dip tanks



(Ökopol 2016)

Where only cyclones (14 data sets) or only electrostatic precipitators (5 data sets) are installed, dust concentrations below 20 mg/Nm³ were measured (see Figure 4).

Figure 4: Dust emissions from sources with cyclones or electrostatic precipitator systems



(Ökopol 2016)

Dust emissions from sources where no waste gas treatment for dust is installed (88 data sets, no mechanical filters, no scrubbers) generally show dust concentrations below 5 mg/Nm³ (91 % of data). Where concentrations are higher than 5 mg/Nm³, mass flows are all < 100 g/h except one case. This data set was measured with 478 g/h and originates from acid production (IED Annex 1 no. 4.2.b).

In short, dust data assessment shows:

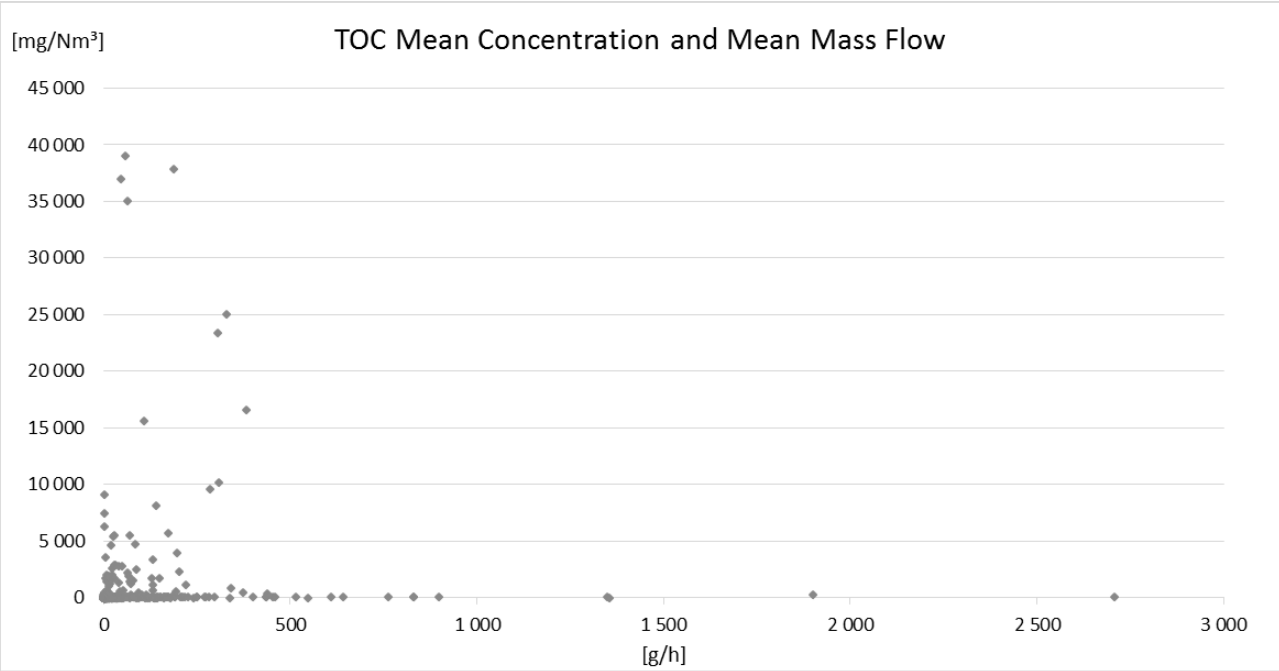
- ► No dust-specific waste gas treatment is installed where mass flows are below 150 g/h.
- ► Where mass flows exceed 150 g/h, cyclons, electrostatic precipitators and fabric filters are installed.
- ► Emission values associated with fabric filters are generally below 5 mg/Nm³ (90 % of the data).
- ► Emission values associated with scrubbers are generally below 10 mg/Nm³ (92 % of data).
- ► The small number of measurements from installations where only cyclons or electrostatic precipitators are installed, shows concentrations below 20 mg/Nm³.

Total organic carbon (TOC) emissions – chapter 4

For TOC, 437 emission data sets have been assessed. Data in Figure 5 illustrate that TOC concentrations are generally below 40 mg/Nm³ (71 % of data). Where concentrations were higher, all but five measurements show a mass flow below 500 g/h; generally, mass flows are below 300 g/h (91 % of data).

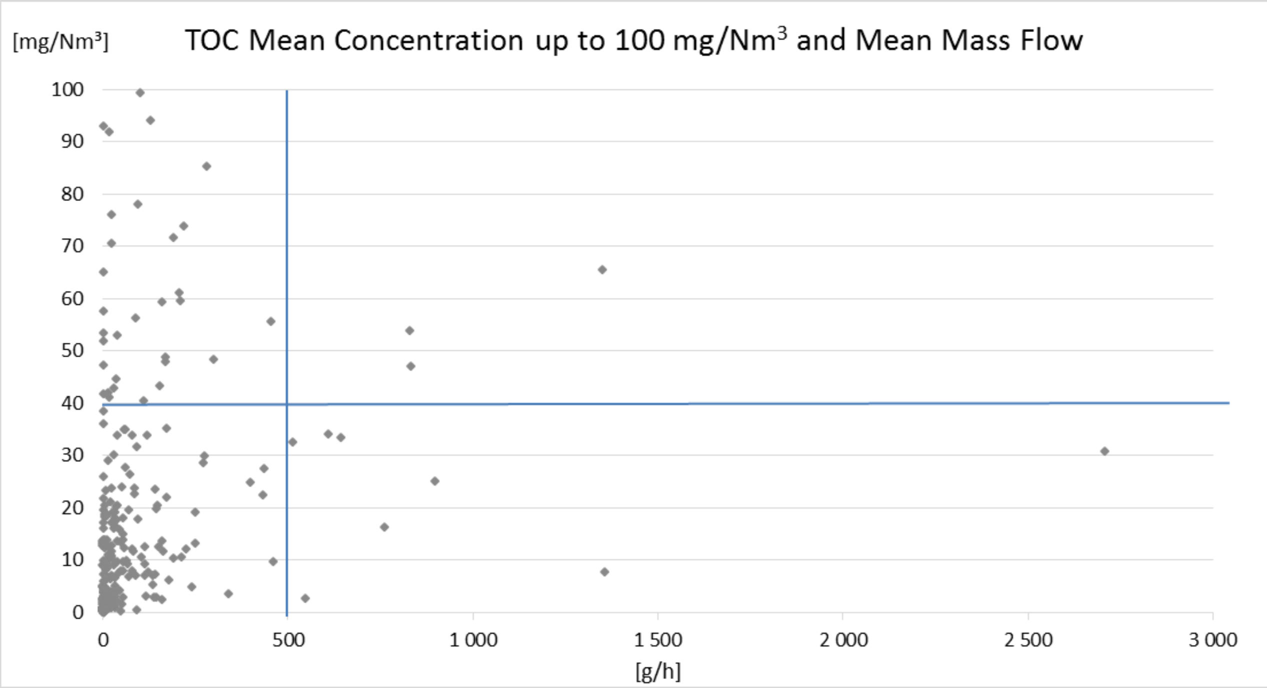
The five values where TOC concentrations above 40 mg/Nm³ were measured with mass flows above 500 g/h originate in four cases from slab stock or moulded polyurethane foam production (IED Annex 1 no. 4.1.h) where hydrocarbons (e.g. pentane) are used as blowing agents; in these cases, no waste gas abatement system is installed. One data set originates from the production of surface-active agents and surfactants (IED Annex 1 no. 4.1.k).

Figure 5: TOC mean concentration and mean mass flow



(Ökopol 2016)

Figure 6: TOC mean concentration up to 100 mg/Nm³ and mean mass flow



Note: Concentration values above 100 mg/Nm³ are cut off; all of these values but two have mass flows below 500 g/h (Ökopol 2016)

Thermal oxidation systems (TO) are used alone or in combination with fabric filters (FF), SCR, DeDiox systems (DD), quenches (Q) and/or scrubbers (S). Catalytic oxidation systems (COX) are used alone or in combination with condensers (C), fabric filters (FF), scrubbers (S) or sinter-plate filters (SP).

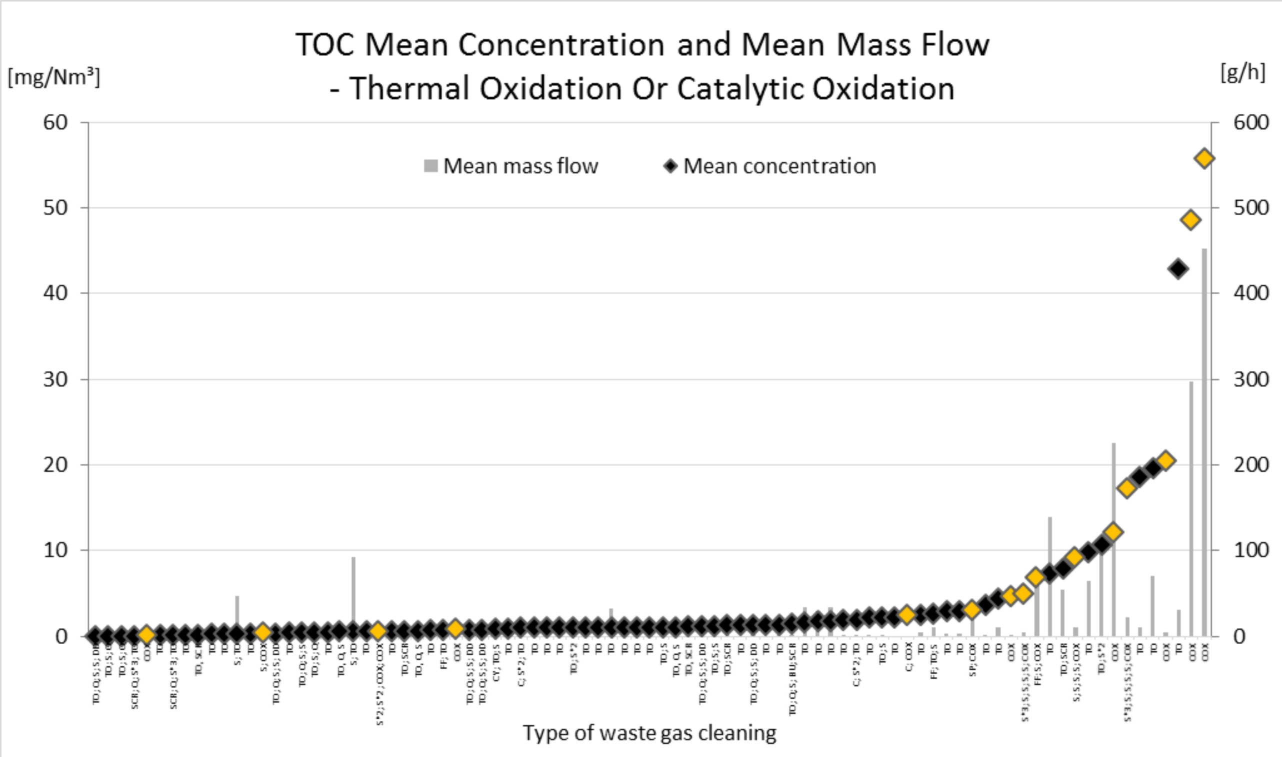
Thermal oxidation is generally associated with TOC concentrations below 5 mg/Nm³ (90 % of the data). Where 5 mg/Nm³ is exceeded, mass flows are generally below 150 g/h (79 % of data); in three cases, mass flows of 200 - 500 g/h were measured.

A high share of TOC emissions from sources with catalytic oxidation (orange rhombus) can rather be found at the upper end of the graph. Around 50 % of values with catalytic oxidation are below 5 mg/Nm³ and generally, emissions are below 20 mg/Nm³ (90 % of data).

About half of the data with thermal oxidation has waste gas volumes below 5 000 m³/h, the other half shows waste gas volumes between 5 000 - 35 000 m³/h, with two cases of 150 000 - 170 000 m³/h. About 60 % of emissions from catalytic oxidation systems have waste gas volumes below 5 000 m³/h, the others shows waste gas volumes between 5 000 - 20 000 m³/h.

Figure 7 shows TOC emission values from sources with thermal oxidation (dark rhombus, 72 data sets) or with catalytic oxidation systems (orange rhombus, 15 data sets). The type of waste gas treatment system is indicated below the values.

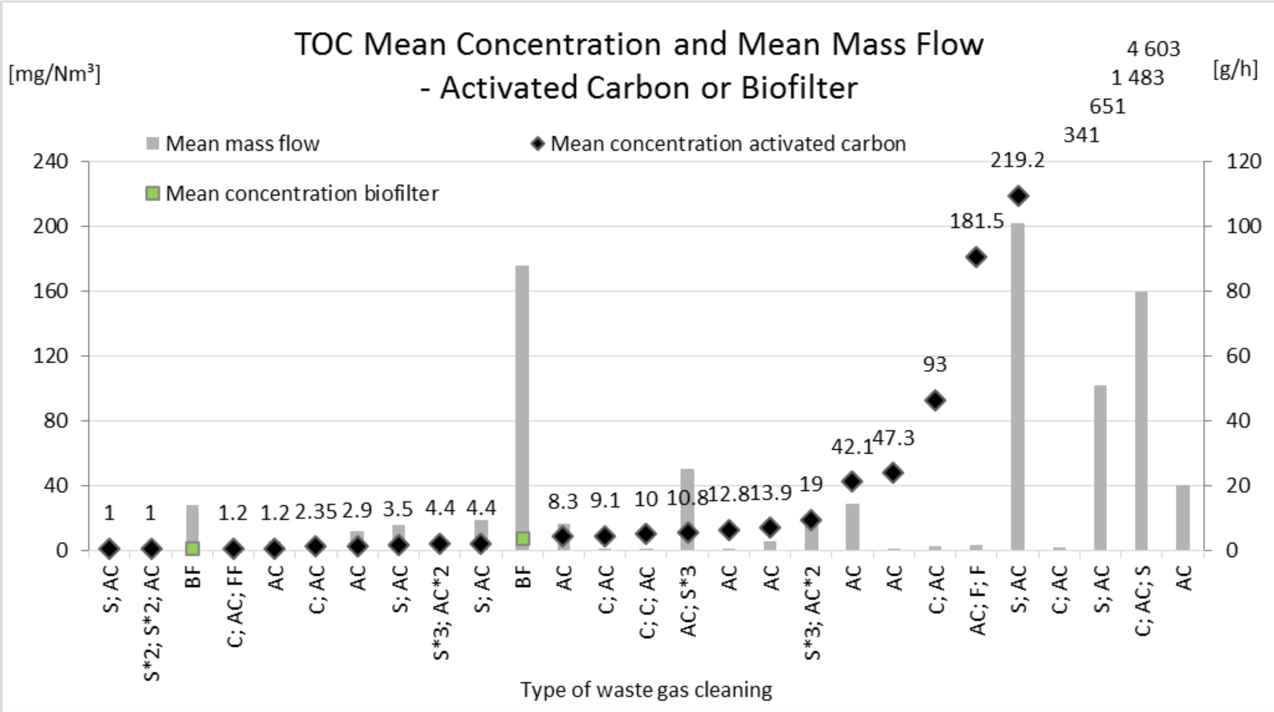
Figure 7: TOC concentrations and mass flow from thermal oxidation or catalytic oxidation



(Ökopol 2016)

Most activated carbon filter systems are associated with TOC emission values below 50 mg/Nm³ (74 % of data). Biofilter systems were measured with TOC concentrations of 1.1 and 7.2 mg/Nm³. Figure 8 shows emission values from activated carbon filters (dark rhombus) and biofilters (green square).

Figure 8: TOC concentrations and mass flow from activated carbon filters or biofilters

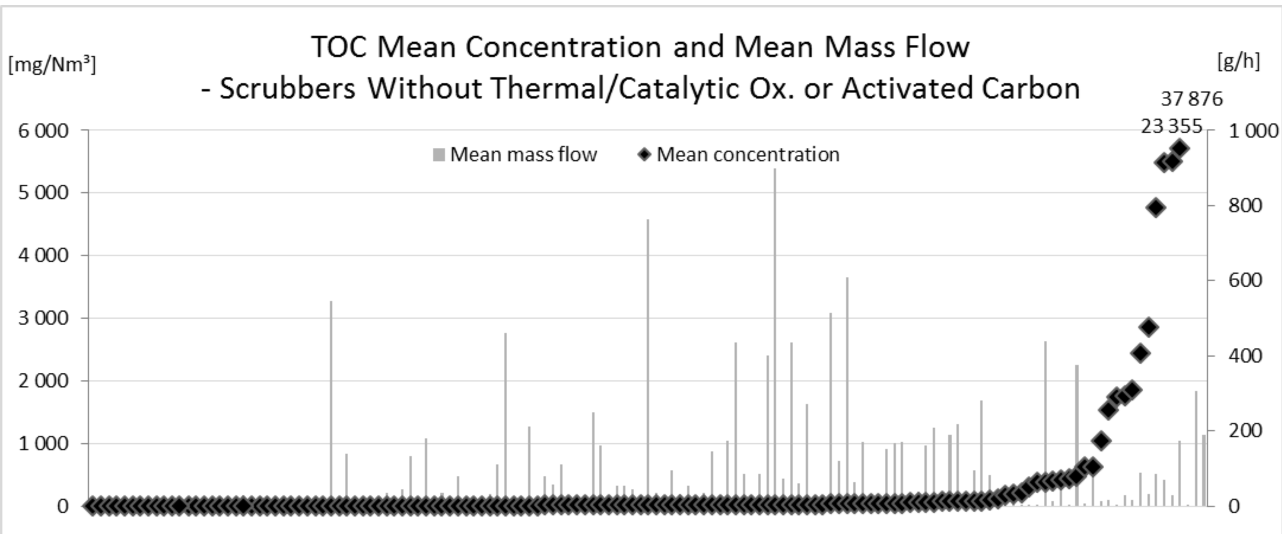


Note: Four concentration values with activated carbon are out of range but indicated in the graph.

(Ökopol 2016)

Scrubbers are generally associated with TOC concentrations below 40 mg/Nm³ (70 % of 141 data sets). Where emission concentrations are higher, the mass flow is below 500 g/h. Figure 9 shows TOC emissions from sources with scrubbers (where these are neither combined with thermal oxidation, catalytic oxidation nor activated carbon filters).

Figure 9: TOC concentrations and mass flow from scrubbers (without thermal/catalytic oxidation or activated carbon system)



Note: Two concentration values above 6 000 mg/Nm³ are out of range but indicated.

(Ökopol 2016)

TOC measurements from sources where no waste gas abatement system for organic compounds is installed (153 data sets) generally show concentrations below 40 mg/Nm³ (75 % of data). Where concentrations exceed 40 mg/Nm³, the mass flow is below 500 g/h and in most cases below 150 g/h (79 % of data). In four cases, where 40 mg/Nm³ and a mass flow of 500 g/h are exceeded, data originate from slab stock or moulded polyurethane foam production where hydrocarbons (e.g. pentane) are used as blowing agents. In one case where 40 mg/Nm³ and a mass flow of 500 g/h are exceeded, the data originates from the production of oxygen-containing hydrocarbons (IED no. 4.1. b).

In short, TOC data assessment shows that

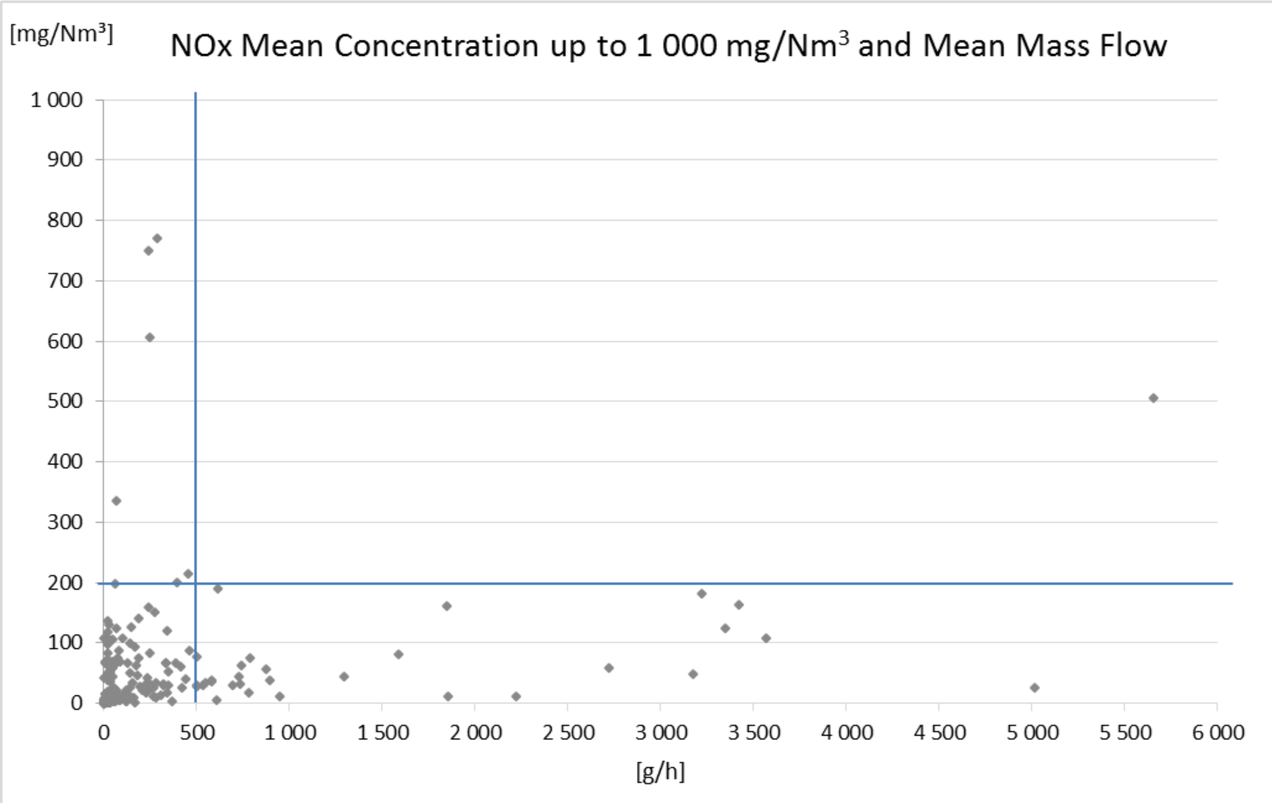
- No TOC-specific waste gas treatment is installed where mass flows are below 150 g/h;
- Where mass flows exceed 150 g/h, scrubber, thermal or catalytic oxidations or biofilters/ activated carbon filters are installed for TOC abatement.
- Biofilters or activated carbon filters are installed where waste gas volumes are below 3 000 m³/h; associated emission values are generally 50 mg/Nm³ (74 % of data).
- Thermal and catalytic oxidations are generally installed for waste gas volumes up to about 35 000 m³/h, with few exeptions where higher volumes are treated; usually scrubbers are installed for larger volumes.
- Emission values associated with thermal oxidation are generally below 5 mg/Nm³ (90 % of the data).
- Emission values associated with catalytic oxidation are partly below 5 mg/Nm³ (50 %) and generally below 20 mg/Nm³ (90 %).
- Emission values associated with scrubbers are partly below 20 mg/Nm³ (50 % of data) and generally below 40 mg/Nm³ (70 % of data).
- No statement can be made whether thermal or catalytic oxidation systems were installed to reduce CMR substances.
- TOC emissions of installations producing plastic materials (polymers, synthetic fibres and cellulose-based fibres) according to IED Annex 1 no. 4.1.h cannot be covered by the scope of the WGC BREF.
- TOC emissions from the production of surface-active agents and surfactants (IED Annex 1 no. 4.1.k respectively no. 4.11 of 4. BImSchV) may need specific consideration regarding inclusion in the scope.

Due to the different performances of thermal oxidation and other abatement systems, selection criteria for separate BAT should be defined, taking into account e.g. energy consumption and the toxicity of the emitted substances. An example of a decision tree with selection criteria is provided in the Reference Document on BAT for the Manufacture of Organic Fine Chemicals (OFC BREF 2006).

Nitrogen oxide (NOx) and carbon monoxide (CO) emissions – chapter 5

For NOx, 211 emission data sets have been assessed. Figure 10 shows that NOx concentrations are generally below 200 mg/Nm³ (96 % of data). Where 200 mg/Nm³ is exceeded, the waste gas emission is linked with a mass flow of less than 500 g/h, except one concentration with a mass flow of 5 654 g/h and 505 mg/Nm³, originating from a fertilizer production (IED Annex 1 no. 4.3).

Figure 10: NOx mean concentration and mean mass flow, reduced scale up to 1 000 mg/Nm³



Note: One concentration value with 1 827 mg/Nm³ and a mass flow of 4 g/h is out-of-scale.

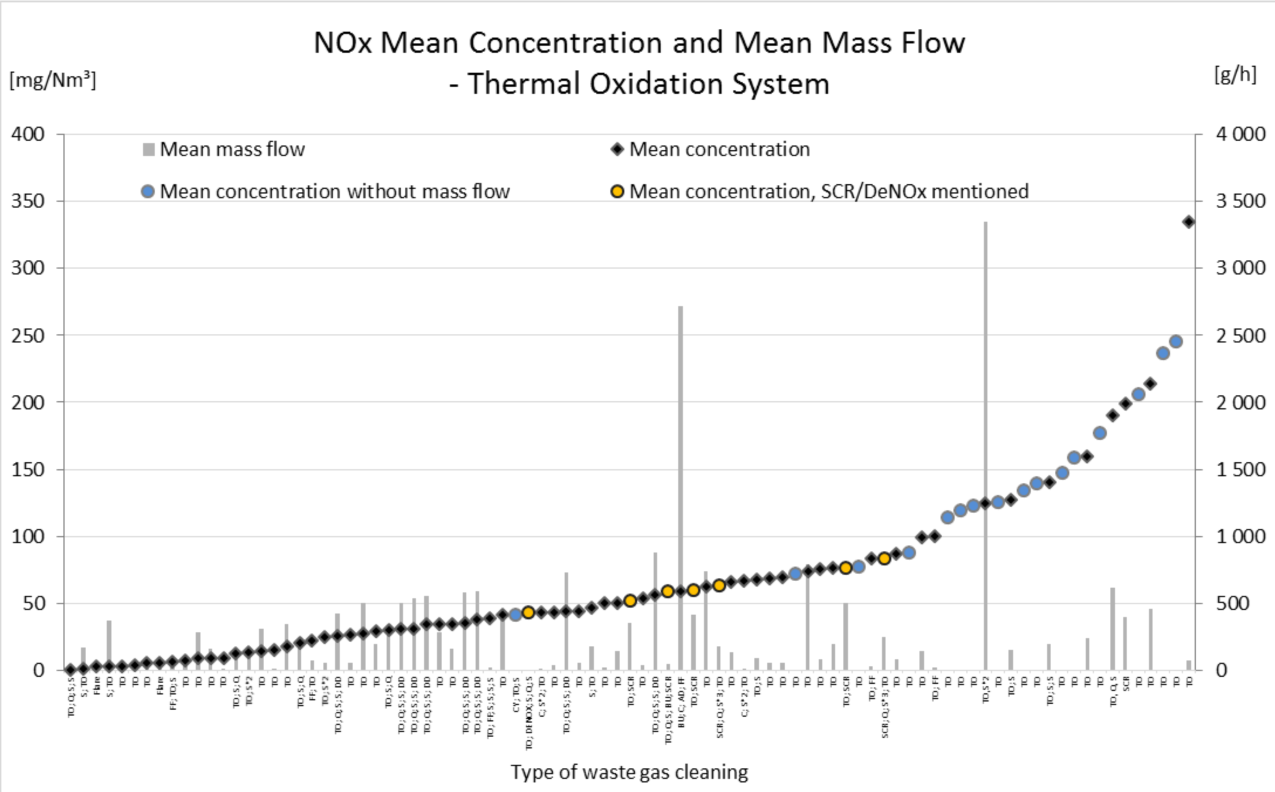
(Ökopol 2016)

Thermal oxidation systems are generally associated with NOx concentrations below 100 mg/Nm³ (76 % of the data). Where SCR systems are installed, associated NOx emissions values are generally below 80 mg/Nm³.

Where emission values are > 100 mg/Nm³, mass flows are generally below 0.5 kg/h (76 % of data). Highest NOx emissions were measured from production processes where nitrogen-containing products are produced.

Figure 11 shows NOx emissions from sources with thermal oxidation (black rhombus, 89 data sets). Where no mass flow was provided, concentrations are plotted as blue dot. Where information about a selective catalytic oxidation system was provided, concentrations are plotted as orange dots.

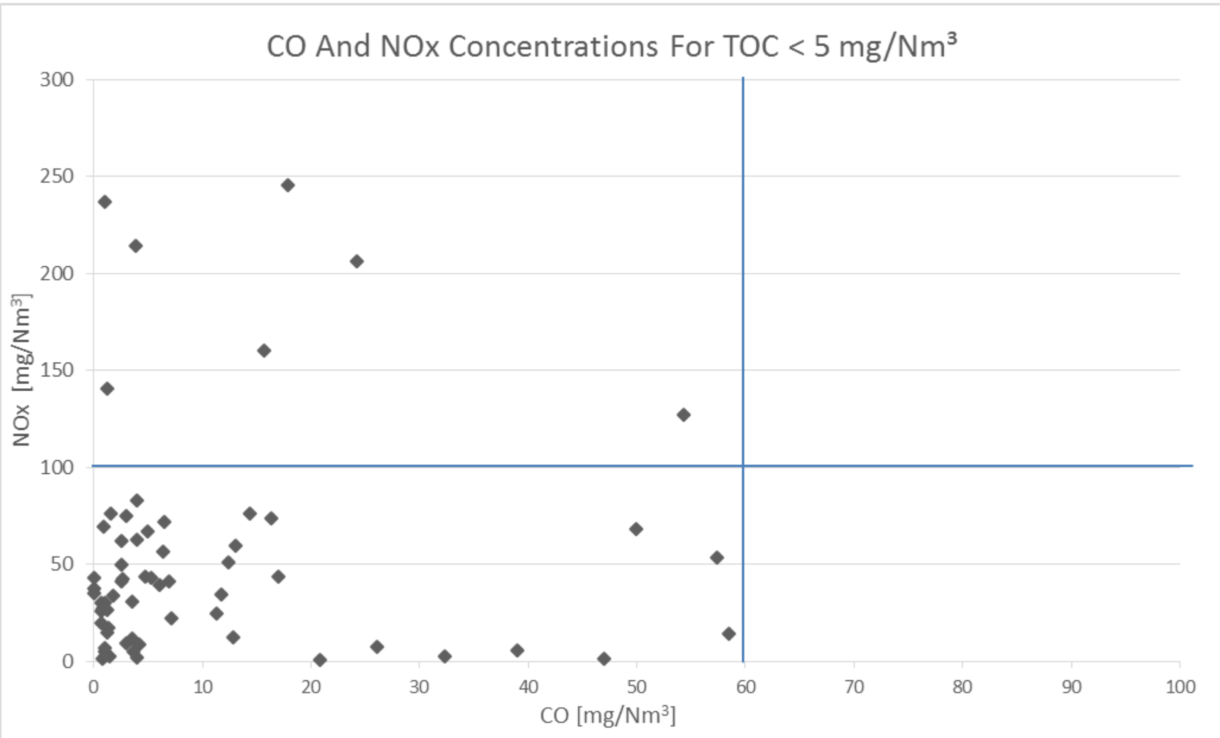
Figure 11: NOx mean concentration and mass flow associated with thermal oxidation



(Ökopol 2016)

Figure 12 shows NOx concentrations and related carbon monoxide (CO) concentrations from sources with thermal oxidation systems where TOC concentrations are below 5 mg/Nm³ (63 data sets).

Figure 12: NOx and CO mean concentrations from sources with TOC emissions below 5 mg/Nm³

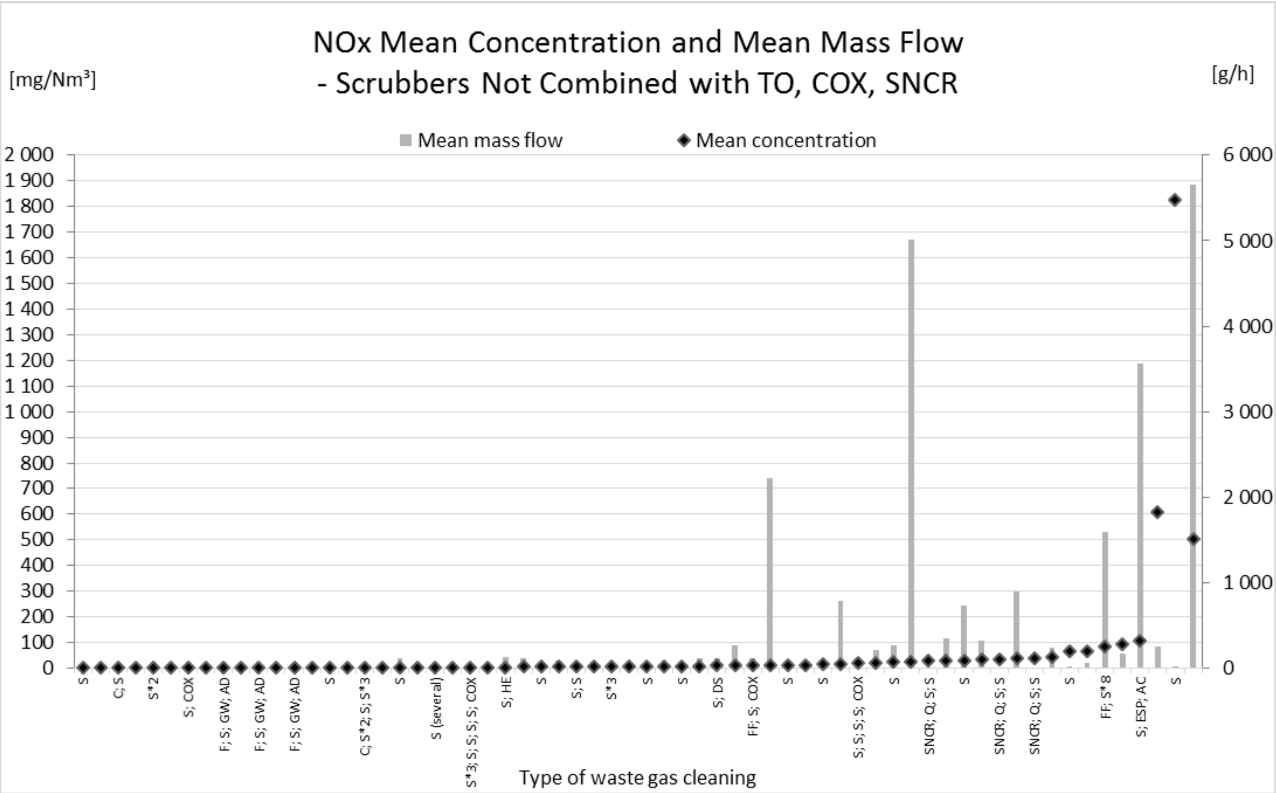


(Ökopol 2016)

Data of Figure 12 show that thermal oxidation systems optimized for all three parameters are generally associated with CO emissions below 60 mg/Nm³ (all data) and NOx emissions below 100 mg/Nm³ (89 % of the data). Where a few higher NOx emissions were measured, they do not exceed 250 mg/Nm³, while corresponding CO emissions were below 30 mg/Nm³.

Scrubbers (64 data sets) are generally associated with NOx emission values below 100 mg/Nm³ (93 % of the data). Where emission values are higher, NOx emission is associated with production processes for nitrogen-containing products. Figure 13 shows NOx emissions from sources with scrubbers, where these are not combined with thermal oxidation or catalytic oxidation systems.

Figure 13: NOx mean concentration and mass flow from scrubbers without thermal oxidation



(Ökopol 2016)

NOx emissions from sources where no thermal oxidation or scrubber is installed showed that concentrations are generally below 200 mg/Nm³ (97 % of the data). In the two cases where values emission were measured (750 - 770 mg/Nm³), the mass flow was below 300 g/h.

In short, NOx data assessment shows:

- Emissions values need seperate assessment for oxidation (incineration) processes generating NOx emissions and chemical processes where NOx emissions originate from the process;
- No NOx abatement systems are installed where mass flows are below 500 g/h;
- Where mass flows exceed 500 g/h, SCR, SNCR or scrubbers are installed for NOx abatement;
- Thermal or catalytic oxidations are generally installed for waste gas volumes up to about 35 000 m³/h;
- NOx emissions associated with thermal or catalytic oxidation are generally below 100 mg/Nm³ (76 % of the data); where SCR systems are installed, associated NOx emissions are generally below 80 mg/Nm³;
- Thermal or catalytic oxidation systems achieving TOC emissions below 5 mg/Nm³ are generally associated with NOx emissions below 100 mg/Nm³ and CO emission below 60 mg/Nm³.

- Scrubbers are generally associated with NOx emissions below 100 mg/Nm³.
- NOx emissions of installations producing nitrogen-based fertilisers according to IED Annex 1 no. 4.3 cannot be covered by the scope of the WGC BREF.
- NOx emissions from installations producing nitrogeous hydrocarbons (IED Annex 1 no. 4.1.d) need specific consideration for inclusion in the scope fo the WGC BREF.

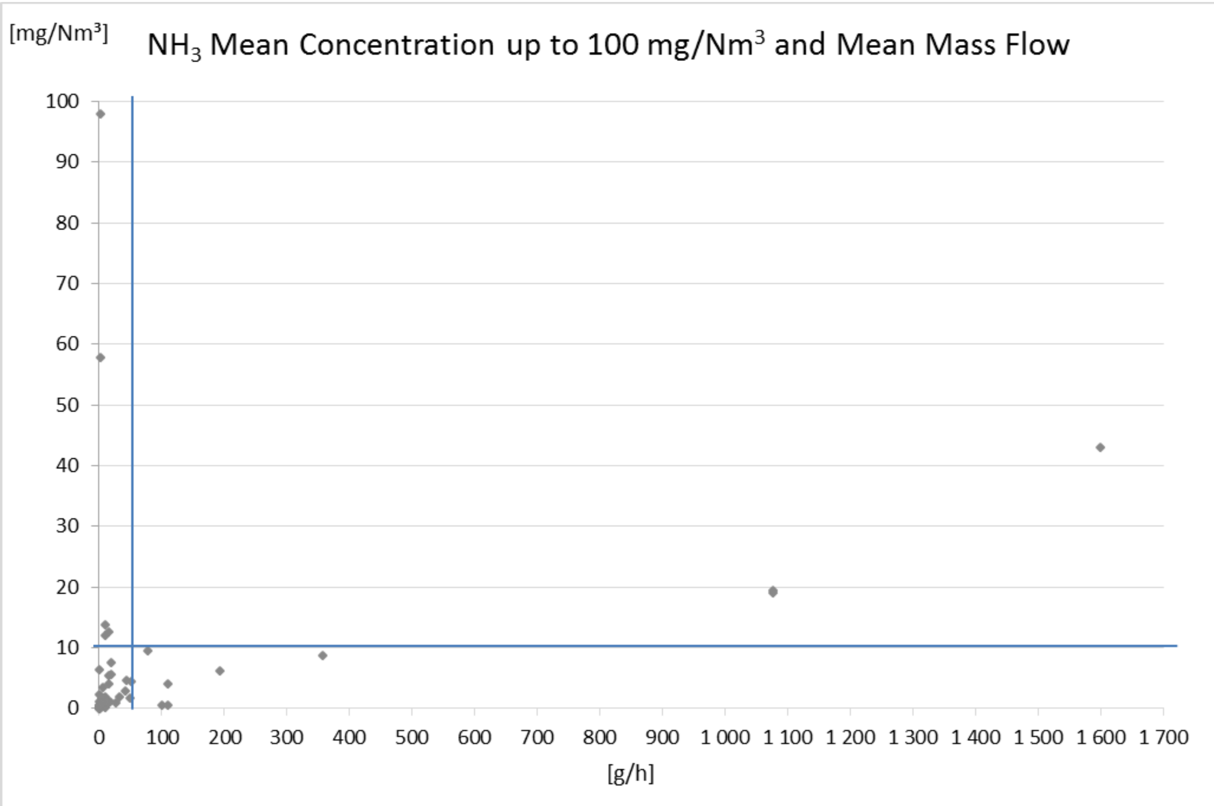
Ammonia (NH_3) emissions – chapter 6

For ammonia (NH_3), 80 emission data sets have been assessed. Figure 14 shows that NH_3 concentrations are generally below 10 mg/Nm³ (86 %).

Where concentrations are above 10 mg/Nm³, the majority of mass flows is below < 150 g/h.

Exceptions were three cases, where concentrations between 15 and 45 mg/Nm³ were measured with mass flows between 1 000 and 1 600 g/h. They originate from the production of plastics respectively PVC.

Figure 14: NH_3 mean concentration and mean mass flow

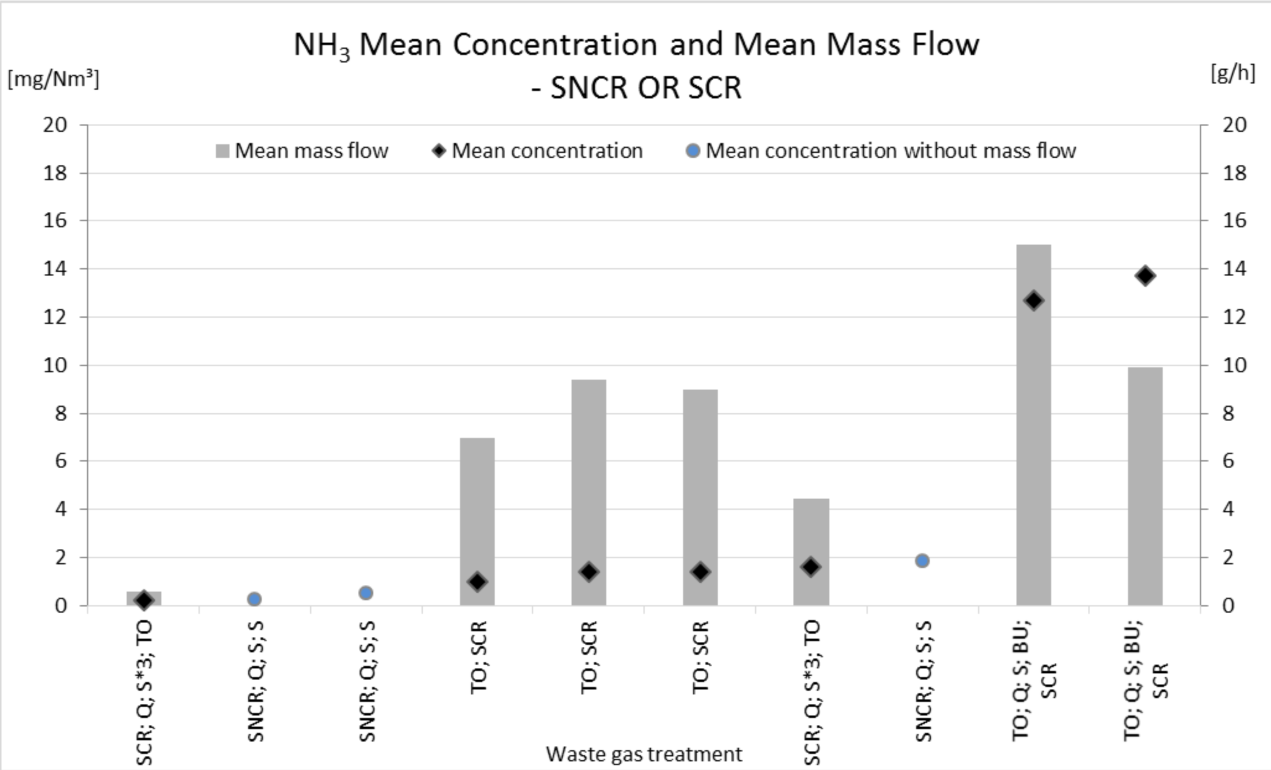


Note: Three values with concentrations of 163 - 682.34 mg/Nm³ and mass flows of 11 - 113.5 g/h are cut off.

(Ökopol 2016)

NH_3 emission concentrations associated with SNCR and SCR systems ("NH_3 slip") are generally below 3 mg/Nm³ (80 % of data). Figure 15 shows NH_3 concentrations from sources with SNCR or SCR.

Figure 15: NH_3 mean concentration and mass flow from sources with SNCR or SCR



(Ökopol 2016)

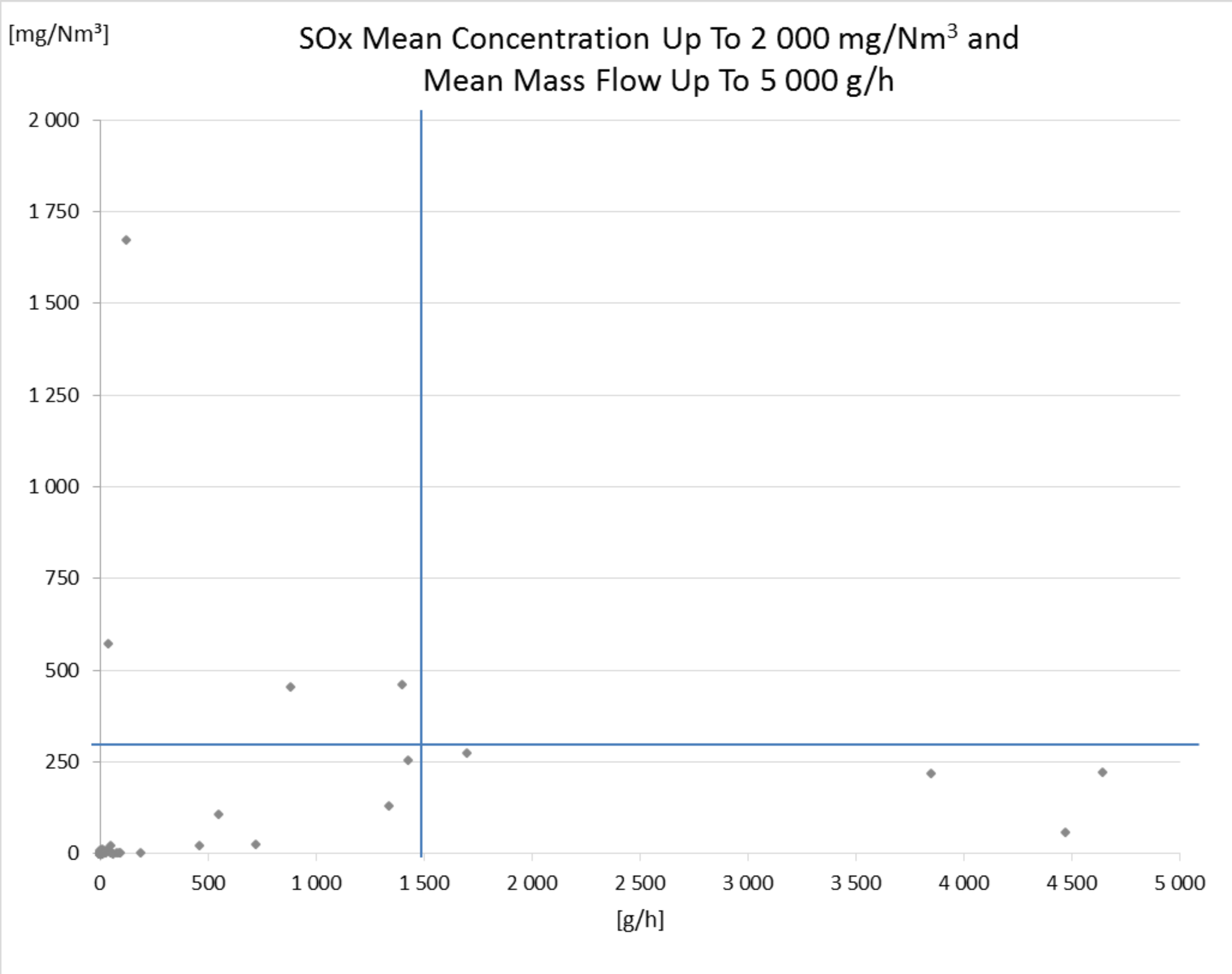
In short, NH_3 data assessment shows:

- NH_3 emissions originate either from chemical processes or from SCR/SNCR abatement systems (ammonia slip).
- No abatement system for NH_3 is installed where the mass flow is below 100 g/h.
- Where mass flows exceed 100 g/h, scrubbers are installed for NH_3 abatement.
- Scrubbers are generally associated with NH_3 emissions below 10 mg/Nm³.
- Emissions resulting from SCR/SNCR (ammonia slip) are mostly below 3 mg/Nm³.
- Emissions of NH_3 from installations for the production of PVC polymers (IED Annex 1 no. 4.1. h respectively no. 4.1.8 of 4. BImSchV) or from the production of fertilizers (IED Annex 1 no. 4.3 respectively no. 4.1.18 of 4. BImSchV) cannot be covered by the scope of the WGC BREF.
- Emissions from the production of flame retardands (no. 4.1 of 4. BImSchV) and the production of aromatic amino compounds (IED Annex 1 no. 4.1. d respectively no. 4.1.4 of 4. BImSchV) cannot be covered by the scope of the WGC BREF.

Sulphur dioxides (SOx) emissions – chapter 7

For sulphur dioxides (SOx), 92 emission data sets were assessed. Figure 16 shows that concentrations are generally below 25 mg/Nm³ (86 % of data sets). Where concentrations are higher than 300 mg/Nm³, mass flows do not exceed 1 500 g/h, except one measurement, which results from a sulphuric acid production.

Figure 16: SOx mean concentration and mean mass flow, reduced scale up to 2 000 mg/Nm³ and 5 000 g/h



Note: Two values with 26.546 g/h and 403.4 mg/Nm³ as well as a value with 63 g/h and 7 151.9 mg/Nm³ are cut off.

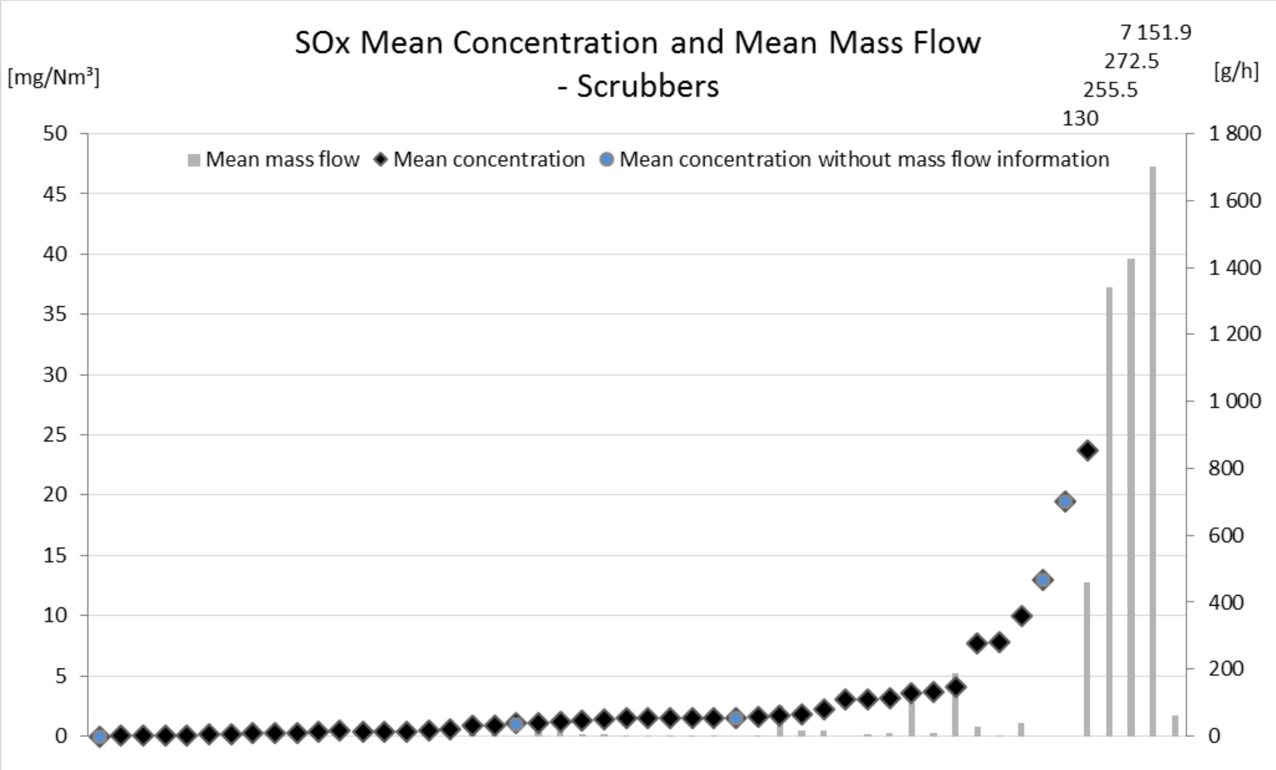
(Ökopol 2016)

Figure 17 shows that scrubbers are generally associated with SOx emission concentrations below 25 mg/Nm³ (92 % of the data). In four cases where concentration values are higher than 25 mg/Nm³, the mass flow is below 1 500 g/h, except for one data with a mass flow of 1 700 g/h.

Three data with highest mass flows between 1 340 and 1 700 g/h originate from the production of sodium hydrogen sulphate (no. 4.1 of 4. BImSchV) and from the production of cement additives (no. 4.1.8 of 4. BImSchV).

The highest concentration value of 7 151.9 mg/Nm³ (with a mass flow of 63 g/h) originates from the production of alcane sulphonates (no. 4.1.11 of 4. BImSchV).

Figure 17: SOx mean concentration and mass flow from scrubbers, reduced scale up to 50 mg/Nm³



Note: Four highest concentration values are out-of-range but indicated in the graph.

(Ökopol 2016)

SOx emission data from sources where no waste gas treatment for SOx is installed have either concentrations below 300 mg/Nm³ (88 % of data) or mass flows below 1 500 g/h, with one exception. That emission with a concentration of about 400 mg/Nm³ and a mass flows of about 26 500 g/h originates from the production of sulphuric acids (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV).

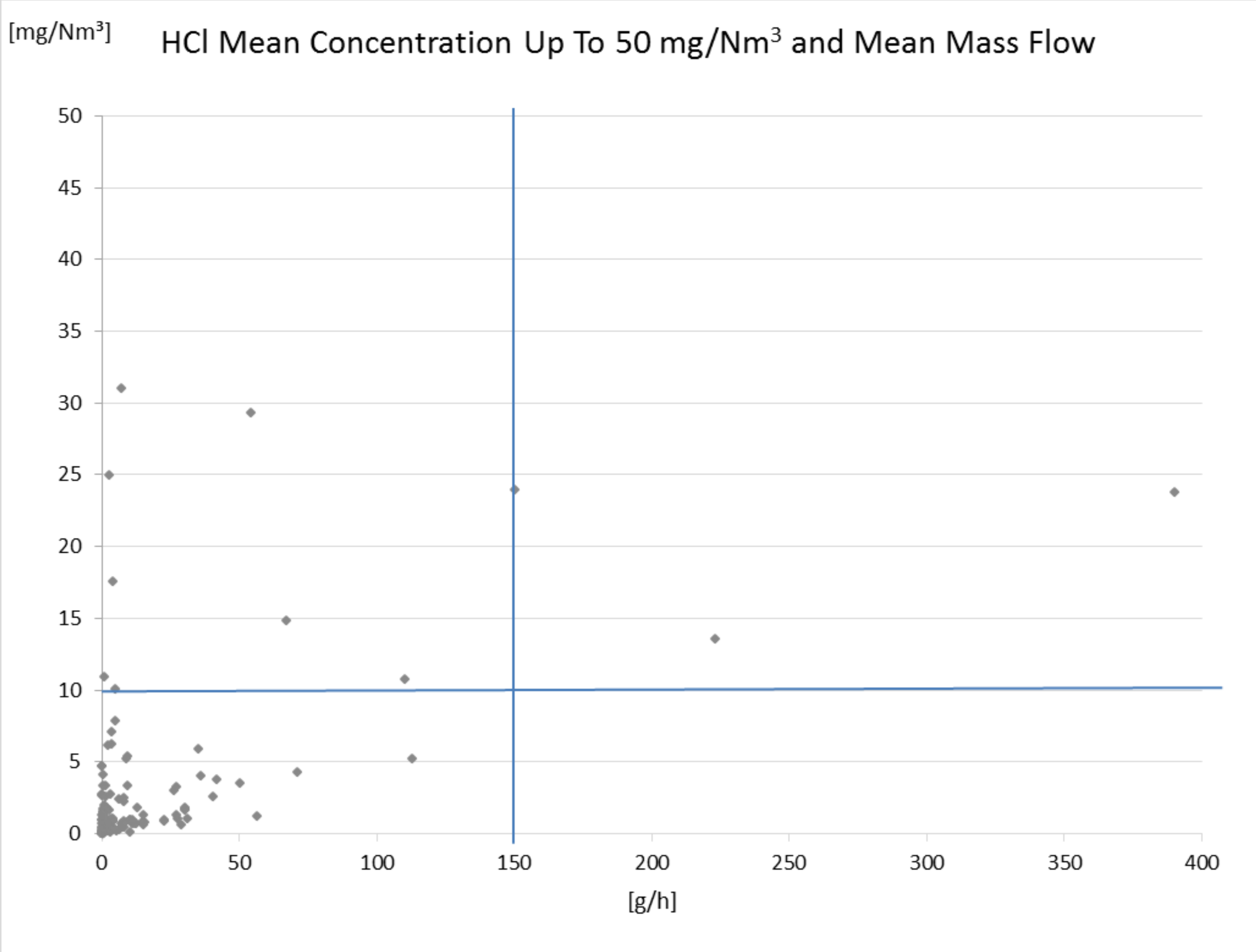
In short, SOx data assessment shows:

- Abatement of sulphur oxides emissions is either realized with scrubbers or with process-integrated techniques (e.g. in sulphuric acid production).
- No abatement system for SOx is installed where the mass flow is below 1 500 g/h.
- Scrubbers are generally associated with SOx emissions below 25 mg/Nm³.
- Emissions from the production of sulphuric acids (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV) cannot be covered by the scope of the WGC BREF.
- Emissions from the production of sodium hydrogen sulphate (4.1 of 4. BImSchV) and from the production of cement additives (4.1.8 of 4. BImSchV) need specific consideration for inclusion in the scope.

Hydrogen chloride (HCl) emissions – chapter 8

For hydrogen chloride (HCl), 177 emission data sets were assessed. Figure 18 shows that HCl concentrations are generally below 10 mg/Nm³ (93 % of data). If higher concentrations were measured, the mass flow was below 150 g/h, except two values. These had concenctrations between 10 - 25 mg/Nm³ and mass flows between 200 - 400 g/h.

Figure 18: HCl mean concentration and mean mass flow, reduced scale up to 50 mg/Nm^3



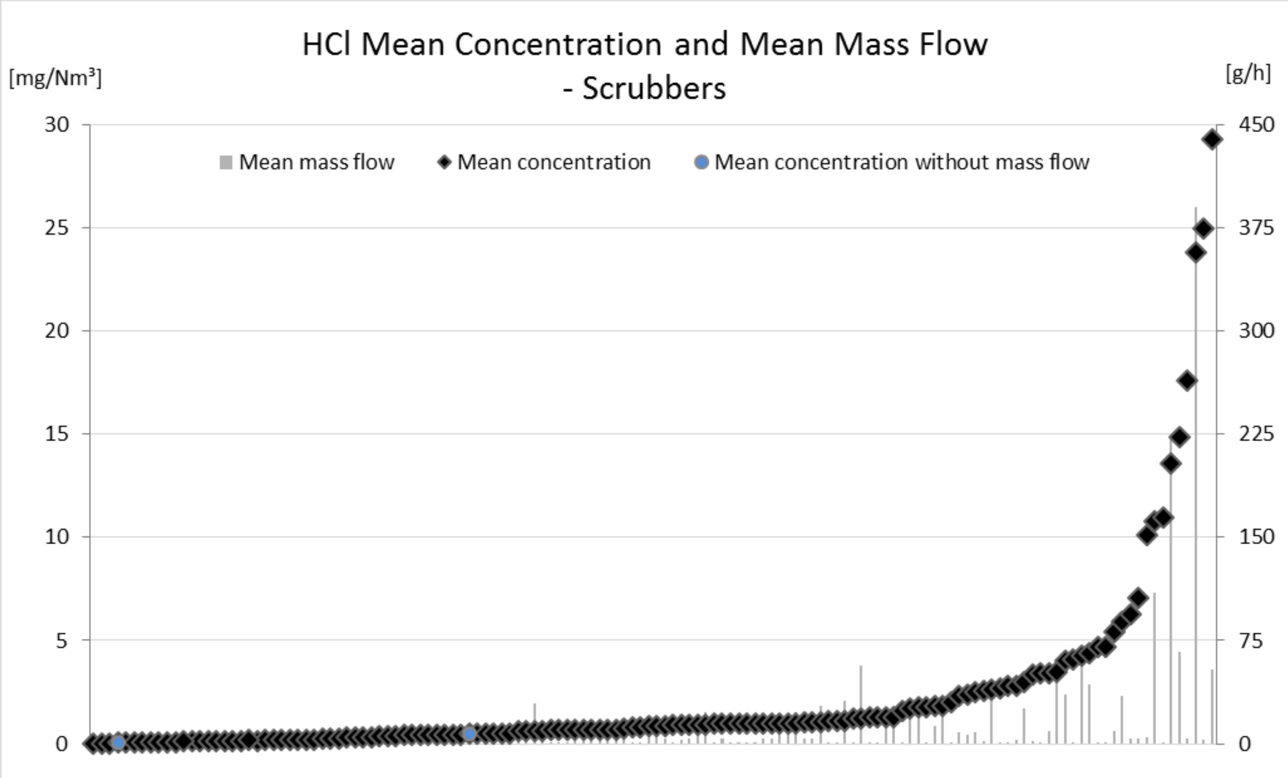
Note: One value with a concentration of 314 mg/Nm^3 and a mass flow of 73 g/h is out-of-scale.

(Ökopol 2016)

Scrubbers (139 data sets) are generally associated with HCl concentrations below 5 mg/Nm^3 (91 % of data). In cases where concentration values are higher, the mass flow is below 150 g/h, except two cases. The two cases showed concentrations between 10 - 25 mg/Nm^3 and mass flows between 200 - 400 g/h and originate from the production of sodium hydrogen sulphate and the production of halogenated hydrocarbons.

Figure 19 shows HCl emission data from sources with scrubbers.

Figure 19: HCl mean concentration and mass flow from scrubbers



(Ökopol 2016)

HCl emission data from sources where no treatment for HCl in waste gas is installed (no waste gas treatment or no scrubber) show that concentrations are generally below 10 mg/Nm³ and mass flows below 10 g/h (95 % of data). In two cases, mass flows between 70 - 150 g/h were measured, with concentrations between 20 - 320 mg/Nm³.

In short, HCl data assessment shows that

- ► in general no abatement system for HCl is installed where the mass flow is below 10 g/h and concentrations below 10 mg/Nm³.
- ► scrubbers are generally associated with HCl emissions below 5 mg/Nm³;
- ► emissions from the production of the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e) may need a specific assessment to be covered by the scope of the WGC BREF as well as emissions from the production of Grignard reagents (IED Annex 1 no. 4.1.g).

Hydrogen fluoride (HF) and hydrogen bromide (HBr) emissions – chapters 9 and 10

For hydrogen fluoride (HF), 41 emission data sets were assessed, for hydrogen bromide 9 data sets. Concentrations are generally below 1 mg/Nm³ (93 % of HF data, all HBr data). Where concentrations in case of HF are higher, the mass flows does not exceed 3 g/h.

Chlorine (Cl_2) emissions – chapter 11

For chlorine (Cl_2), 41 emission data sets were assessed. Concentrations are generally below 3 mg/Nm³ (93 % of data). Where concentrations are higher than 3 mg/Nm³, mass flows do not exceed 5 g/h.

Methanol (CH_4O) emissions – chapter 12

For methanol (CH_4O), 80 emission data sets were assessed. Concentrations are generally ≤ 20 mg/Nm³ (83 % of data). Where concentrations are higher than 20 mg/Nm³, mass flows do not exceed 30 g/h.

Data show that thermal oxidation or activated carbon filters are generally associated with methanol emission concentrations below 5 mg/Nm³ (75 % of the data). Scrubbers or condensers are generally associated with methanol emission concentrations below 20 mg/Nm³ (81 % of the data). Where 20 mg/Nm³ are exceeded, emissions have generally mass flows below 10 g/h. This is also the case where no treatment for organic compounds is installed: concentrations are generally below 20 mg/Nm³ or mass flows below 10 g/h.

Acetic acid ($C_2H_4O_2$) emissions – chapter 13

For acetic acid ($C_2H_4O_2$), 44 emission data sets were assessed. Concentrations are generally equal or below 20 mg/Nm³ (80 % of data). Where concentrations are higher than 20 mg/Nm³, mass flows are below 150 g/h.

Thermal oxidation and activated carbon filters are associated with concentrations below 5 mg/Nm³ (83 % of the data). Scrubbers are generally associated with acetic acid emission concentrations below 30 mg/Nm³ (90 % of the data).

CMR substances emissions – chapters 14 to 23

Formaldehyde concentrations are generally below 5 mg/Nm³ (79 % of 34 data). Where concentrations are above 5 mg/Nm³, the mass flows is equal or below 1 g/h in three cases and between 12 - 110 g/h in four cases. Thermal oxidation, catalytic oxidation or activated carbon filters are mostly associated with concentrations below 1 mg/Nm³ (67 % of data).

Ethylene oxide concentrations are generally below 0.2 mg/Nm³ (90 % of 31 data). Where concentrations are higher than 0.2 mg/Nm³, mass flows do not exceed 0.5 g/h.

PCDD/F concentrations are generally < 0.025 ng/Nm³ (83 % of 30 data).

Toluene (not CMR but suspected to be) concentrations are generally below 20 mg/Nm³ (85 % of 26 data); thermal oxidation and activated carbon filters are associated with concentrations below 5 mg/Nm³. Where higher concentration values than 20 mg/Nm³ were measured, the mass flow is below 80 g/h. No abatement is linked with mass flows < 2 g/h.

Propylene oxide concentrations are all below 0.25 mg/Nm³ (24 data). No abatement is linked with mass flows below 2.5 g/h.

Benzene concentrations are generally below 0.5 mg/Nm³ (83 % of 18 data). Where higher concentration values were measured, the mass flow was below 2 g/h. No abatement is linked with mass flows below 1 g/h.

Phenol concentrations are all equal or below 1 mg/Nm³ (7 data sets). No abatement is linked in one case with a mass flow below 1 g/h.

Toluene diisocyanate concentrations are all below 0.25 mg/Nm³ (18 data); mass flows are ≤ 10 g/h.

Vinyl chloride concentrations are all below 0.3 mg/Nm³ (11 data); mass flows are below 3 g/h.

Benzyl chloride (1 data set) and **epichlorohydrin** (2 data) treated with scrubbers are associated with concentrations below 2 mg/Nm³. Where concentration exceeds 1 mg/Nm³, the related mass flow is < 2.5 g/h.

Dichloroethane (10 data sets) and **benzyl chloride** (2 data) treated with thermal oxidation are associated with concentrations below 1 mg/Nm³.

Non-CMR halogenated organic compound emissions – chapter 24

For non-CMR halogenated organic compounds, 47 emission data sets were assessed. Thermal oxidation, catalytic oxidation or activated carbon filters are generally associated with concentrations below 5 mg/Nm^3 (78 % of data). Where concentrations are above 5 mg/Nm^3, a mass flow of 100 g/h is not exceeded. Scrubbers are generally associated with concentrations below 20 mg/Nm^3 (95 % of data). Where 20 mg/Nm^3 is exceeded, one value was measured with 104 mg/Nm^3 and a mass flow of 3.7 g/h.

More harmful organic compound emissions – chapter 25

For more harmful organic compounds (listed in Annex 1 of the report), 49 emission data sets were assessed. Thermal oxidation and catalytic oxidation are all associated with concentrations below 5 mg/Nm^3 (18 data sets). Scrubbers are generally associated with concentrations below 10 mg/Nm^3 (90 % of 31 data sets). Where concentrations are above 10 mg/Nm^3, a mass flow of 100 g/h is not exceeded. Where no treatment for organic compounds is installed, concentrations are below 10 mg/Nm^3 or the mass flow is below 30 g/h.

Metal emissions – chapter 26

Mercury concentrations are generally below 15 µg/Nm^3 (73 % of 11 data sets). Where concentrations are higher, emissions have mass flows below 0.25 g/h.

Cobalt, lead, nickel, selenium and telluric concentrations, reported individually or (where several of the metals occur) reported as sum are generally below 0.01 mg/Nm^3 (67 % of 42 data sets). Where concentrations are higher, a mass flow of 0.5 g/h is not exceeded.

Antimony, chromium, copper, manganese, tin and vanadium concentrations are generally below 0.5 mg/Nm^3 (84 % of 49 data sets). Where concentrations are higher, a mass flow of 1.0 g/h is not exceeded.

Zusammenfassung

Die Industrieemissions-Richtlinie der Europäischen Union (2010/75/EU) verlangt für besonders umweltrelevante Industriebranchen einen europaweiten Informationsaustausch („Sevilla-Prozess“) zur Festsetzung von besten verfügbaren Techniken (BVT) in „BVT-Merkblättern“. Die Schlussfolgerungen der BVT-Merkblätter werden von Vertretern der EU-Kommission, der Mitgliedstaaten sowie der Industrie- und Umweltverbände festgelegt und im EU-Amtsblatt in allen offiziellen EU-Sprachen veröffentlicht. Die BVT-Merkblätter (engl. „BREFs“) setzen europaweit Maßstäbe zur Vermeidung und Verminderung von Emissionen sowie zur energieeffizienten und nachhaltigen Produktion; BVT-Merkblättern und BVT-Schlussfolgerungen wird auch weltweit Beachtung geschenkt.

Die BVT-Merkblätter enthalten Richtwerte für Konzentrations- oder Frachtbegrenzungen. Bei umweltrelevanten Anlagen, die von der Industrieemissions-Richtlinie betroffen sind, müssen die EU-Mitgliedstaaten in der Genehmigung und Überwachung sicherstellen, dass die Emissionswerte nicht die in den BVT-Schlussfolgerungen genannten, mit BVT assoziierten Werte überschreiten.

Ziel ist die Schaffung europaweit harmonisierter Genehmigungsgrundlagen auf der Basis der BVT-Schlussfolgerungen. Damit soll in den EU-Mitgliedstaaten eine Annäherung der Umweltschutzstandards auf hohem Niveau erreicht werden. Deutschland beteiligt sich intensiv am Informationsaustausch, um die Verbreitung der eigenen hohen Umweltschutzstandards zu fördern.

Die Europäische Kommission hat im September 2016 einen Informationsaustausch mit den Mitgliedstaaten sowie den Industrie- und Umweltverbänden über die besten verfügbaren Techniken zur Abgasbehandlung in der chemischen Industrie begonnen. Ziel des Informationsaustausches ist die Erarbeitung eines prozessübergreifenden BVT-Merkblattes zur Abgasbehandlung in der chemischen Industrie, auf Englisch „BREF on Common Waste Gas Treatment in the Chemical Sector“ (WGC BREF).

Das Umweltbundesamt leistet mit dem hier dokumentierten Forschungsvorhaben in diesem Bereich einen fundierten Beitrag. Ziel des Projektes ist es, luftseitige Emissionswerte aus Anlagen der chemischen Industrie in Deutschland zu ermitteln und zu bewerten.

Der vorliegende Endbericht beschreibt die Ergebnisse des Forschungsvorhabens. Der Bericht analysiert 2972 Messberichte von 1209 Emissionsquellen der chemischen Industrie in Deutschland. Die Daten stammen aus 550 ausgewerteten Messberichten (etwa jede vierte der rund 2000 Anlagen der chemischen Industrie in Deutschland, siehe Anhang 55). Die meisten Messungen wurden in den Jahren 2012 bis 2015 durchgeführt. Die Messberichte wurden von den zuständigen Überwachungsbehörden und mehreren Betrieben übermittelt. Der Projektschwerpunkt lag auf Messberichten von wiederkehrenden Kurzzeitmessungen, da diese Berichte Informationen zum Kontext der Messung enthalten, wie zum Abgasreinigungssystem, dem Prozess und teilweise zu den eingesetzten Stoffen. Kontinuierliche Messungen wurden im Rahmen des Projektes nicht betrachtet.

Die Auswertung basiert auf normierten Mittelwerten (trockenes Abgas, 1013 hPa, 273 K), die in den meisten Fällen aus drei dreißig minütigen Einzelmessungen gemittelt wurden, die aufeinander folgend am selben Tag unter normalen Betriebsbedingungen bei Zustand der größten Emission ausgeführt wurden. Die Messunsicherheit wurde bei den ausgewerteten Daten weder zugezählt noch abgezogen.

Wenn in den Messergebnissen andere als normale Betriebsbedingungen berichtet wurden, wurden die Ergebnisse von der Auswertung ausgeschlossen. Außergewöhnliche Betriebszustände während der Messungen waren z.B. Störungen des Abgasreinigungssystems oder Fehlfunktionen der Messgeräte. Messwerte, die nicht die Genehmigungswerte einhielten wurden den außergewöhnlichen Betriebsbedingungen zugeordnet und von der Datenauswertung ausgeschlossen.

Die Auswertung für jeden Parameter beginnt mit einer Grafik, die die mittleren Konzentrationswerte und mittleren Massenströme aufzeigt. Die Grafik gibt einen Überblick über das allgemeine Emissionsniveau einschließlich der Ausreißer. Die nachfolgenden Grafiken zeigen jeweils Daten in Verbindung mit einem speziellen Abgasreinigungssystem. Üblicherweise lässt sich in jeder Grafik ein spezifisches Emissionsniveau ablesen, das in den meisten Fällen erreicht wird, ausgenommen von Ausreißern und kleinen Mengenströmen. In den meisten Grafiken weisen kleine Mengenströme hohe Konzentrationswerte auf.

Der Anteil der Daten mit einem geringen Massenstrom und hohen Konzentrationswerten ist bei den Parametern unterschiedlich groß. Beispielsweise gibt es bei allen Staubwerten geringe Konzentrationswerte mit wenigen Ausnahmen während bei den Werten für organische Verbindungen (Gesamt C) ein wesentlich größerer Anteil der Daten hohe Konzentrationswerte mit geringem Massenstrom auf; diese Werte resultieren z.B. aus der Messung von Lagertank-Lüftungen oder aus der Messung von Verdrängungsluft beim Befüllen von Reaktionsbehältern.

Das Projekt ermittelte folgende wesentliche Umweltindikatoren für die chemische Industrie, da sie bei Anwendung von besten verfügbaren Techniken ein europaweites Minderungspotenzial aufweisen:

Tabelle 5: Wesentliche Umweltindikatoren der chemischen Industrie

Charakter	Parameter
Summenparameter	Staub, TOC, NOx, SOx, PCDD/F, sonstige CMR-Stoffe, halogenierte nicht als CMR-eingestufte Stoffe, besonders schädliche organische Stoffe, Metalle (drei Klassen)
Einzelsubstanzen	Chlorwasserstoff, Ammoniak, Methanol, Essigsäure, Ethylenoxid, Formaldehyd, Fluorwasserstoff, Bromwasserstoff, Chlor, Chlormethan, Propylenoxid, Toluol, Benzol, Vinylchlorid, Phenol, Dichlorethan

Die Auswertung zeigte, dass Konzentrationswerte stets zusammen mit dem Massenstrom betrachtet werden sollten. Erhöhte Konzentrationen können niedrige Umweltauswirkungen haben, wenn sie mit geringen Abgasvolumina verbunden sind und somit nur geringe Massenströme verursachen. Bei der Festlegung von maximalen Massenströmen als Alternative zu maximalen Konzentrationswerten müssen jedoch der Arbeitsschutz und der Schutz der Nachbarschaft mit berücksichtigt werden.

Im Folgenden werden die wesentlichen Ergebnisse der Datenauswertung dargstellt. Zu jedem Parameter und jedem Datensatz enthält der Bericht zusätzliche, detaillierte Informationen (Kategorie der Chemieanlage, Art der Abgasreinigung, Messmethode sowie Ergebnisse hinsichtlich Konzentrationwerten und Massenstrom).

Der Endberichtentwurf wurde auf einem Fachgespräch präsentiert, auf dem die interessierten Kreise die Ergebnisse diskutierten. Die Stakeholder-Kommentare wurden mit dem UBA besprochen und im Endbericht berücksichtigt. Der Endbericht dient als Beitrag Deutschlands im Informationsaustausch der Europäischen Union zur Festlegung von besten verfügbaren Techniken (BVT) und mit ihnen verbundenen Emissionsbandbreiten für die allgemeine Abgasreinigung in der chemischen Industrie.

Empfehlungen für die Erstellung des BVT-Merkblattes zur Abgasreinigung in der chemischen Industrie (WGC BREF)

Der Bericht zeigt, dass die folgenden prioritären Schadstoffe wesentliche Umweltthemen der chemischen Industrie sind (Englisch: „Key Environmental Issues“ – KEI):

- Staub (aus chemischen Prozessen und Verbrennungsprozessen)
- Gesamt-C (aus chemischen Prozessen und Verbrennungsprozessen; bei letzteren ist die Berücksichtigung der damit verbundenen Gesamt-C und CO-Emissionen notwendig);
- NOx (aus chemischen Prozessen und Verbrennungsprozessen; bei letzteren ist die Berücksichtigung der damit verbundenen Gesamt-C und CO-Emissionen notwendig)
- NH_3 (aus chemischen Prozessen und Verbrennungsprozessen, wenn SCR oder SNCR eingesetzt wird)

- SOx (aus chemischen Prozessen und Verbrennungsprozessen bei schwefelhaltigen Brennstoffen)
- Halogene und ihre Verbindungen (aus chemischen Prozessen und aus der Verbrennung bestimmter Brennstoffe)
- CMR-Substanzen (Formaldehyd, Ethylenoxid, PCDD/F, Toluol, Benzol, Phenol, Toluoldiisocyanat, 1,2-Dichlorethan, Benzolchlorid, Epichlorhydrin)
- Nicht als CMR eingestufte organische Substanzen, e.g. Methanol, Essigsäure (aus chemischen Prozessen)
- Metalle (aus chemischen Prozessen)

Die Datenauswertung zeigt, dass die Definition von BATAEL als Konzentrationsmittelwerte [mg/Nm^3] in Verbindung mit Massenstrom-Schwellenwerten erfolgen sollte, ausgedrückt in Gramm pro Stunde [g/h]. Für jeden Parameter sollten sich diese Massenstrom-Schwellenwerte auf die gesamte Anlage beziehen, damit eine Erhöhung der Emissionen durch eine Erhöhung der Anzahl der Punktquellen vermieden wird.

Es wird empfohlen, mit BVT verbundene Emissionswerte nicht nur für Summenparameter sondern auch für Einzelstoffe festzulegen, wenn Stoffe wegen der Gefährdungseinstufung und/oder wegen des Einsatzes großer Mengen in der Branche von Bedeutung sind, wie z.B. Formaldehyd, Toluol, Methanol.

Im Laufe der Datenauswertung wurden für mehrere Parameter Ausreißer identifiziert (außergewöhnlich hohe Konzentrationsmittelwerte oder Massenstromwerte). Diese Daten stammen regelmäßig aus bestimmten Prozessen der chemischen Industrie, wie der Herstellung von Polymeren (IED Anhang 2 Nr. 4.1.h) und der Herstellung von anorganischen Grundchemikalien, insbesondere Säuren (IED Anhang 4.2.b) und von Düngemitteln (IED Anhang 1 Nr. 4.3). Für weitere auffällige Werte siehe Kapitel 2.7 (S. 78) sowie die Analysen in den Kapiteln, in denen einzelne Schadstoffe analysiert werden.

Im künftigen BVT-Merkblatt für die Abgasbehandlung in der chemischen Industrie (WGC BREF) können Emissionen aus diesen Prozessen nicht in den Geltungsbereich der allgemeingültigen mit BVT verbundenen Emissionswerte (BATAEL) einbezogen werden. Diese Prozesse benötigen die Erarbeitung sektorspezifischer mit BVT verbundener Emissionswerte.

Basierend auf der Auswertung der Gesamt-C-Emissionen wird empfohlen, ein System zur Auswahl einer geeigneten Abgasbehandlung zu definieren, das durch einen technikbezogenen BATAEL beeinflusst wird und einerseits für ein thermisches Oxidationssystem und andererseits für sonstige Abgasreinigungstechniken gilt. Das Auswahlsystem sollte den Energieverbrauch der Abgasreinigung und die Gefährlichkeit der emittierten Substanzen berücksichtigen. Ein Beispiel für einen solchen Entscheidungsbaum mit Auswahlkriterien für Gesamt-C-Emissionen aus der Herstellung von organischen Feinchemikalien wird in Kapitel 4.8 auf Seite 95 gezeigt.

Für mehrere Parameter zeigt die Datenauswertung Beispiele für Massenströme, bei denen eine Abgasreinigung nicht für notwendig gehalten wurde. Die folgende Tabelle zeigt Ergebnisse für mehrere Massenstromschwellenwerte. Dabei ist zu berücksichtigen, dass diese Werte stets zusammen mit einer Beurteilung des ausreichenden Schutzes der Nachbarschaft der Anlage betrachtet werden müssen.

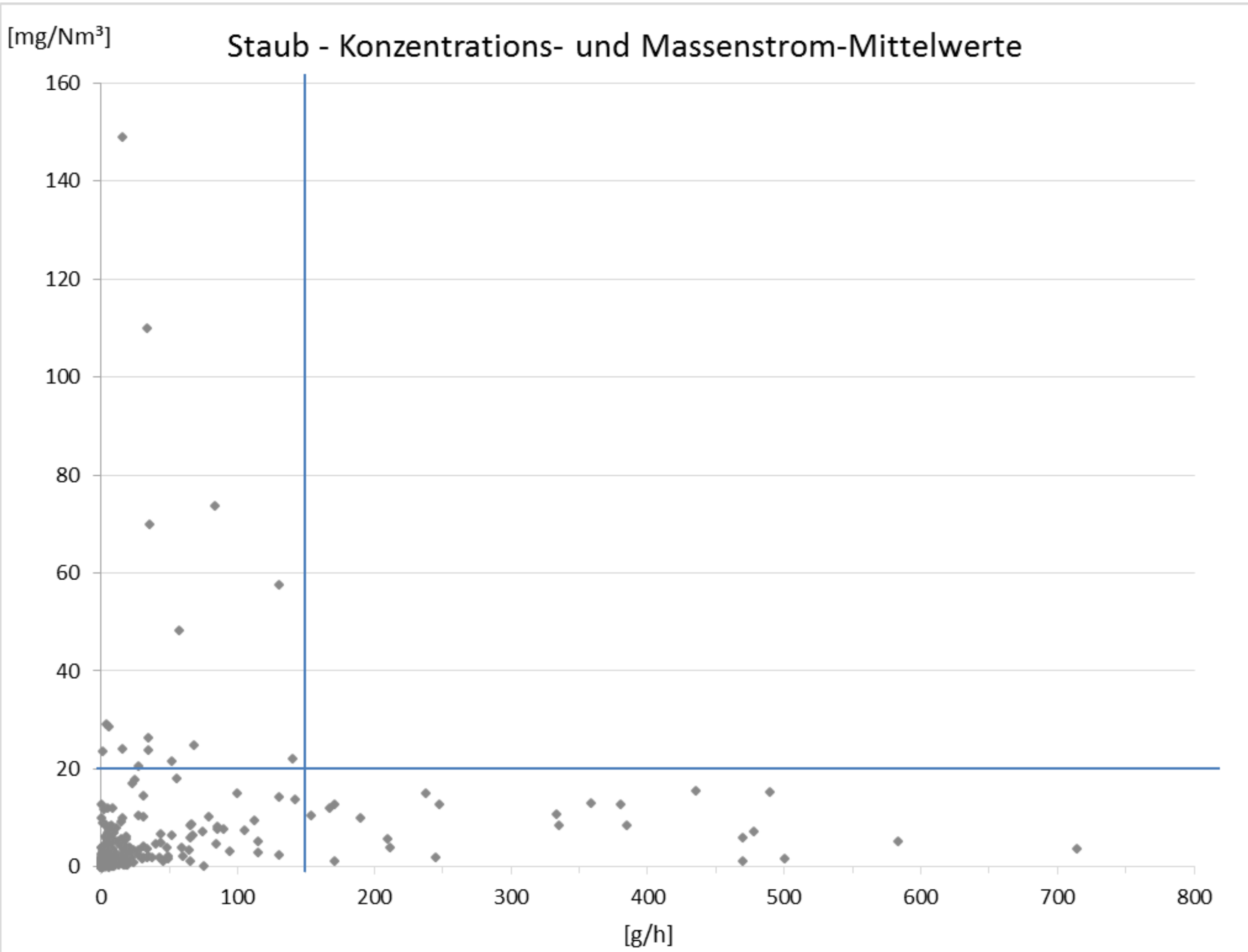
Tabelle 6: Anlagenbezogene Schwellenwerte (wenn keine Abgasbehandlung vorhanden war, lagen die Massenströme in der Regel unterhalb dieser Schwellenwerte)

Parameter	Massenstrom-Schwellenwert [g/h]	Parameter	Massenstrom-Schwellenwert [g/h]
Staub	100	HCl	10
Gesamt-C	150	HF	3
NOx	500	Methanol	30
NH_3	100	Ethylenoxide	0,5
SOx	1500	Toluol	80
Cl_2	5	Benzol	1,5

Staub-Emissionen – Kapitel 3

Zu Staubemissionen wurden 682 Datensätze ausgewertet. Abbildung 20 zeigt, dass die Staubkonzentrationen allgemein unter 20 mg/Nm³ liegen (98 % der Werte); die meisten Werte liegen auch unter 10 mg/Nm³ (94 % der Werte). Bei Staubkonzentrationen über 20 mg/Nm³ lag der Massenstrom unter 150 g/h.

Abbildung 20: Staub Konzentrations- und Massenstrom-Mittelwerte

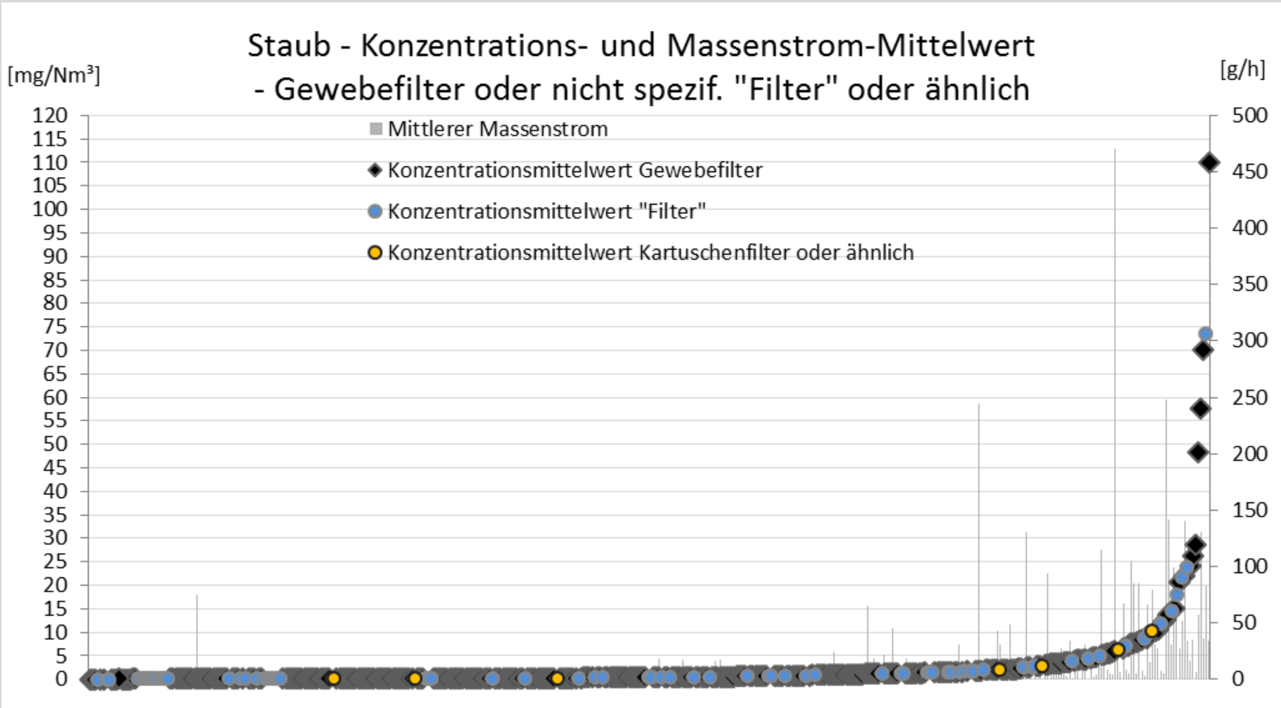


(Ökopol 2016)

Gewebefilter und ähnliche Filter (478 Datensätze) sind allgemein mit Staubkonzentrationen unter 5 mg/Nm³ verbunden (90 % der Daten). Höhere Konzentrationsmittelwerte haben stets einen Massenstrom unter < 500 g/h und allgemein unter 150 g/h (95 % der Daten). Diese höheren Massenströme von 248 - 470 g/h stammen aus der Herstellung von Nicht-Metallen, Metalloxiden oder anderen anorganischen Verbindungen (IED Anhang 1 Nr. 4.2.e) und aus der Herstellung von speziellen anorganischen Chemikalien (IED Anhang 1 Nr. 4.2).

Abbildung 21 zeigt Gewebefilter als schwarze Raute. Wenn im Messbericht lediglich "Filter" angegeben waren (ohne Spezifizierung), werden Gewebefiltern vermutet (aufgetragen als blaue Punkte). Kartuschenfilter und Sinterlamellenfilter sind als orange Punkte gekennzeichnet.

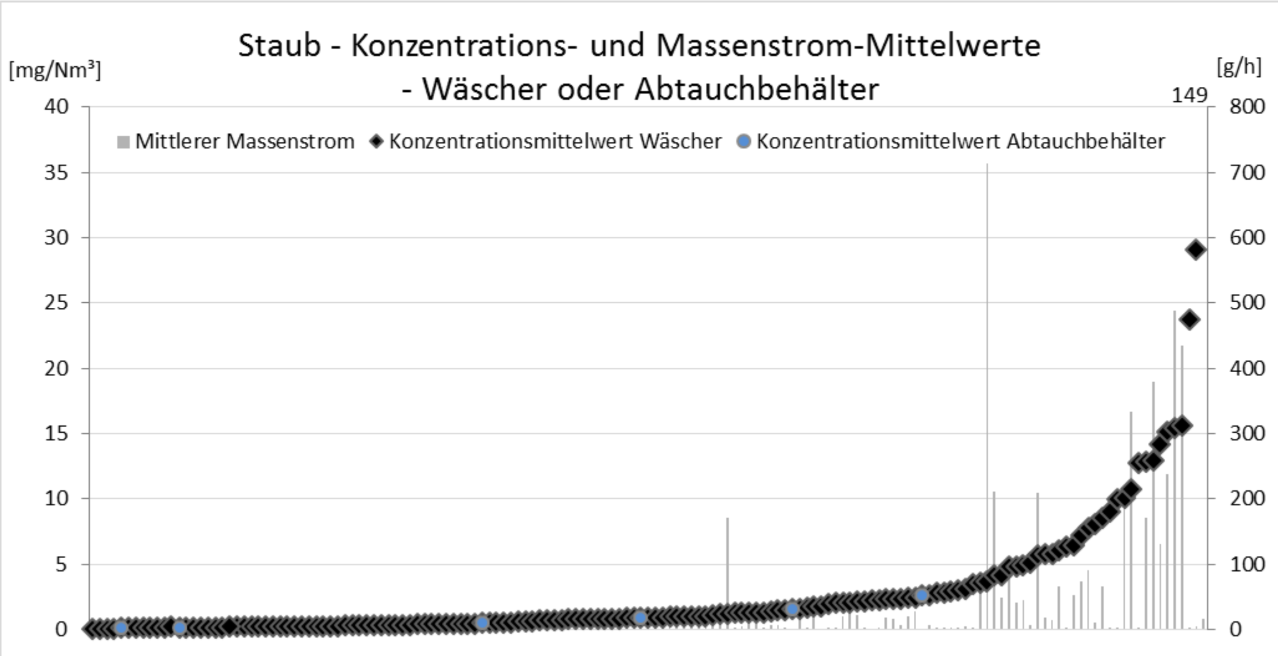
Abbildung 21: Staubemissionen aus Quellen mit Gewebefiltern und ähnlichen Systemen



(Ökopol 2016)

Wäscher und Abtauchbehälter sind allgemein mit Staubkonzentrationen unter 10 mg/Nm³ verbunden (92 % der Daten). Höhere Konzentrationsmittelwerte haben einen Massenstrom unter 500 g/h. Abbildung 22 zeigt Konzentrationsmittelwerte von Quellen mit Wäschern (schwarze Raute, 149 Datensätze) und Abtauchbehältern (blauer Punkt, 6 Datensätze) sowie zugehörige Massenströme (grauer Balken). Der höchste Konzentrationswert (149 mg/Nm³) liegt außerhalb der Skala, ist aber als Wert angegeben. Die Konzentration hat einen Mengenstrom von 16 g/h und stammt aus der Produktion von organometallischen Verbindungen.

Abbildung 22: Staubemissionen aus Quellen mit Wäscher oder Abtauchbehälter



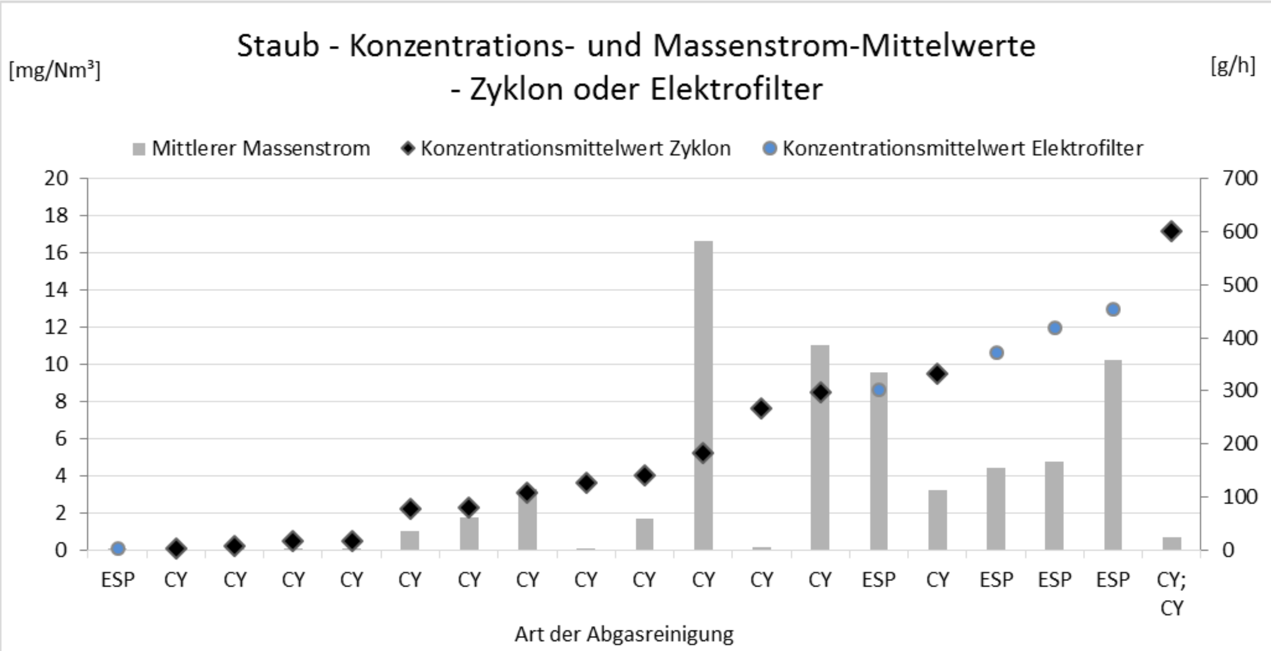
(Ökopol 2016)

Höchste Massenströme mit Wäscher und Abtauchbehälter stammen in zwei Fällen aus der Herstellung von Kunststoffen (IED Anhang 1 Nr. 4.1.h), in zwei anderen Fällen aus der Herstellung von sauerstoffhaltigen Kohlenwasserstoffen (IED Anh. 1 Nr. 4.1.b) und in zwei weiteren Fällen aus der Herstellung organischer Chemikalien (IED Anh. 1 Nr. 4.1).

Der höchste Konzentrationswert (149 mg/Nm³) liegt außerhalb der Skala; er ist in der Grafik genannt. Er ist mit einem Massenstrom von 16 g/h verbunden und stammt aus der Herstellung organischer Chemikalien (IED Anh. 1 Nr. 4.1.a).

Abbildung 23 zeigt Quellen, die nur mit Zyklonen (14 Datensätze) oder Elektrofiltern (5 Datensätze) ausgestattet sind. Hier wurden Staubkonzentrationen unter 20 mg/Nm³ gemessen.

Abbildung 23: Staubemissionen aus Quellen ausschließlich mit Zyklonen oder Elektrofiltern



(Ökopol 2016)

Staubemissionen von Quellen, die keine Abgasbehandlung für Staub aufweisen (88 Datensätze, keine mechanischen Filter, keine Wäscher) haben allgemein Konzentrationsmittelwerte unter 5 mg/Nm³ (91 % der Daten). Bei höheren Konzentrationsmittelwerten liegen die Massenströme allgemein unter 100 g/h; in einem Fall mit einer Konzentration von 7,3 mg/Nm³ wurde ein Massenstrom von 478 g/h gemessen. Die Messung stammt aus der Herstellung von Säuren (IED Anhang 1 Nr. 4.2.b).

Im Ergebnis zeigt die Analyse der Staubdaten:

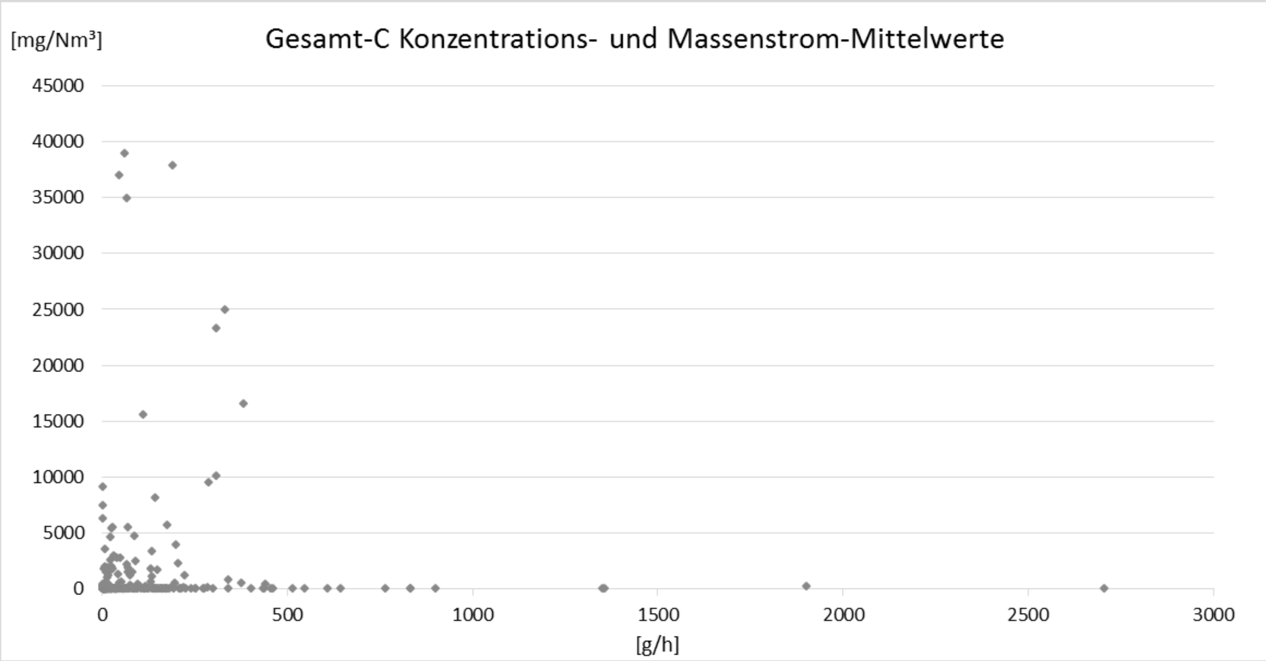
- Keine staubspezifische Abgasreinigung bei Massenströmen unter 150 g/h installiert ist.
- Bei Massenströmen über 150 g/h werden Zyklone, Elektrofilter und Gewebefilter eingesetzt;
- Gewebefilter weisen im Allgemeinen Konzentrationsmittelwerte unter 5 mg/Nm³ auf (90 % der Daten).
- Wäscher weisen im Allgemeinen Emissionswerte unter 10 mg/Nm³ auf (92 % der Daten).
- Die wenigen Messwerte von Anlagen, in denen nur Zyklone oder Elektrofilter installiert sind, sind mit Emissionswerten unter 20 mg/Nm³ verbunden.

Gesamt-Kohlenstoff-Emissionen (Gesamt-C) – Kapitel 4

Zu Gesamt-Kohlenstoff (Gesamt-C) wurden 437 Datensätze ausgewertet. Abbildung 24 und Abbildung 25 zeigen, dass die Gesamt-C-Konzentrationen allgemein unter 40 mg/Nm³ liegen (71 % der Daten). Bei Gesamt-C-Konzentrationen über 40 mg/Nm³ wird ein Massenstrom von 500 g/h nicht überschritten (fünf Ausnahmen); bei Konzentrationsmittelwerten über 40 mg/Nm³ lag der Massenstrom meistens unter 300 g/h (91 % der Daten).

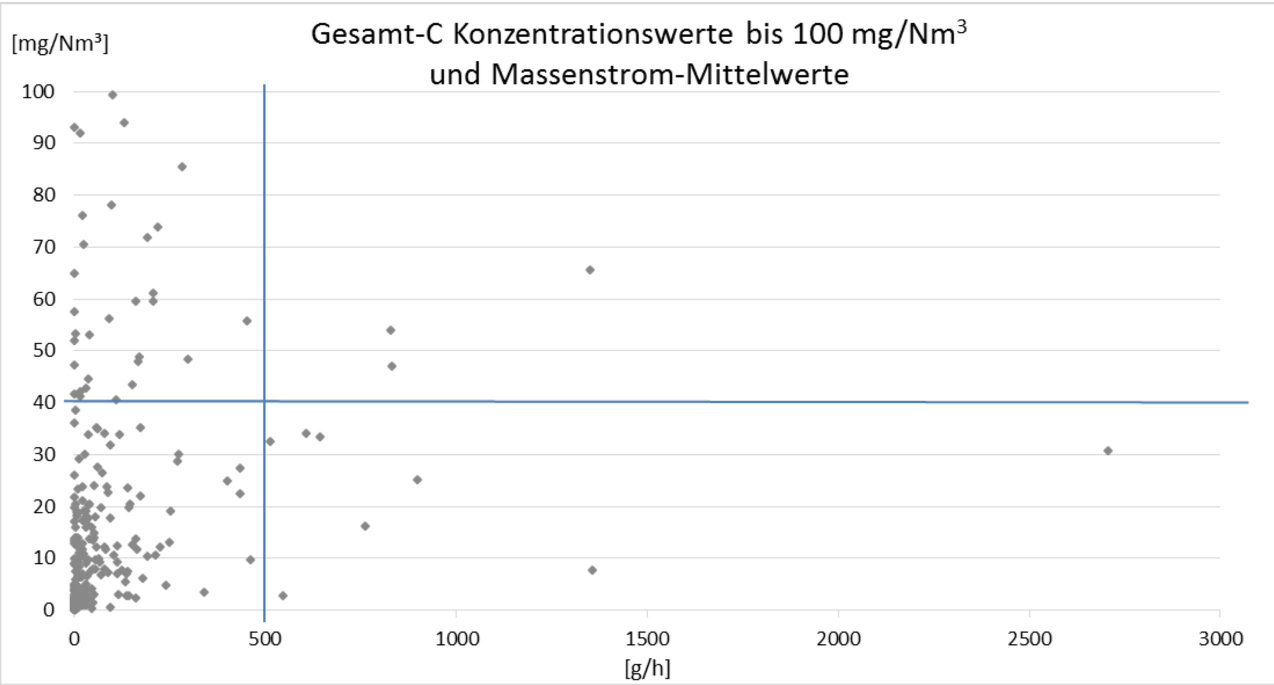
Fünf Werte mit Gesamt-C-Konzentrationen über 40 mg/Nm³ und Massenstromwerten über 500 g/h stammen aus der Herstellung von Polyurethan-Form- und Blockschaum unter Verwendung von Kohlenwasserstoff-Treibmitteln (z.B. Pentan); in diesen Fällen war keine Abgasreinigung vorhanden. Ein Datensatz stammt aus der Herstellung von oberflächenaktiven Stoffen und Tensiden (IED Anhang 1 Nr. 4.1.k).

Abbildung 24: Gesamt-C Konzentrations- und Massenstrom-Mittelwerte



(Ökopol 2016)

Abbildung 25: Gesamt-C Konzentrations- und Massenstrom-Mittelwerte, reduzierte Skala bis 100 mg/Nm³



(Ökopol 2016)

Thermische Oxidation (TO) wird allein oder in Kombination mit Gewebefiltern, SCR, DeDiox-Systemen (DD), Quenche (Q) und/oder Wäschern (S) verwendet. Katalytische Oxidation (COX) wird allein oder in Kombination mit Kondensatabscheidern (C), Gewebefiltern (FF), Wäschern (S) oder ein spezieller Filter (SP, hier: „Sinterlamellenfiltern") genutzt.

Thermische Oxidation ist allgemein mit Gesamt-C-Konzentrationen unter 5 mg/Nm³ verbunden (90 % der Datensätze). Wenn 5 mg/Nm³ überschritten werden (14 Datensätze), liegt der Massenstrom allgemein unter 150 g/h (79 % der Datensätze); in drei Fällen wurden Massenströme zwischen 200 und 500 g/h gemessen.

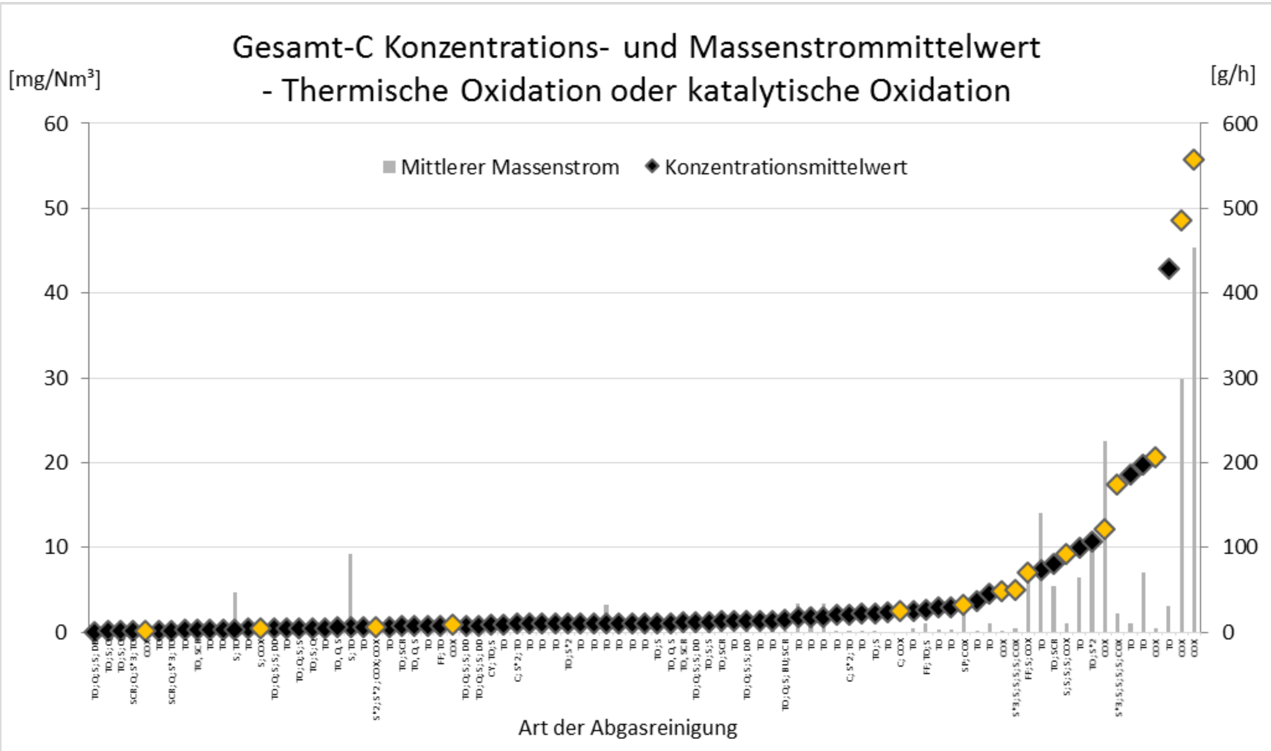
Bei katalytischer Oxidation (orange Rauten in Abbildung 25) liegen die meisten Konzentrationsmittelwerte am oberen Ende der Grafik. Etwa 50 % der Konzentrationsmittelwerte liegen unter 5 mg/Nm³, 90 % der Werte liegen unter 20 mg/Nm³.

Bei thermischer Oxidation liegen die Abgasvolumina bei etwa der Hälfte der Werte unter 5.000 m³/h, die andere Hälfte hat Abgasvolumina von 5.000 - 35.000 m³/h, sowie zwei Fällen von 150.000 - 170.000 m³/h.

Bei katalytischer Oxidation haben rund 60 % der Werte Abgasvolumina unter 5.000 m³/h, die übrigen Werte weisen Abgasvolumina zwischen 5.000 - 20.000 m³/h auf.

Abbildung 26 zeigt Gesamt-C-Emissionswerte von Quellen mit thermischer Oxidation (schwarze Rauten in der Abbildung, 72 Datensätze) oder mit katalytischer Oxidation (orange Rauten, 15 Datensätze). Die Art der Abgasreinigung ist unter den Markierungen angegeben.

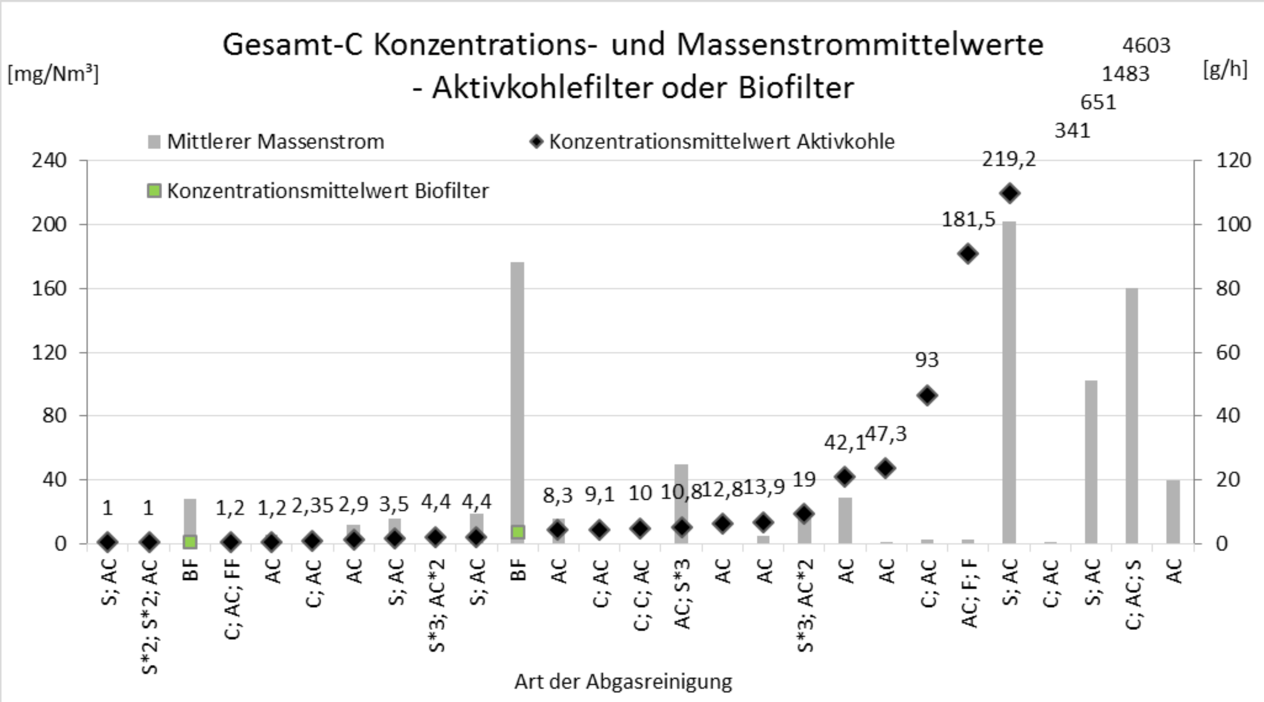
Abbildung 26: Gesamt-C Mittlere Konzentrations- und Massenstromwerte bei thermischer Oxidation und katalytischer Oxidation



(Ökopol 2016)

Aktivkohlefilter haben meistens Gesamt-C-Emissionen unter 50 mg/Nm³ (74 % der Daten). Nach Biofiltern wurden Gesamt-C-Konzentrationen von 1,1 mg/Nm³ und 7,2 mg/Nm³ gemessen. Abbildung 27 zeigt Gesamt-C-Werte von Aktivkohlefiltern (schwarze Rauten) oder Biofiltern (grüne Quadrate).

Abbildung 27: Gesamt-C Konzentrations- und Massenstromwerte mit Aktivkohlefiltern oder Biofiltern



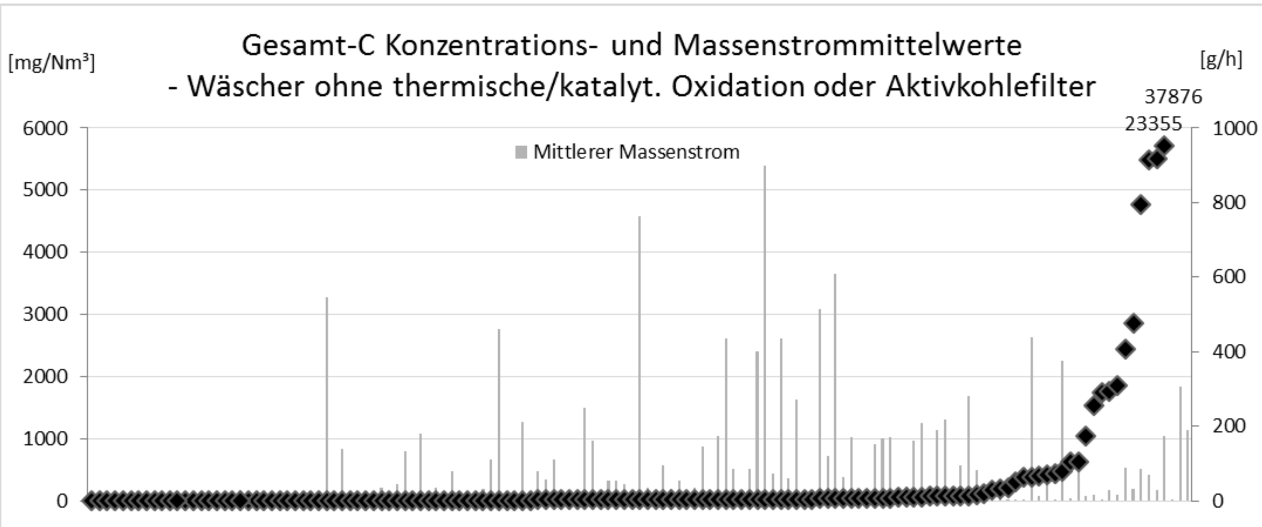
Anmerkung: Vier Konzentrationswerte von Aktivkohlesystemen liegen außerhalb der Skala, sind aber angegeben.

(Ökopol 2016)

Gesamt-C-Konzentrationen nach Wäschern weisen im Allgemeinen Werte unter 40 mg/Nm³ auf (70 % von 141 Datensätzen). Bei höheren Konzentrationsmittelwerten liegt der Massenstrom unter 500 g/h.

Abbildung 28 zeigt Gesamt-C-Konzentrationsmittelwerte von Quellen, bei denen Wäscher installiert sind (ohne Kombination mit thermischer Oxidation, katalytischer Oxidation oder Aktivkohlefiltern).

Abbildung 28: Gesamt-C-Konzentrations- und Massenstromwerte von Wäschern (ohne Kombination mit thermischer Oxidation, katalytischer Oxidation oder Aktivkohlefilter)



Anmerkung: Zwei Konzentrationswerte über 6000 mg/Nm³ liegen außerhalb der Skala, sind aber angegeben.

(Ökopol 2016)

Gesamt-C-Messungen von Quellen ohne Abgasreinigungssystem für organische Verbindungen (154 Datensätze) haben Konzentrationsmittelwerte unter 40 mg/Nm³ (75 % der Werte).

Wenn 40 mg/Nm³ überschritten werden, liegt der Massenstrom unter 500 g/h und in den meisten Fällen unter 150 g/h (79 % der Werte).

In den vier Fällen, bei denen 40 mg/Nm³ und der Massenstrom von 500 g/h überschritten wird, stammen die Werte – wie oben erwähnt – aus der Herstellung von Form- und Blockschaum unter Verwendung von Kohlenwasserstoff-Treibmitteln (z.B. Pentan).

Im Ergebnis zeigt die Analyse der Gesamt-C-Daten, dass

- Anlagen ohne Gesamt-C-spezifische Abgasreinigung Massenströme unter 150 g/h aufweisen;
- wenn Gesamt-C-Massenströme 150 g/h übersteigen, sind zur Gesamt-C-Minderung Wäscher, thermische oder katalytische Oxidation, Biofilter/Aktivkohlefilter installiert.
- Biofilter oder Aktivkohlefilter sind bei Abgasvolumina unter 3000 m³/h installiert; sie weisen im Allgemeinen Emissionswerte unter 50 mg/Nm³ auf (74 % der Daten).
- Thermische und katalytische Oxidation sind im Allgemeinen bei Abgasvolumina bis 35 000 m³/h installiert, mit wenigen Ausnahmen, wenn höhere Abgasvolumina behandelt werden; üblicherweise sind bei höheren Volumina Wäscher installiert.
- Emissionskonzentrationen nach thermischer Oxidation liegen im Allgemeinen unter 5 mg/Nm³ (90 % der Daten).
- Emissionskonzentrationen nach katalytischer Oxidation liegen teilweise unter 5 mg/Nm³ (50 % der Daten) und im Allgemeinen unter 20 mg/Nm³ (90 % der Daten).
- Emissionskonzentrationen nach Wäschern liegen teilweise unter 20 mg/Nm³ (50 % der Daten) und im Allgemeinen unter 40 mg/Nm³ (70 % der Daten).
- Keine Aussage kann darüber gemacht werden, ob die thermischen oder katalytischen Abgasbehandlungen zur Minderung von CMR-Substanzen errichtet wurden.
- Gesamt-C-Emissionen aus Anlagen zur Herstellung von Kunststoffen wie Polymeren, Chemiefasern und Fasern auf Zellstoffbasis (IED Anhang 1 Nr. 4.1.h) können nicht im Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie (WGC BREF) behandelt werden.
- Gesamt-C-Emissionen der Herstellung von Tensiden (IED Anhang 1 Nr. 4.1.k) benötigen hinsichtlich der Aufnahme in den Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie (WGC BREF) eine gesonderte Betrachtung.

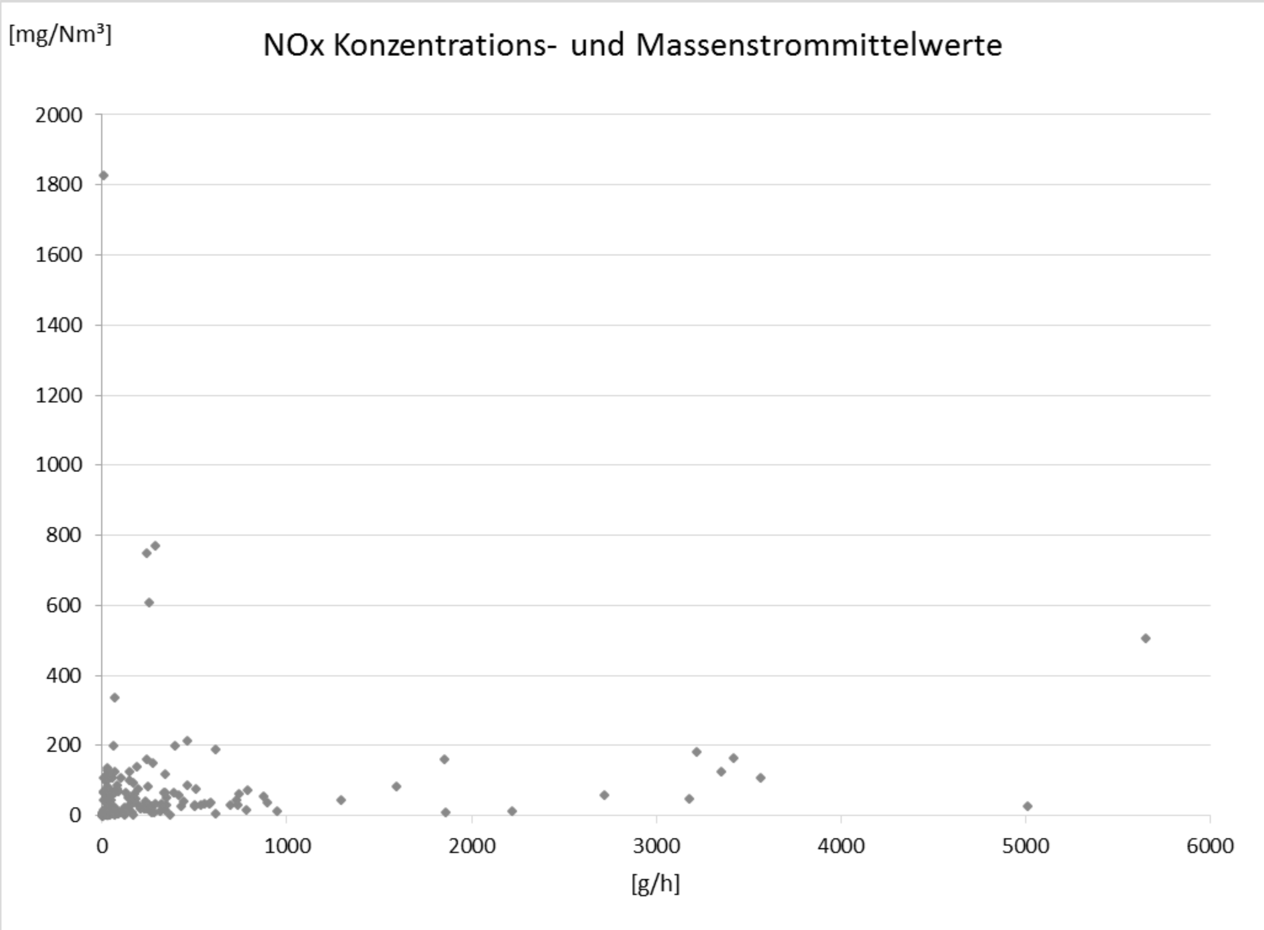
Aufgrund der unterschiedlichen Leistungsfähigkeit der thermischen Oxidation und anderer Abgasreinigungssysteme sollten Auswahlkriterien für verschiedene BVT definiert werden, die z.B. den Energieverbrauch und die Gefährlichkeit der emittierten Stoffe mit berücksichtigen. Ein Beispiel eines solchen Entscheidungsbaumes finded sich im BVT-Merkblatt zur Herstellung von organischen Spezialchemikalien (OFC BREF 2006).

Stickstoffoxide- (NOx) und Kohlenmonoxid- (CO) Emissionen – Kapitel 5

Zu Emissionen von Stickstoffoxiden wurden 211 Datensätze ausgewertet. Abbildungen 29 und 30 zeigen, dass NOx-Konzentrationsmittelwerte allgemein unter 200 mg/Nm³ liegen (96 % der Werte).

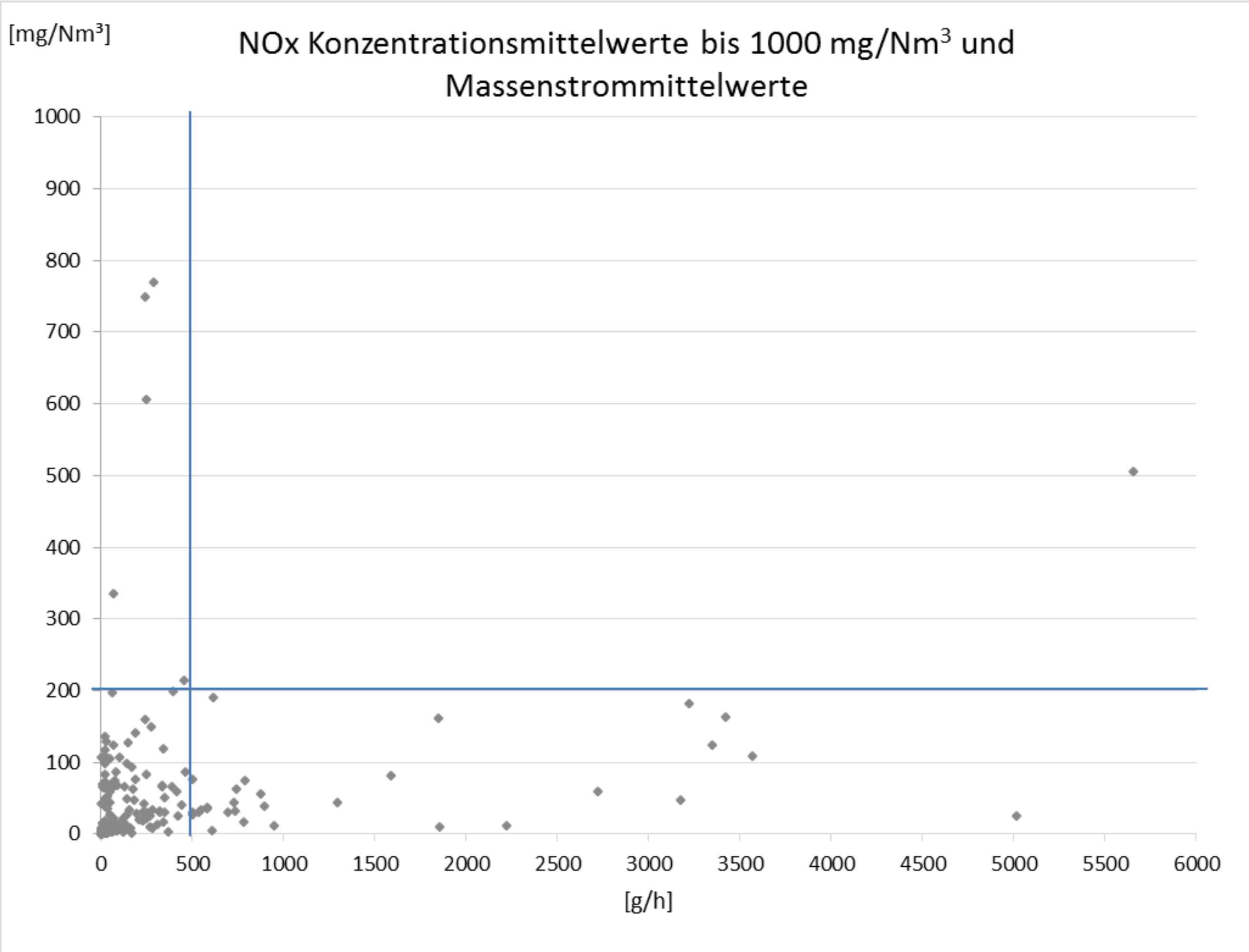
Wenn 200 mg/Nm³ überschritten werden, liegen die Massenströme unter 500 g/h, außer bei einem Datensatz mit einem Massenstrom von 5654 g/h und einer Konzentration von 505 mg/Nm³, der aus der Düngerherstellung stammt.

Abbildung 29: NOx Konzentrations- und Massenstrom-Mittelwerte



(Ökopol 2016)

Abbildung 30: NOx Konzentrationsmittelwerte bis 1000 mg/Nm³ und Massenstrom-Mittelwerte



Anmerkung: Ein Konzentrationswert mit 1827 mg/Nm³ und einem Massenstrom von 4 g/h liegt außerhalb der Skala.

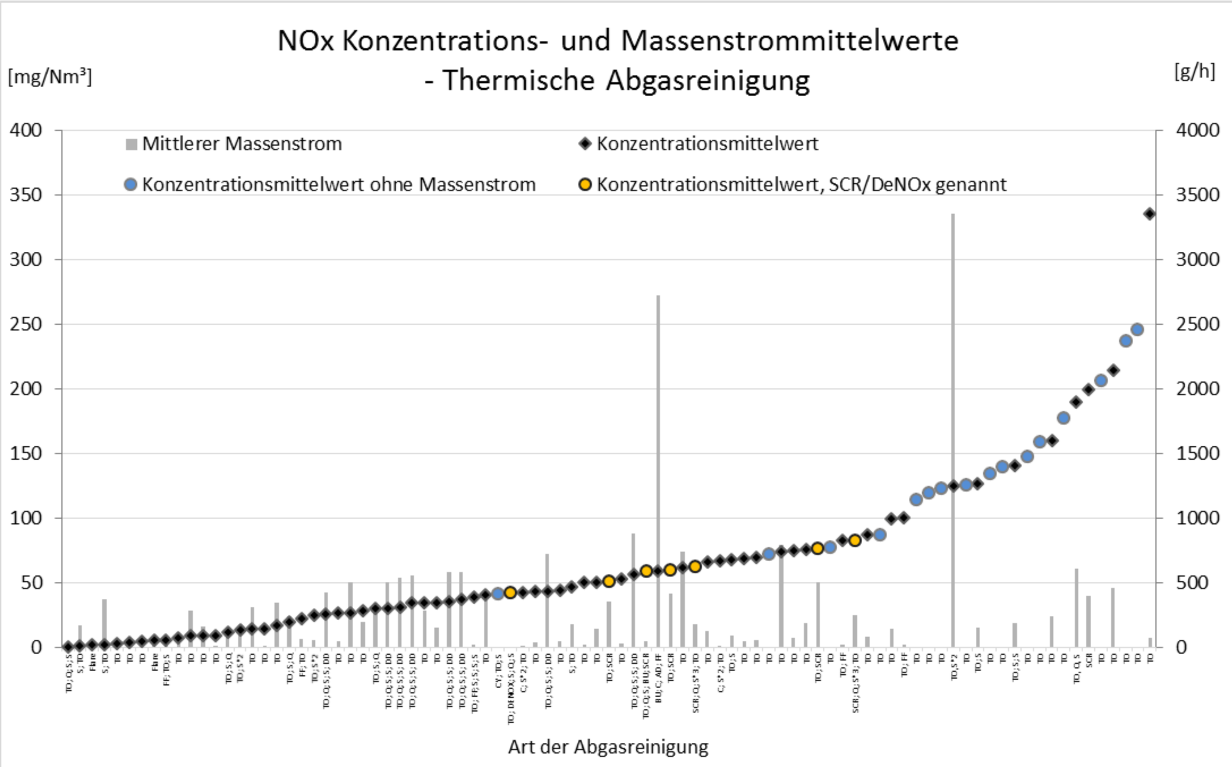
(Ökopol 2016)

Thermische Oxidationssysteme sind allgemein mit NOx Konzentrationen unter 100 mg/Nm³ verbunden (76 % der Werte). Bei allen Quellen, an denen SCR-Systeme installiert sind, liegen die Konzentrationsmittelwerte im Allgemeinen unter 80 mg/Nm³.

Wenn die Konzentrationsmittelwerte über 100 mg/Nm³ liegen, sind die Massenströme allgemein unter 0,5 kg/h (76 % der Werte). Die höchsten NOx-Emissionen wurden bei Produktionsprozessen gemessen, in denen stickstoffhaltige Produkte hergestellt werden.

Abbildung 31 zeigt NOx-Emissionen von Quellen mit thermischer Abgasreinigung (schwarze Rauten, 89 Datensätze). Daten ohne Massenstromwerte sind als blaue Punkte markiert. Werte, bei deren Abgasreinigung SCR-Systeme angegeben wurden, sind als orange Punkte markiert.

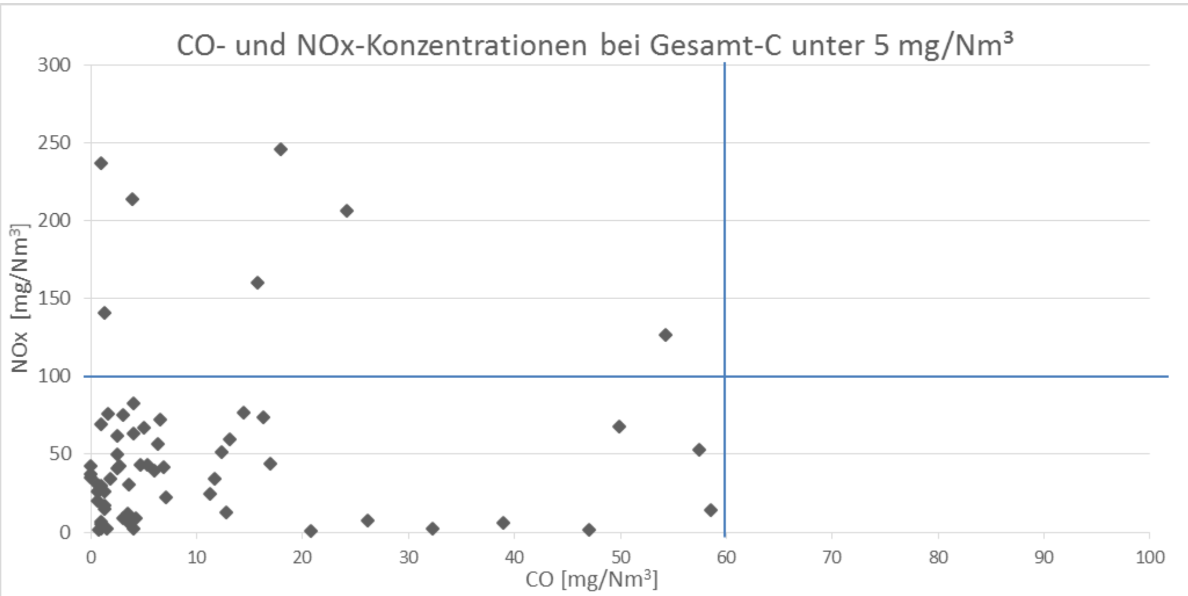
Abbildung 31: NOx Konzentrations- und Massenstrom-Mittelwerte nach thermischer Oxidation



(Ökopol 2016)

Thermische Abgasreinigungen mit Gesamt-C-Konzentrationen unter 5 mg/Nm³ (63 Datensätze) sind allgemein mit CO-Konzentrationen unter 60 mg/Nm³ und NOx-Konzentrationen unter 100 mg/Nm³ verbunden (89 % der Werte). Wenn höhere NOx Emission gemessen wurden, lagen diese unter 250 mg/Nm³, mit korrespondierenden CO-Konzentrationen unter 30 mg/Nm³. Abbildung 32 zeigt NOx-Konzentrationen und CO-Konzentrationen aus Quellen mit thermischer Abgasreinigung und Gesamt-C-Konzentrationen < 5 mg/Nm³.

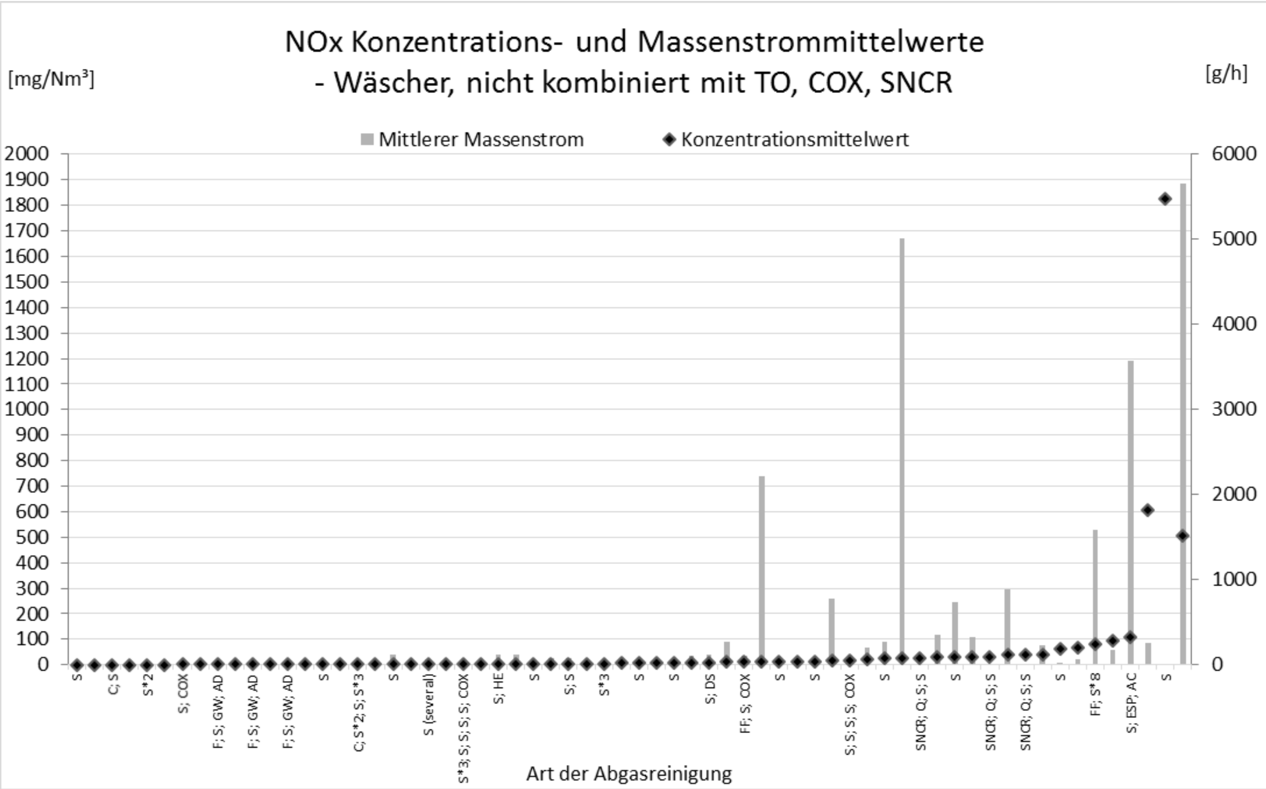
Abbildung 32: NOx- und CO-Konzentrationsmittelwerte bei Quellen mit thermischer Abgasreinigung und Gesamt-C-Konzentrationsmittelwerten unter 5 mg/Nm³



(Ökopol 2016)

Wäscher (64 Datensätze) sind allgemein mit NOx-Emissionswerten unter 100 mg/Nm³ verbunden (93 % der Werte). Wenn die Konzentrationsmittelwerte höher liegen, sind die NOx-Emissionen mit der Herstellung stickstoffhaltiger Produkte verbunden. Abbildung 33 zeigt NOx-Emissionswerte von Quellen mit Wäschern, aus Anlagen, in denen die Wäscher nicht mit thermischer oder katalytischer Abgasreinigung verbunden sind.

Abbildung 33: NOx Konzentrations- und Massenstrom-Mittelwerte ohne thermische oder katalytische Abgasreinigung



(Ökopol 2016)

NOx-Emissionen aus Quellen ohne thermische Abgasreinigung und ohne Wäscher weisen allgemein Konzentrationsmittelwerte unter 200 mg/Nm³ auf (97 % der Werte). In zwei Fällen, bei denen höhere Konzentrationsmittelwerte gemessen wurden (750 - 770 mg/Nm³), lag der Massenstrom unter 300 g/h.

Zusammengefasst zeigt die Analyse der NOx-Daten:

- Emissionswerte benötigen eine getrennte Auswertung für oxidative (Verbrennungs-) Prozesse, bei denen NOx-Emissionen entstehen, und chemische Prozesse bei denen NOx aus dem Prozess stammt.
- Wenn keine Abgasreinigung für NOx installiert ist, liegen die Massenströme unter 500 g/h.
- Bei Massenströmen über 500 g/h sind SCR, SNCR oder Wäscher zur NOx-Minderung installiert.
- Thermische oder katalytische Oxidationssysteme sind im Allgemeinen bei Abgasvolumina bis etwa 35.000 m³/h installiert.
- NOx-Emissionen nach thermischer oder katalytischer Oxidation liegen im Allgemeinen unter 100 mg/Nm³ (76 % der Daten); wenn SCR-Systeme installiert sind, liegen die damit verbundenen NOx-Emissionswerte im Allgemeinen unter 80 mg/Nm³.
- Thermische oder katalytische Oxidationssysteme erreichen bei TOC-Werten unter 5 mg/Nm³ im Allgemeinen NOx-Emissionen unter 100 mg/Nm³ und CO-Emissionen unter 60 mg/Nm³;
- Wäscher sind im Allgemeinen mit NOx-Emissionen unter 100 mg/Nm³ verbunden.

- NOx-Emissionen aus Anlagen, die stickstoffbasierte Düngemittel nach IED Anhang 1 Nr. 4.3 herstellen, können nicht vom Geltungsbereich eines BVT-Merkblattes für die Abgasbehandlung in der chemischen Industrie (WGC BREF) abgedeckt werden.
- NOx-Emissionen aus Anlagen, die stickstoffhaltige Kohlenwasserstoffe herstellen (IED Anhang 1 Nr. 4.1.d) müssen genauer untersucht werden, ob sie für den Geltungsbereich eines BVT-Merkblattes für die Abgasbehandlung in der chemischen Industrie (WGC BREF) geeignet sind.

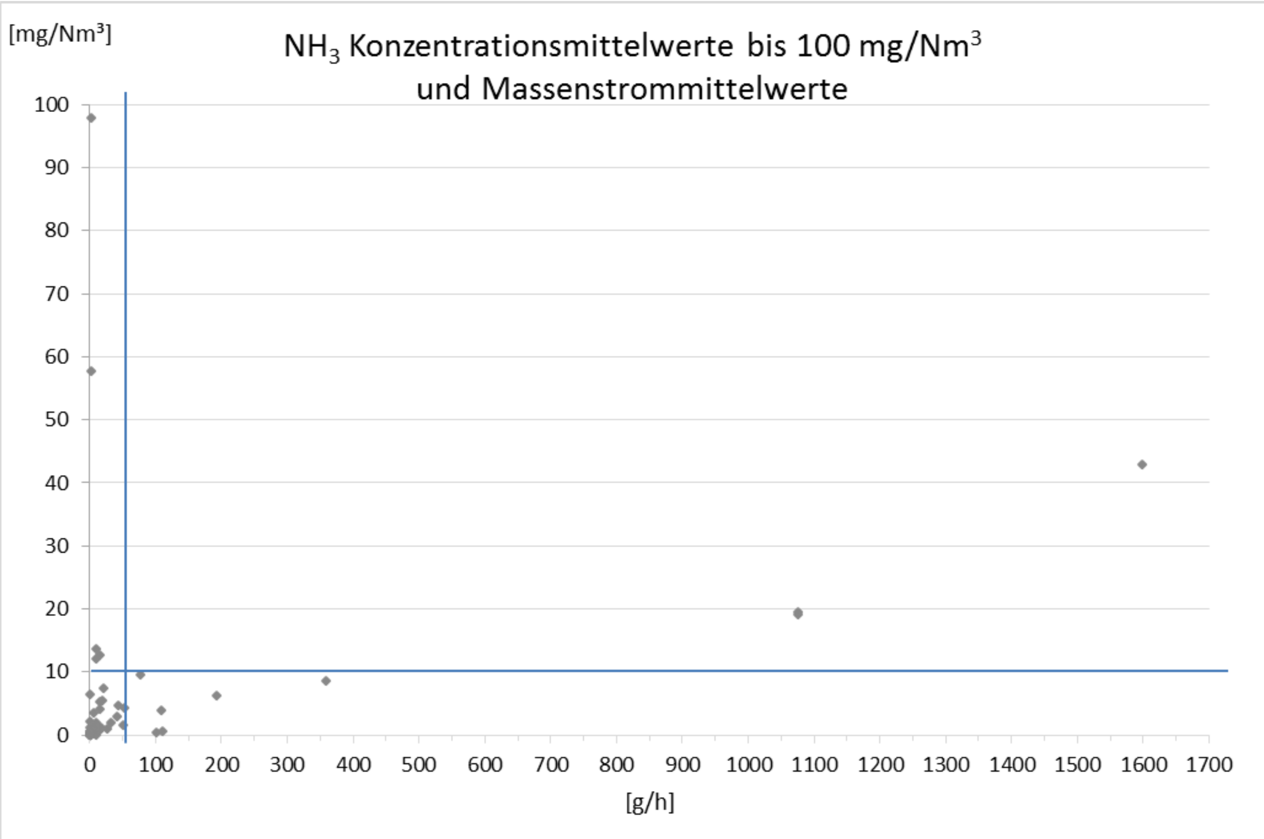
Ammoniak (NH_3) Emissionen – Kapitel 6

Zu Ammoniak (NH_3) wurden 80 Datensätze ausgewertet. Abbildung 33 und 34 zeigen, dass die NH_3-Konzentrationsmittelwerte allgemein unter 10 mg/Nm³ liegen (86 % der Werte).

Bei Konzentrationsmittelwerten über 10 mg/Nm³ lag der Massenstrom allgemein unter 150 g/h.

Ausnahmen waren drei Datensätze, in denen Konzentrationsmittelwerte zwischen 15 - 45 mg/Nm³ gemessen wurden und der Massenstrom zwischen 1000 und 1600 g/h lag. Sie stammen aus der Herstellung von Kunststoffen bzw. PVC.

Abbildung 34: NH_3 Konzentrationsmittelwerte bis 100 mg/Nm³ und Massenstrom-Mittelwerte

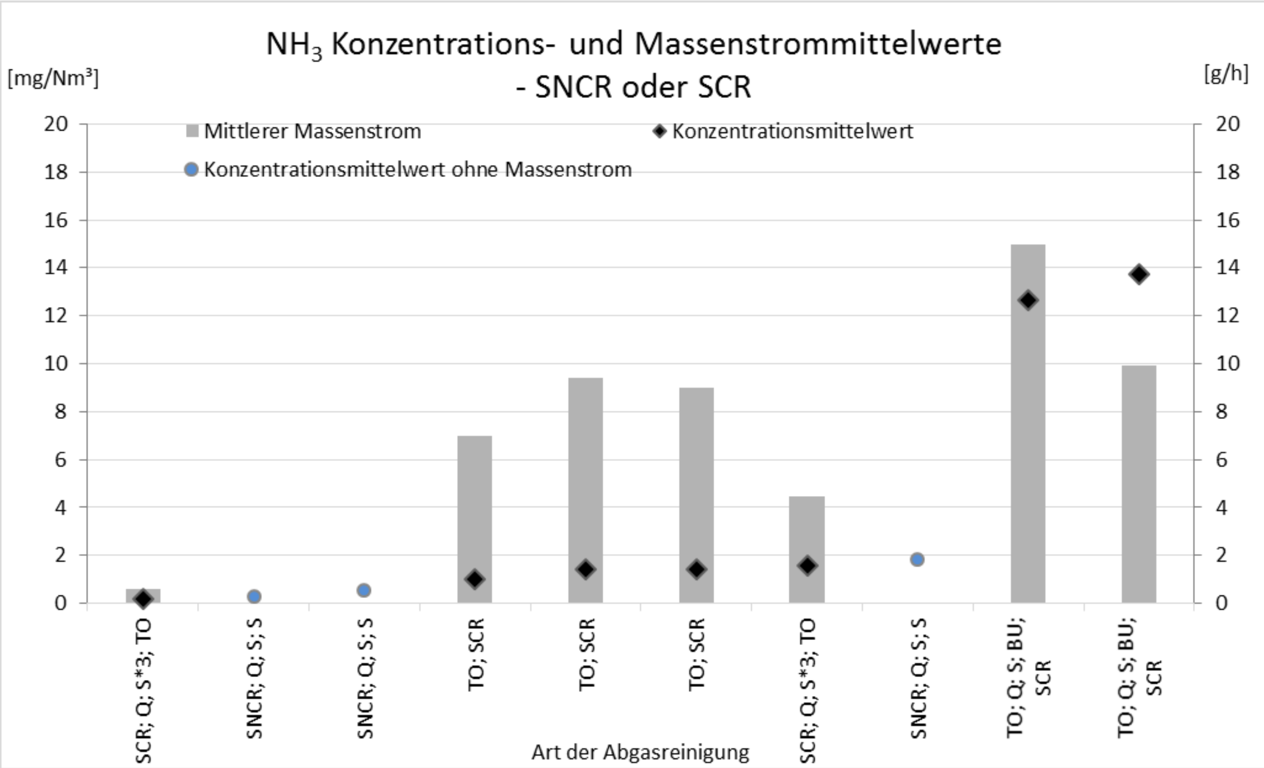


Anmerkung: Drei Werte mit Konzentrationen zwischen 163 - 682,34 mg/Nm³ und Massenströmen von 11 - 113,5 g/h sind abgeschnitten.

(Ökopol 2016)

Die mit SNCR- und SCR-Systemen verbundenen NH_3-Konzentrationen (“NH_3-Schlupf”) liegen allgemein unter 3 mg/Nm³ (80 % der Werte). Abbildung 35 zeigt NH_3-Konzentrationen von Quellen, die mit SNCR- oder SCR-Systemen ausgestattet sind.

Abbildung 35: NH_3 Konzentration- und Massenstrom-Mittelwerte von Quellen mit SNCR oder SCR



(Ökopol 2016)

Im Ergebnis zeigt die Analyse der NH_3-Daten:

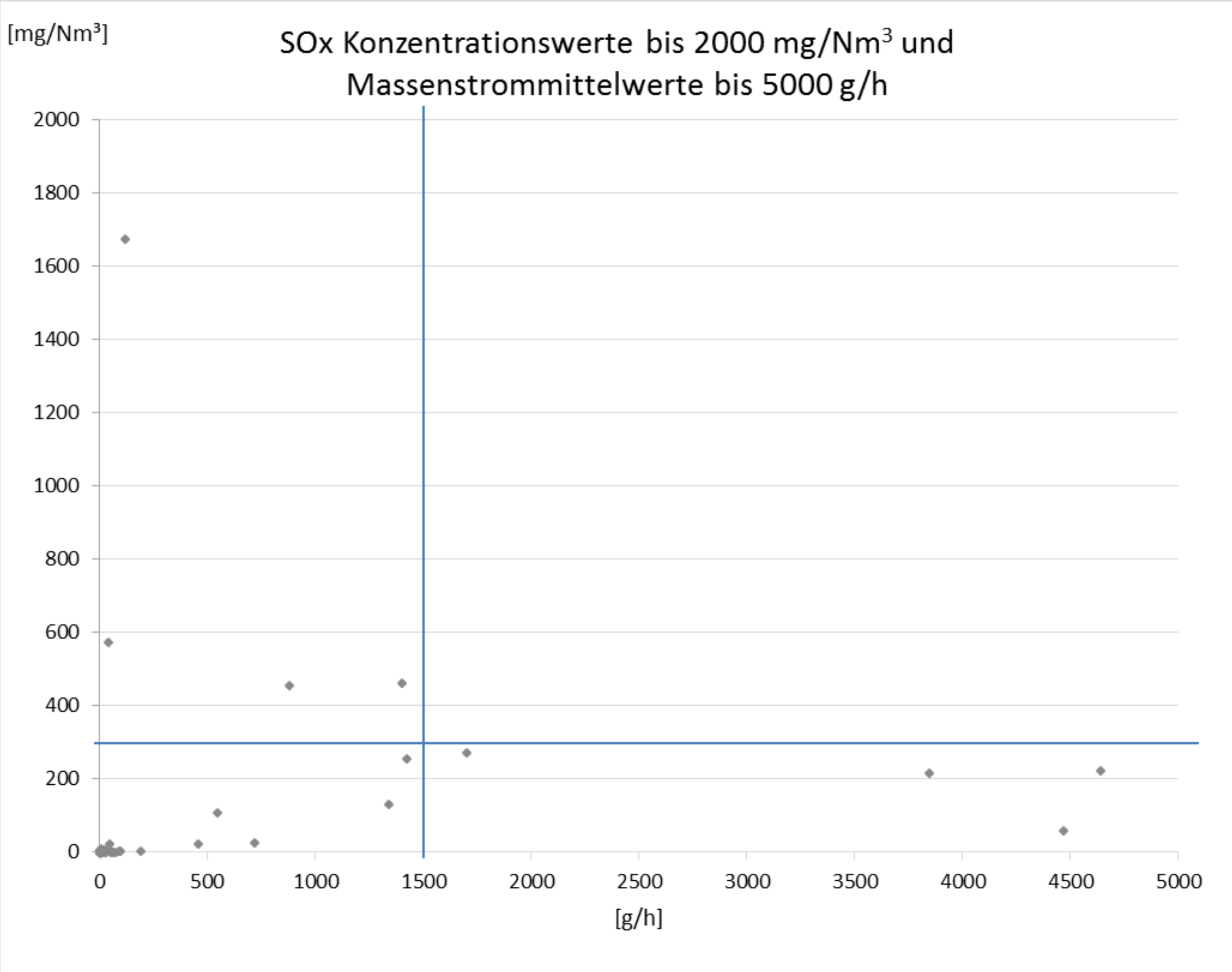
- NH_3-Emissionen stammen entweder aus chemischen Prozessen oder aus Abgasreinigungen mit SCR/SNCR (Ammoniakschlupf);
- wenn keine Abgasreinigung für NH_3-Emissionen installiert ist liegen die Massenströmen unter 100 g/h;
- wenn Massenströme über 100 g/h liegen, sind Wäscher zur NH_3-Minderung installiert;
- Wäscher sind im Allgemeinen mit NH_3-Emissionen unter 10 mg/Nm³ verbunden;
- Emissionen aus SCR/SNCR (Ammoniakschlupf) liegen meist unter 3 mg/Nm³;
- NH_3-Emissions aus der Herstellung von PVC-Polymeren (IED Anhang 1) oder aus der Herstellung von Düngemitteln (IED Anhang 1 Nr. 4.3) können nicht im Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasreinigung in der chemischen Industrie (WGC BREF) behandelt werden;
- Emissionen aus der Herstellung von Flammschutzmitteln und der Herstellung von aromatischen Stickstoffverbindungen (IED Anhang 1 Nr. 4.1) können ebenfalls nicht im Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie (WGC BREF) behandelt werden.

Schwefeldioxide-Emissionen (SOx) – Kapitel 7

Zu Emissionen von Schwefeldioxid und Schwefeltrioxid (SOx) wurden 92 Datensätze ausgewertet. Die Abbildung 36 zeigt, dass die Konzentrationsmittelwerte allgemein unter 30 mg/Nm³ liegen (86 % der Daten). Höhere Konzentrationsmittelwerte haben allgemein eine Konzentration unter 300 mg/Nm³.

Ein Massenstrom von 1500 g/h wird nicht überschritten, außer bei einer Messung (26.546 g/h), die bei der Herstellung von Schwefelsäure erreicht wurde (in Abbildung 36 außerhalb der Skala).

Abbildung 36: SOx Konzentrations- und Massenstrom-Mittelwerte mit reduzierter Skala bis 2000 mg/Nm³ und bis 5000 g/h



Anmerkung: Zwei Werte mit 26.546 g/h und 403,4 mg/Nm³ sowie mit 64 g/h und 7.1519 mg/Nm³ liegen außerhalb der Skalen und sind nicht dargestellt.

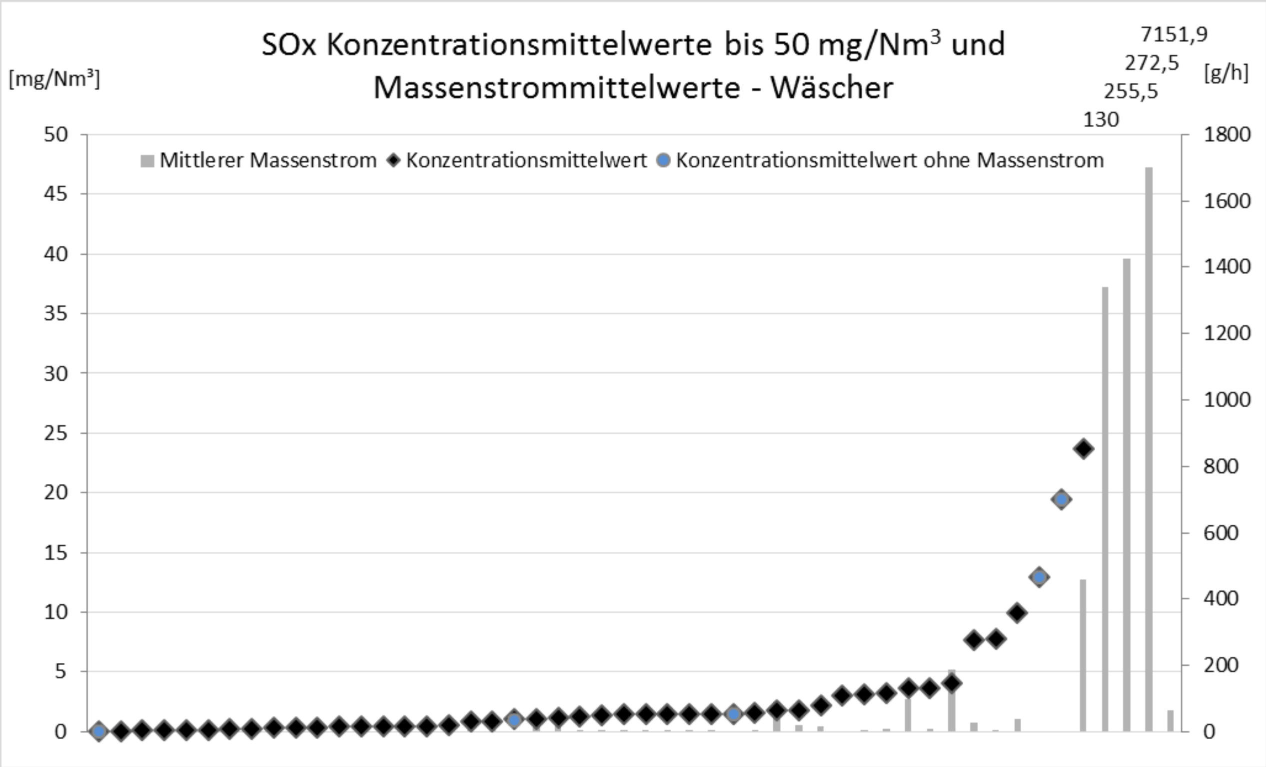
(Ökopol 2016)

Abbildung 37 zeigt, dass Wäscher allgemein SOx-Konzentrationen unter 25 mg/Nm³ aufweisen (92 % der Werte). Bei höheren Konzentrationsmittelwerten liegt der Massenstrom unter 1500 g/h, außer einem Massenstrom mit 1.700 g/h.

Die drei Werte mit Massenströmen zwischen 1.340 und 1.700 g/h stammen aus der Herstellung von Natriumhydrogensulfat (Nr. 4.1 der 4. BImSchV) und aus der Herstellung von Zementadditiven (Nr. 4.1.8 der 4. BImSchV).

Der höchste Konzentrationswert von 7.151.9 mg/Nm³ (verbunden mit einem Massnstrom von 63 g/h) stammt aus der Herstellung von Alkansulfonaten (Nr. 4.1.11 der 4. BImSchV).

Abbildung 37: SOx Konzentrations- und Massenstrom-Mittelwerte von Wäschern, reduzierte Skala bis 50 mg/Nm³



Anmerkung: Vier höchste Konzentrationswerte liegen außerhalb der Skala, sind aber in der Grafik aufgeführt.

(Ökopol 2016)

SOx-Emissionswerte von Quellen, bei denen keine Abgasreinigung vorhanden ist, weisen Konzentrationsmittelwerte unter 300 mg/Nm³ (88 % of Werte) oder einen Massenstrom unter 1500 g/h auf, bis auf einen Fall, bei dem eine Konzentration von rund 400 mg/Nm³ und ein Massenstrom von rund 26.500 g/h in der Herstellung von Schwefelsäure gemessen wurde.

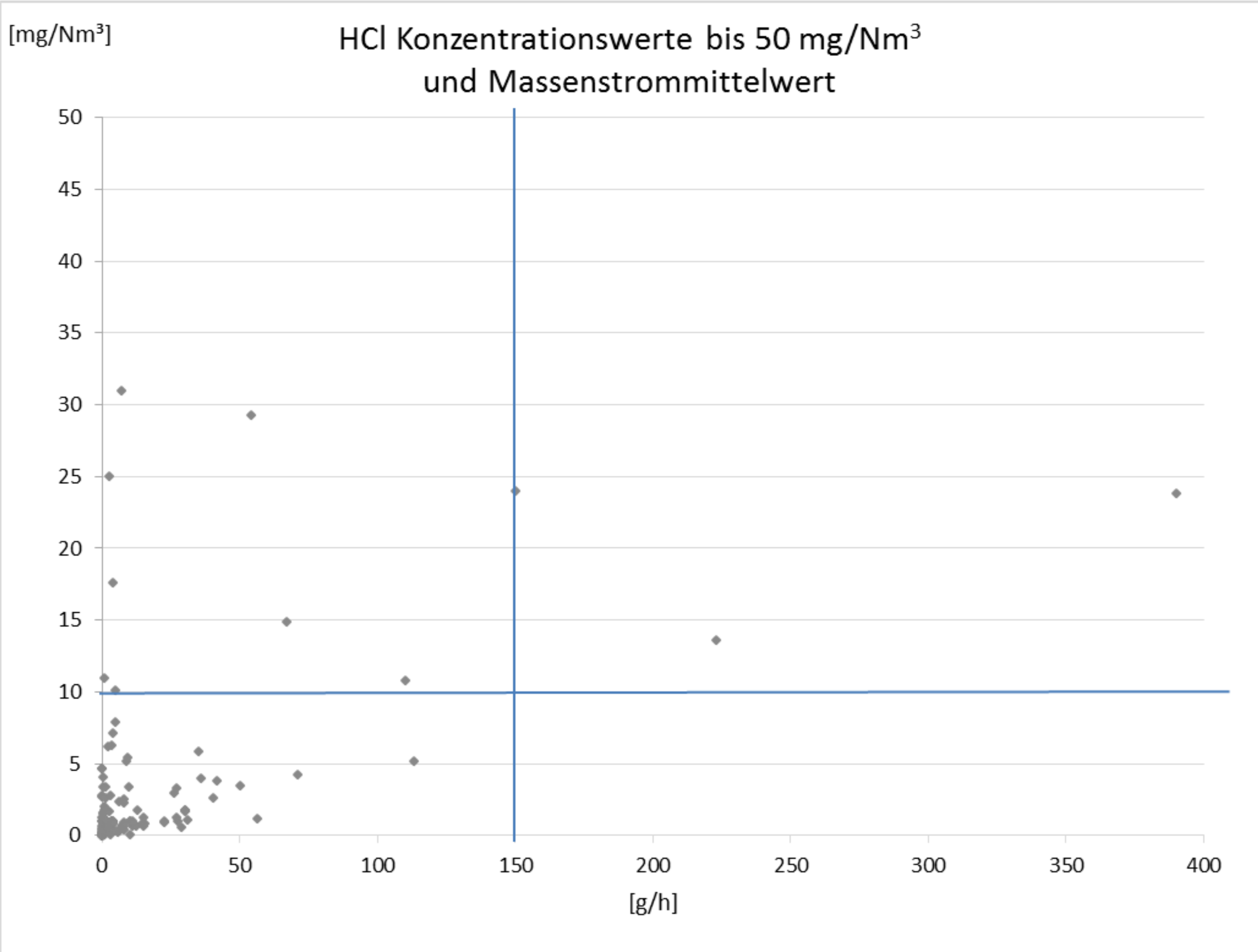
Im Ergebnis zeigt die Analyse der SOx-Daten:

- Abgasreinigung für Schwefeldioxide wird mit Wäschern oder prozessintegrierten Techniken realisiert (z.B. bei der Schwefelsäureproduktion).
- Wenn keine Abgasreinigung für SOx-Emissionen installiert war, lagen die Massenströmen unter 1500 g/h.
- Wäscher sind im Allgemeinen mit SOx-Emissionen unter 25 mg/Nm³ verbunden.
- Emissionen der Herstellung von Schwefelsäure (IED-Anhang 4.2.b) können nicht im Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie (WGC BREF) mit behandelt werden.
- Emissionen der Herstellung von Natriumhydrogensulfat (Nr. 4.1 der 4. BImSchV) und der Herstellung von Zementadditiven (4.1.8 der 4. BImSchV) benötigen eine gesonderte Betrachtung hinsichtlich der Aufnahme in den Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie (WGC BREF).

Chlorwasserstoff-Emissionen (HCl) – Kapitel 8

Zu Chlorwasserstoff (HCl) wurden 177 Datensätze ausgewertet. Abbildung 38 zeigt, dass die HCl-Konzentrationsmittelwerte allgemein unter 10 mg/Nm³ liegen (93 % der Werte). Wenn höhere Konzentrationsmittelwerte gemessen wurden, lag der Massenstrom unter 150 g/h, außer bei zwei Werten. Diese hatten Konzentrationsmittelwerte von 10 - 25 mg/Nm³ und einen Massenstrom von 200 - 400 g/h.

Abbildung 38: HCl Konzentrations- und Massenstrom-Mittelwerte



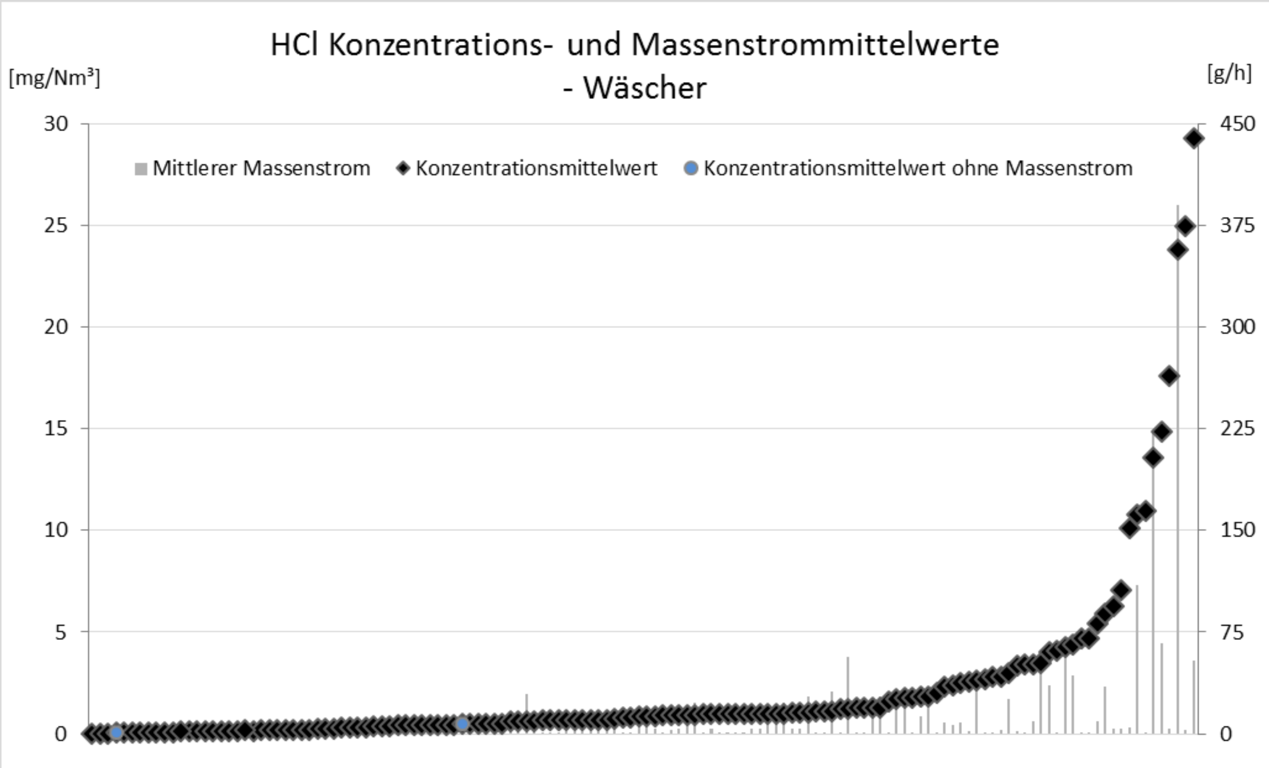
Anmerkung: Ein Wert mit einer Konzentration von 314 mg/Nm³ und einem Massenstrom von 73 g/h liegt außerhalb der Skala.

(Ökopol 2016)

Wäscher (139 Datensätze) sind allgemein mit HCl Konzentrationen unter 5 mg/Nm³ verbunden (91 % der Werte). Bei höheren Konzentrationsmittelwerten liegt der Massenstrom allgemein unter 150 g/h.

In zwei Fällen lag die Konzentration zwischen 10 - 25 mg/Nm³ und der Massenstrom zwischen 200 - 400 g/h. Die Emissionen stammen aus der Herstellung von Natriumhydrogensulfat und der Herstellung von halogenierten Kohlenwasserstoffen.

Abbildung 39: HCl Konzentrations- und Massenstrom-Mittelwerte von Wäschern



(Ökopol 2016)

HCl-Emissionswerte von Quellen ohne HCl-Abgasbehandlung (keine Abgasreinigung oder kein Wäscher) weisen allgemein Konzentrationen unter 10 mg/Nm³ und Massenströme unter 10 g/h auf (95 % der Werte). In zwei Fällen lag der Massenstrom zwischen 70 - 150 g/h, bei Konzentrationen zwischen 20 - 320 mg/Nm³.

Im Ergebnis zeigt die Analyse der HCl-Daten:

- wenn keine Abgasreinigung für HCl installiert ist, liegen die Massenströmen unter 10 g/h und die Konzentrationsmittelwerte liegen unter 10 mg/Nm³.
- Wäscher sind im Allgemeinen mit HCl-Emissionen unter 5 mg/Nm³ verbunden;
- Emissionen aus der Herstellung von Nichtmetallen, Metalloxiden oder sonstigen anorganischen bedürfen einer besonderen Prüfung, ob sie für den Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie geeignet sind (IED Anhang 1 Nr. 4.2.e);
- Anlagen zur Herstellung von Grignard-Verbindungen bedürfen ebenso einer besonderen Prüfung, ob sie für den Geltungsbereich eines BVT-Merkblattes zur allgemeinen Abgasbehandlung in der chemischen Industrie geeignet sind (IED Anhang 1 Nr. 4.1.g).

Fluorwasserstoff- und Bromwasserstoff-Emissionen (HF und HBr) – Kapitel 9 und 10

Zu Fluorwasserstoff-Emissionen (HF) wurden 41 Datensätze ausgewertet, zu Bromwasserstoff-Emissionen (HBr) 9 Datensätze. Die Konzentrationsmittelwerte liegen allgemein unter 1 mg/Nm³ (93 % der HF-Werte, alle HBr-Werte). Im Fall von HF haben Konzentrationen über 1 mg/Nm³ einen Massenstrom unter 3 g/h.

Chlor-Emissionen (Cl_2) – Kapitel 11

Zu Chlor-Emissionen (Cl_2) wurden 41 Datensätze ausgewertet. Konzentrationsmittelwerte liegen allgemein unter 3 mg/Nm³ (93 % der Werte). Konzentrationsmittelwerte über 3 mg/Nm³ haben einen Massenstrom unter 5 g/h.

Methanol-Emissionen (CH_4O) – Kapitel 12

Zu Methanol-Emissionen (CH_4O) wurden 80 Datensätze ausgewertet. Konzentrationsmittelwerte sind allgemein kleiner oder gleich 20 mg/Nm³ (83 % der Werte). Konzentrationsmittelwerte über 20 mg/Nm³ haben einen Massenstrom unter 30 g/h. Thermische Oxidation oder Aktivkohlefilter sind allgemein mit Methanol-Konzentrationen unter 5 mg/Nm³ verbunden (75 % der Werte). Wäscher oder Kondensatoren sind allgemein mit Konzentrationen < 20 mg/Nm³ verbunden (81 % der Werte). Konzentrationsmittelwerte über 20 mg/Nm³ haben einen Massenstrom < 10 g/h. Dies gilt auch für Quellen, die keine Abgasreinigung für organische Verbindungen haben: Auch hier liegen Konzentrationsmittelwerte im Allgemeinen unter 20 mg/Nm³ oder die Massenströme sind kleiner 10 g/h.

Essigsäure-Emissionen ($C_2H_4O_2$) – Kapitel 13

Zu Essigsäure-Emissionen ($C_2H_4O_2$) wurden 44 Datensätze ausgewertet. Die Konzentrationsmittelwerte sind allgemein < 20 mg/Nm³ (80 % der Werte). Konzentrationsmittelwerte über 20 mg/Nm³ haben einen Massenstrom < 150 g/h.

Thermische Oxidation oder Aktivkohlefilter sind allgemein mit Konzentrationen unter 5 mg/Nm³ (83 % der Werte) verbunden. Wäschers sind allgemein mit Konzentrationsmittelwerten unter 30 mg/Nm³ verbunden (90 % der Werte).

Emissionen von CMR –Substanzen – Kapitel 14 bis 23

Formaldehyd-Konzentrationsmittelwerte liegen allgemein unter 5 mg/Nm³ (79 % der 34 Datensätze). Konzentrationsmittelwerte über 5 mg/Nm³ haben einen Massenstrom unter 1 g/h in drei Fällen und in vier Fällen zwischen 12 - 110 g/h. Thermische Oxidation, katalytische Oxidation oder Aktivkohlefilter sind meist mit Konzentrationsmittelwerten unter 1 mg/Nm³ verbunden (67 % der Werte).

Ethylenoxid-Konzentrationsmittelwerte liegen allgemein unter 0,2 mg/Nm³ (90 % von 31 Datensätzen). Höhere Konzentrationsmittelwerte über 0,2 mg/Nm³ haben einen Massenstrom unter 0,5 g/h.

PCDD/F-Konzentrationsmittelwerte liegen im Allgemeinen unter 0,025 ng/Nm³ (83 % der 30 Datensätze).

Toluol- (kein CMR, aber in Verdacht) Konzentrationsmittelwerte liegen i.A. unter 20 mg/Nm³ (85 % der 26 Datensätze); thermische Oxidation und Aktivkohlefilter sind mit Konzentrationen unter 5 mg/Nm³ verbunden. Wenn Konzentrationsmittelwerte über 20 mg/Nm³ liegen, haben diese einen Massenstrom unter 80 g/h. Wenn keine Abgasreinigung installiert ist, lagen die Massenströme < 2 g/h.

Propylenoxide-Konzentrationsmittelwerte liegen alle unter 0,25 mg/Nm³ (24 Datensätze). Wenn keine Abgasreinigung installiert ist, liegen die Massenströme unter 2,5 g/h.

Benzol-Konzentrationsmittelwerte liegen allgemein unter 0,5 mg/Nm³ (83 % der 18 Datensätze). Konzentrationsmittelwerte über 0,5 mg/Nm³ haben einen Massenstrom unter 2 g/h. Wenn keine Abgasreinigung installiert ist, liegen die Massenströme unter 1 g/h.

Phenol-Konzentrationsmittelwerte liegen alle ≤ 1 mg/Nm³ (7 Datensätze). In einem Fall, bei dem keine Abgasreinigung installiert ist, liegen die Massenströme unter 1 g/h.

Toluoldiisocyanat-Konzentrationsmittelwerte liegen alle < 0,25 mg/Nm³ (18 Werte); Massenströme sind ≤ 10 g/h.

Vinylchlorid-Konzentrationsmittelwerte liegen alle unter 0,3 mg/Nm³ (11 Datensätze); Massenströme sind < 3 g/h.

Benzylchlorid (1 Datensatz) und **Epichlorohydrin** (2 Datensätze) zeigen nach Wäschern Konzentrationsmittelwerte unter 2 mg/Nm³. Die Konzentrationsmittelwerte über 1 mg/Nm³ haben einen Massenstrom unter 2,5 g/h.

Dichloroethan (10 Datensätze) und **Benzylchlorid** (2 Datensätze) zeigen nach thermischer Abgasbehandlung Konzentrationsmittelwerte unter 1 mg/Nm³.

Emissionen von nicht als CMR eingestuften halogenierten organischen Verbindungen – Kapitel 24

Zu Emissionen von halogenierten organischen Verbindungen, die nicht als CMR-Substanzen eingestuft sind, wurden 47 Datensätze ausgewertet. Thermische Oxidation, katalytische Oxidation oder Aktivkohlefilter sind allgemein mit Konzentrationsmittelwerten unter 5 mg/Nm³ verbunden (78 % der Werte); Konzentrationen über 5 mg/Nm³ haben einen Massenstrom unter 100 g/h. Wäscher sind allgemein mit Konzentrationsmittelwerten unter 20 mg/Nm³ verbunden (95 % der Werte); ein höherer Wert hatte einen Massenstrom unter 5 g/h.

Emissionen von schädlicheren organischen Verbindungen – Kapitel 25

Zu Emissionen von schädlicheren organischen Verbindungen (aufgelistet in Anhang 1 des Berichtes) wurden 49 Datensätze ausgewertet. Thermische Oxidation und katalytische Oxidation sind mit Konzentrationsmittelwerten unter 5 mg/Nm³ verbunden (18 Datensätze). Wäscher sind allgemein mit Konzentrationsmittelwerten unter 10 mg/Nm³ verbunden (90 % of 31 Datensätze). Konzentrationsmittelwerte über 10 mg/Nm³ haben einen Massenstrom unter 100 g/h. Quellen ohne Abgasreinigung zeigen Werte unter 10 mg/Nm³ oder unter 30 g/h.

Metall-Emissionen – Kapitel 26

Quecksilber-Konzentrationsmittelwerte liegen allgemein unter 15 µg/Nm³ (73 % der 11 Datensätze). Konzentrationsmittelwerte über 15 µg/Nm³ haben einen Massenstrom unter 0,25 g/h.

Blei, Kobalt, Nickel, Selen und Tellur-Konzentrationsmittelwerte liegen (einzeln oder in Summe) < 0,01 mg/Nm³ (67 % of 42 Datensätze). Konzentrationsmittelwerte über 0,01 mg/Nm³ haben einen Massenstrom unter 0,5 g/h.

Antimon, Chrom, Kupfer, Mangan, Vanadium und Zinn-Konzentrationsmittelwerte liegen im Allgemeinen unter 0,5 mg/Nm³ (84 % der 49 Datensätze). Konzentrationsmittelwerte über 0,5 mg/Nm³ haben einen Massenstrom < 1,0 g/h.

1 Context

1.1 Objectives and scope

This report is the result of a research project by Ökopol Institute on behalf of Germany's Environment Agency ("Umweltbundesamt"), executed between November 2014 and October 2016.

The project aims at the compilation and assessment of air emission data from the chemical industry sector in Germany. Besides being covered by national regulations, all installations of the sector are subject to regulations under the European Industrial Emissions Directive (IED 2010).

Table 7 shows chemical industry activities covered by the scope of the EU IED:

Table 7: Chemical industry activities under the scope of the EU Industrial Emissions Directive

4. Chemical industry: For the purpose of this section, production within the meaning of the categories of activities contained in this section means the production on an industrial scale by chemical or biological processing of substances or groups of substances listed in points 4.1 to 4.6	
4.1. Production of organic chemicals, such as:	(a) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic);
	(b) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters and mixtures of esters, acetates, ethers, peroxides and epoxy resins;
	(c) sulphurous hydrocarbons;
	(d) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates;
	(e) phosphorus-containing hydrocarbons;
	(f) halogenic hydrocarbons;
	(g) organometallic compounds;
	(h) plastic materials (polymers, synthetic fibres and cellulose-based fibres);
	(i) synthetic rubbers;
	(j) dyes and pigments;
	(k) surface-active agents and surfactants.
4.2. Production of inorganic chemicals, such as:	(a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride;
	(b) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids;
	(c) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide;
	(d) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate;
	(e) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide.
4.3. Production of phosphorous-, nitrogen- or potassium-based fertilisers (simple or compound fertilisers)	
4.4. Production of plant protection products or of biocides	
4.5. Production of pharmaceutical products including intermediates	
4.6. Production of explosives	

(IED 2010, Annex I)

1.2 BAT Reference Documents and Strategy to Review the Chemical BREFs

For industrial sectors with relevant environmental impact potential, the Industrial Emissions Directive of the European Union (2010/75/EU) requires a European-wide information exchange („Sevilla Process“) for determination of best available techniques (BAT) in BAT Reference Documents (BREFs). (IED 2010)

The objective of the Industrial Emissions Directive is the creation of a European-wide harmonized permitting system based on BAT Reference Documents. By this system, EU Member States shall achieve an approximation of standards for environmental protection on a high level.

For plants of environmental concern and covered by the Industrial Emissions Directive, European Member States have to ensure by permitting and inspection that compliance is ensured with emission values. These emission values can be achieved with best available techniques (BAT) and are documented in the BAT Reference Documents and related BAT Conclusions. Hence, BAT Reference Documents provide guidance regarding emission values associated with best available techniques. The emission values are expressed for example as ranges of concentrations or as loads. If relevant, applicability restrictions are documented for each of the techniques concluded to be BAT. The BAT Reference Documents determine European-wide standards for prevention and reduction of emissions as well as for energy efficient and sustainable production.

BAT Conclusions of the BAT Reference Documents (BREFs) are determined by representatives of the European Commission, Member States, industry concerned and environmental NGOs. They are published as legally binding documents in the Official Journal of the European Union and translated in all EU member state languages. In existing installations of the European Union, compliance with BAT Conclusions is required in at the latest four years after their publication. BAT Conclusions have attracted international attention and are used by world-wide experts to determine best available techniques.

For the chemical sector, eight BAT Reference Documents were developed between December 1997 and August 2007 (see Table 8). Until 2016, for three documents (CAK, CWW, LVOC) a revision process was realized. BAT Conclusions (BATC) have been published for the CAK BREF and the CWW BREF, see also http://eippcb.jrc.ec.europa.eu/reference/ for download of documents. (EIPPCB 2016)

Table 8: Chemical industry sector BREFs developed in the European Union

Name	BREF Published	BATC Published
Chlor-Alkali Manufacturing Industry (CAK BREF 2001)	12/2001	
Chlor-Alkali Manufacturing Industry (CAK BREF 2014, BATC 2013)	10/2014	12/2013
Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (CWW BREF 2003)	02/2003	
Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (CWW BREF 2016, BATC 2016)	07/2016	06/2016
Large Volume Organic Chemicals (LVOC BREF 2003)	02/2003	
Manufacture of Organic Fine Chemicals (OFC BREF 2006)	08/2006	
Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers Industries (LVIC–AAF BREF 2007)	08/2007	
Manufacture of Large Volume Inorganic Chemicals – Solids and Others Industry (LVIC–S BREF 2007)	08/2007	
Production of Speciality Inorganic Chemicals (SIC BREF 2007)	08/2007	
Production of Polymers (POL BREF 2007)	08/2007	

(EIPPCB 2016)

In September 2014, the European Commission presented a "Working Document - Reconsideration of the 'Strategy to review the chemical BREFs'" to the Stakeholder Forum established according to Article 13 of the Industrial Emissions Directive. In the Working Document, the Commission reconsidered the Chemical Strategy as adopted in 2007. The Commission proposed a new approach for the revision of the eight chemical sector BREFs. (EC 2014)

The EC Working Document was commented by the Forum members and discussed on the subsequent meetings of the Article 13 Forum, taking place in December 2014 and in October 2015. (EC 2015a, EC 2015b)

In October 2015, the European Commission concluded:

"The forum confirmed the need to conduct the review of the chemical BREF series with more effectiveness and efficiency, and more specifically to readjust the balance between generic and specific BAT conclusions, relying on the following general principles:

- Targeted effort: ensure that resource inputs match information exchange outputs, and focus TWG efforts on BAT/BAT-AELs for key environmental issues;
- Transparency: enhance transparency of the information exchange;
- Efficiency: ensure that efforts made so far are not wasted and avoid further delays to BREF reviews;
- Generic BAT if possible: define BAT/BAT-AELs at the most generic level possible and describe specific products/processes only if key environmental issues cannot be adequately covered by generic BAT."

(EC 2015b)

Following these principles and addressing air pollutants common to the chemical industry, the Commission started in September 2016 with the activation of a European working group for a BAT Reference Document on Common Waste Gas Treatment in the Chemical sector (WGC BREF). (EC 2016)

As agreed on the Article 13 Forum meeting in October 2015, the revised Working Plan of the European Commission foresees, that the drawing up of the new WGC BREF will involve:

- "Collecting comprehensive and representative information and data on abatement techniques and emission levels across the whole chemical industry;
- Collecting information and data from specific products/processes that might require a dedicated approach (e.g. by relying on current BREFs or Member States' legislation);
- A thorough analysis of the information and data collected;
- The definition of generic BAT and BAT-AELs for emissions to air for the whole chemical industry, while identifying processes requiring further specific consideration."

(EC 2015b)

On this background, this report presents the findings of a research project by Ökopol Institute on behalf of the German Environment Agency, conducted from 2014 to 2016 as a contribution to the information exchange on best available techniques for waste gas treatment in the chemical sector organized in the framework of the European Industrial Emissions Directive (2010/75/EC).

2 Data collection

2.1 Proceeding

For the data collection, the common working group ("AISV") of Germany's Federal Ministry of Environment (BMUB) and the competent authorities of the federal states ("Bundesländer") was informed about the project of the Environment Agency and was asked for support by providing measurement reports of the chemical industry sector.

It was agreed with the UBA to focus the data collection on periodic measurements. This approach was followed because results of periodic measurements are documented in reports which contain relevant information about the waste gas treatment systems as well as information on the related processes.

2.2 Challenges of the data collection

Measurement results are documented in measurement reports of several dozens of pages. In competent authorities, most of the measurement reports are only available in paper form. Additionally, the paper document has a fixed bonding that doesn't allow easy disassembling for its electronic scanning. If the original document shall not be destroyed, a time-consuming page-by-page manual scanning is necessary to produce an electronic document. For this reason, most documents are only available in paper form. Most competent authorities aim at an electronic registration of the measurement results as well as additional context information. At present, the systems are installed, but in most cases it is a voluntary task to copy the results into the system. Due to other priority tasks and time-consuming copy-and-paste work, the electronic data base systems are not used widely, yet.

For the research project, competent authorities have provided both paper documents and electronic PDF documents. One competent authority provided measurement results and contextual information in an excel file.

2.3 Monitoring information

Monitoring reports generally comprise information about the type of installation, about one or several measured sources, about associated processes and about process conditions during measurement (some also include substances involved), waste gas abatement system, measurement standards and measurement results, as well as permit values.

Emission values are generally expressed in concentrations and mass flows under standard conditions; this means that measurement results are converted into dry waste gas volume at 273 K and 1013 hPa. To comply with periodic measurement requirements, in most cases three measurements of 30 minutes duration are performed and documented in the measurement report, together with the measurement conditions.

The results comprise each concentration values and the related waste gas volume, mass flow and information on temperature, humidity and oxygen content. Measurement results are both documented under measured conditions and after convertion under standard conditions. Where required in the permit, additional convertion to a reference oxygen content is undertaken (in general where combustion processes for heat or electricity generation are monitored, to for thermal oxidation or other waste gas treatment in the chemical industry). Generally, the measurement uncertainty is provided in the reports. Most reports comprise a summary providing the mean concentration of all measured periods as well as the the maximum value; often the maximum value is documented additionally with the measurement uncertainty added as well as subtracted.

Some of the measurements result in values below the detection limit. In this case, the results are presented in the reports with a "smaller than" ("<") symbol in front of the detection limit value. If measurement results are below the detection limit, the mean values are calculated in two different ways: values below the detection limit can be included in the mean value by calculating with the detection limit value or by calculation with 50 % of the detection limit value. The resulting mean is presented in the report with a „<“ sign.

In Germany, all measurements of air emissions have to be conducted during normal operating conditions and under process conditions that generate maximum emission levels. The process conditions during the measurements are observed and documented in the measurement reports.

In Germany, each measurement has to comply with an emissions limit value expressed as maximum concentration [mg/Nm³] or – where low mass flows occur – as maximum mass flow [g/h]. Mass flows emission limits always refer to the entire installation to avoid that many small emissions from several sources occur. Therefore, for compliance check with the maximum mass flow, the mass flows of all souces of an installation are summed up.

2.4 Collected reports and monitored parameters

In October 2016, inspection lists published by the competent authorities of the federal states of Germany reported 2 017 installations of the chemical industry sector (see Annex 55) according to IED Annex 1 numbers 4.1 to 4.6 respectively numbers 4.1 and 4.6 of the German Ordinance on Installations Requiring a Permit (4. BImSchV 2013). For this report, 550 measurement reports were collected and assessed, hence about every forth chemical installation of Germany was covered by the study. Combustion plants and waste incineration plants at chemical installations were not included in the study.

As chemical installations often have more than one emission source to air, the data collection covers a total of 1 209 sources. At each source, more than one parameter may be measured and documented in the same measurement report. Therefore, 2 972 measurement data sets were assessed, each of them reported with mean values (for concentration, mass flow, volume), based in general on at least three measurements of half an hour duration, conducted subsequently on the same day during normal operating conditions at production conditions generating the maximum emission level. The periodic measurement results were converted into normalized values (dry air, 1013 hPa, 273 K); measurement uncertainties have neither been subtracted nor added to the assessed data.

Where periodic measurement is required in chemical installations of Germany, they are generally realized every three years. Therefore, measurements from different years were collected, generally including latest measurement results of most recent calender years. Most data originate from measurements realized between 2012 and 2015. Table 9 indicates the years of the measurements assessed.

Table 9: Year of the measurements assessed

Year	Number of parameters measured
2008	11
2009	41
2010	73
2011	183
2012	544
2013	952
2014	720
2015	347
Sum	**2 871**
Several years	101
Sum	**2 972**

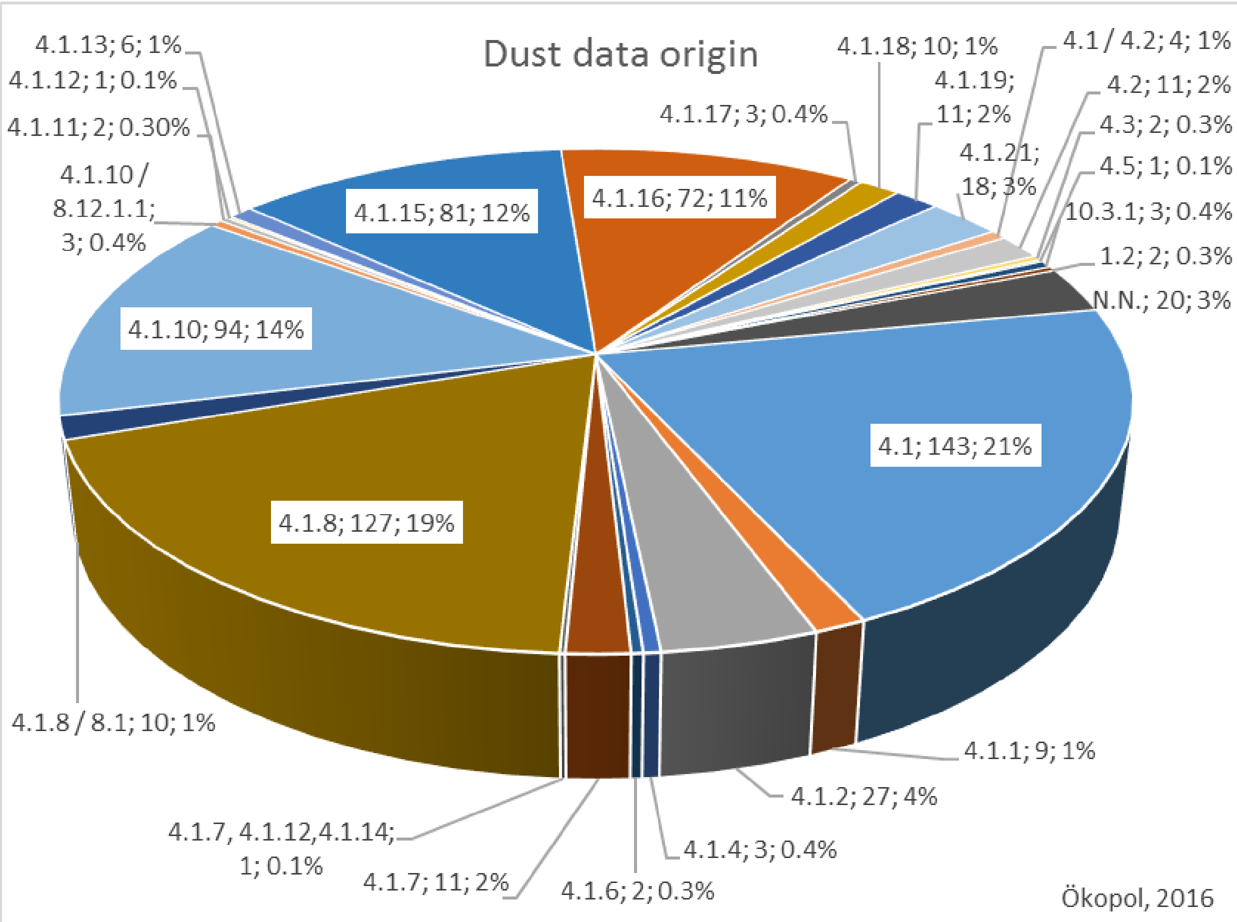
Figure 40 shows the origin of the measurements for the example of dust data (682 data). Process numbers relate to the numbering of the 4. BImSchV as provided in the measurement reports (compare Annex 2, Table 24).

Most sources (21 % of total) are reported without further specification of the detailed number 4.1 of the 4. BImSchV. The general group is characterized as: „Installations for the production of substances or groups of substances by chemical transformation on industrial scale, excluding installations for the production or fission of nuclear fuels or for the reprocessing of spent nuclear fuels".

The second biggest group of dust data (19 % of total) originates from sources specified with number 4.1.8 of 4. BImSchV, indicating the production of basic plastic materials (synthetic resins, polymers, man-made fibres, fibres on basis of cellulose).

The three next largest groups of sources with dust measurements (11 - 14 % of total) originate from numbers 4.1.10 of 4. BImSchV (dyestuffs and pigments as well as intermediates for dyes and paint materials), number 4.1.15 of 4. BImSchV (salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate) and number 4.1.16 of 4. BImSchV (non-metals, metal oxides or other inorganic compounds, such as calcium carbide, silicon, silicon carbide, inorganic peroxides, sulphur).

Figure 40: Chemical processes linked with dust measurement results (4. BImSchV numbers)



Lists of all measured parameters and related waste gas treatment can be found in the annexes where also information is provided

- Type of process (process number according to 4. BImSchV);
- Estimated type of waste gas treatment: stand alone for one process (S) or centralized (C);
- Measurement method, e.g. International Standard (ISO), European Standard (EN), German Standard (DIN), German Engineers Association Standard (VDI) or other;
- Waste gas volume (in case of several measurements the mean of the volume flow was calculated);
- Mass flow (mean value of periodic measurements);
- Mean concentration (mean value of periodic measurements; where measurement results were below the detection limit, 50 % of the detection limit is reported, together with the original measurement result and its reported measurement unit).

Table 10 shows substances (or groups of substances) measured most frequently in the 550 reports assessed.

Table 10: Substances most frequently measured

Substance	Number of measurements	Substance	Number of measurements
Dust	682	Dioxins and furans	30
TOC	438	Toluene	26
Nitrogen oxide	211	Propylene oxide	24
Hydrogen chloride	177	Nickel	24
Carbon monoxide	123	Chloromethane	22
Sulphur dioxide	92	Benzene	18
Ammonia	80	Toluene diisocyanate	18
Methanol	80	Copper	15
Acetic acid	44	Chromium	14
Hydrogen fluoride	41	Manganese	12
Chlorine	41	Vinyl chloride	12
Formaldehyde	34	Mercury	11
Ethylene oxide	31	Dichloro ethane	10

2.5 Waste gas treatment

Measurement reports from periodic measurement include a section on waste gas treatment. The information provided in the reports reveals details on the type of waste gas system. Table 11 shows abbreviations used in graphs and tables of the report for indicating the type of waste gas abatement system.

Table 11: Type of waste gas treatment systems and abbreviations used in the graphs

Abbreviation	Waste gas treatment system (1)	Abbreviation	Waste gas treatment system (2)
AB	absorber	F	filter
AC	activated carbon	FF	fabric filter
AD	adsorber	Flare	flare oxidation ("Muffelfackel")
BF	biofilter	GW	glow wire oxidation ("Glühdraht")
BU	additional burner	HE	heat exchanger
C	condensation	MF	membrane filters
CART	cartridge filter	Q	quench
CF	candle filter	RU	recovery unit
COX	catalytic oxidation	S	scrubber
CY	cyclone	SCR	selective catalytic reduction
DD	DeDiox (PCDD/F abatement)	SNCR	selective non-catalytic reduction
DeNOx	DeNOx	SP	special system (e.g. combined flows with
DS	droplet separator		different pre-treatments, special filters)
DT	dip tank	SR	solvent recovery
ESP	electrostatic precipitator	TO	thermal oxidation
N. N.	no information available	none	no waste gas cleaning

The term "Special system" ("SP") was used for other abatement systems than the ones listed in the table (e.g. where waste gas after pre-treatment from different sources is treated in a combined abatement system).

If reports showed evidence that no waste gas abatement is installed, "none" was used. In few cases where a report did not clearly indicate whether a waste gas abatement system was used or not, "N. N." was applied.

In the measurement reports, waste gas treatment systems were not always described with all details. Therefore general expressions and copy-and-paste terms were documented according to the information provided in the reports, like "filter", "special systems", "additional burner". In some cases "heat exchangers" were reported. Heat exchangers may have similar effects as condensation systems, therefore they are indicated whenever they were mentioned in the waste gas abatement section of the measurement reports.

Table 12 shows the most frequent types of waste gas treatment systems installed and the number of measured parameters associated with each type of system. Where "filters" were named, it was assumed that fabric filters are installed. Where "absorbers" were mentioned, they were assumed to be scrubbers. Where "additional burner" was mentioned, these are used e.g. to heat-up a subsequent catalyst. If "adsorption" was specified as an adsorption system using activated carbon, this system was combined with "activated carbon"; other adsorption systems (e.g. on clay) or unspecified adsorption systems were indicated separately as "adsorption".

Table 12: Most frequent types of waste gas systems installed (alone or in combination)

Abbreviation	Waste gas treatment system	Number of parameters measured after the system
S (or AB)	scrubber (+ "absorber")	1 199 (+6)
FF (or F)	fabric filter (+ "filter")	589 (+192)
TO	thermal oxidation or regenerative thermal oxidation	479
C	condensation	151
AC	activated carbon	117
CY	cyclone	108
COX	catalytic oxidation	75
SCR	selective catalytic reduction	69
SNCR	selective non-catalytic reduction	21
AD	adsorption	23
BU	additional burner	12
ESP	electrostatic precipitator	6
none	no waste gas cleaning	412

2.6 Data assessment

In the following chapters, an evaluation of measurement results is done for all parameters. Some parameters were grouped according to their risk, e.g. substances classified with cancerogenic, mutagenic or reproduction toxic (CMR) properties. For each parameter and each measurement result, the mean waste gas concentration of all periodic measurements documented in the report and the related mean mass flow were assessed in combination.

Where mass flow and concentration values are plotted and assessed together, mass flow values are always presented as bars, concentration values as rhombus or dots.

Measurement results reported below a detection limit were plotted in the graphs with half the detection limit value (to distinguish from values on the same level as the detection limit.

In the annex, all mean values are listed, including mean volumes and original measurement values of the reports (see "<" symbols indicating results below the detection limit).

If waste gas treatment systems are indicated in the graphs of this report, abbreviations indicate the type of abatement system at the bottom (x-axis) of each measurement value.

Due to legal requirements, it has to be noted that all measurements were realized during normal operating conditions and under process conditions that generate maximum emission levels.

In cases where measurement results were reported as originating from other than normal conditions (OTNOC), the results were excluded from the assessment. OTNOC that occurred during the measurement period were e.g. malfunctions of the waste gas abatement system or malfunctions of the measurement equipment. Measurement values not in compliance with the permit were considered as originating from OTNOC; they were also excluded from the data assessment.

For each parameter, mean concentration values and mean mass flow values of generally three consecutive measurements given in the emission reports were assessed first. The graph provides a general overview on emission concentrations achieved. They also show a mass flow threshold. Below this mass flow threshold a striking number of values exceeds an emission concentration generally achieved with the techniques. The share of values with a low mass flow and high emission concentration does not follow a general principle like "10 % of total data" or "15 % of total data", but the number of such values varies for each parameter. For example, dust emissions show generally low concentrations with few exemptions whereas TOC emissions show a high number of high emission concentrations with a low mass flow, e.g. when emissions from storage tanks are measured or displacement air from filling.

After the general chart, the subsequent charts analyse emissions associated with the waste gas abatement systems, grouped according to similar characteristics. For this group of data it is analysed which general level of emission concentration is associated with the technique. Finally, a chart is presented for all data where no waste gas abatement system is reported. It is analysed whether a general mass flow threshold can be observed, associated with emissions where no waste gas system is installed.

2.7 Process examples linked with data outliers

In the subsequent assessments, a first analysis of outliers and related processes is made on the graph showing all data of a parameter. Subsequently, for each group of waste gas abatement systems, the outliers and related processes are analysed. The following list shows exemplary outliers:

- TOC: production of plastic materials (polymers, synthetic fibres and cellulose-based fibres: slab stock or moulded polyurethane foam production using hydrocarbons like pentane as blowing agents (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV) and production of surface-active agents and surfactants (IED Annex 1 no. 4.1.k respectively no. 4.11 of 4. BImSchV).
- NOx: fertilizer production (IED Annex 1 no. 4.3 respectively no. 4.1.17 of 4. BImSchV) and nitrogenous hydrocarbons (IED Annex 1 no. 4.1.d respectively no. 4.1.4 of 4. BImSchV).
- NH_3: production of PVC polymers (IED Annex 1 no. 4.1. h respectively no. 4.1.8 of 4. BImSchV), production of fertilizers (IED Annex 1 no. 4.3 respectively no. 4.1.18 of 4. BImSchV), production of aromatic hydrocarbons containing fluorine (IED Annex 1 no. 4.1 f respectively no. 4.1.1 of 4. BImSchV), production of flame retardands (no. 4.1 of 4. BImSchV) and production of nitrogenous hydrocarbons (IED Annex 1 no. 4.1.d respectively no. 4.1.4 of 4. BImSchV).
- SOx: production of sulphuric acids (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV), of sodium hydrogen sulphate (4.1 of 4. BImSchV) and of cement additives (4.1.8 of 4. BImSchV).
- HCl: production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV).

The following chapters present the results of the data assessment for each parameter, sorted by the number of measurements available for each of the parameters (see above, Table 10).

3 Dust

3.1 Dust measurement

Dust concentrations are usually measured by dust collection on a filter and manual gravimetric determination of the dust content. Generally, method EN 13284-1 is used. Additionally, VDI 2066 is applied, identical with EN 13284 for cleaned-up gas with concentrations up to 50 mg/Nm³ (application range A of VDI 2066).

- EN 13284-1:2002 - Stationary source emissions - Determination of low range mass concentration of dust - Part 1: Manual gravimetric method.
- VDI 2066 Bl. 1:2006 (confirmed 2012) - Particulate matter measurement - Dust measurement in flowing gases - Gravimetric determination of dust load.

3.2 Dust treatment

Table 13 shows the types of waste gas treatment applied for dust emission reduction. In total 682 data sets were reported. Fabric filters or similar types of abatement are most commonly used (61 % of data), followed by scrubbers (23 % of data). Data from processes where no dust-specific abatement system is installed, were identified from 13 % of the data.

Table 13: Waste gas treatment systems applied where dust emissions are measured

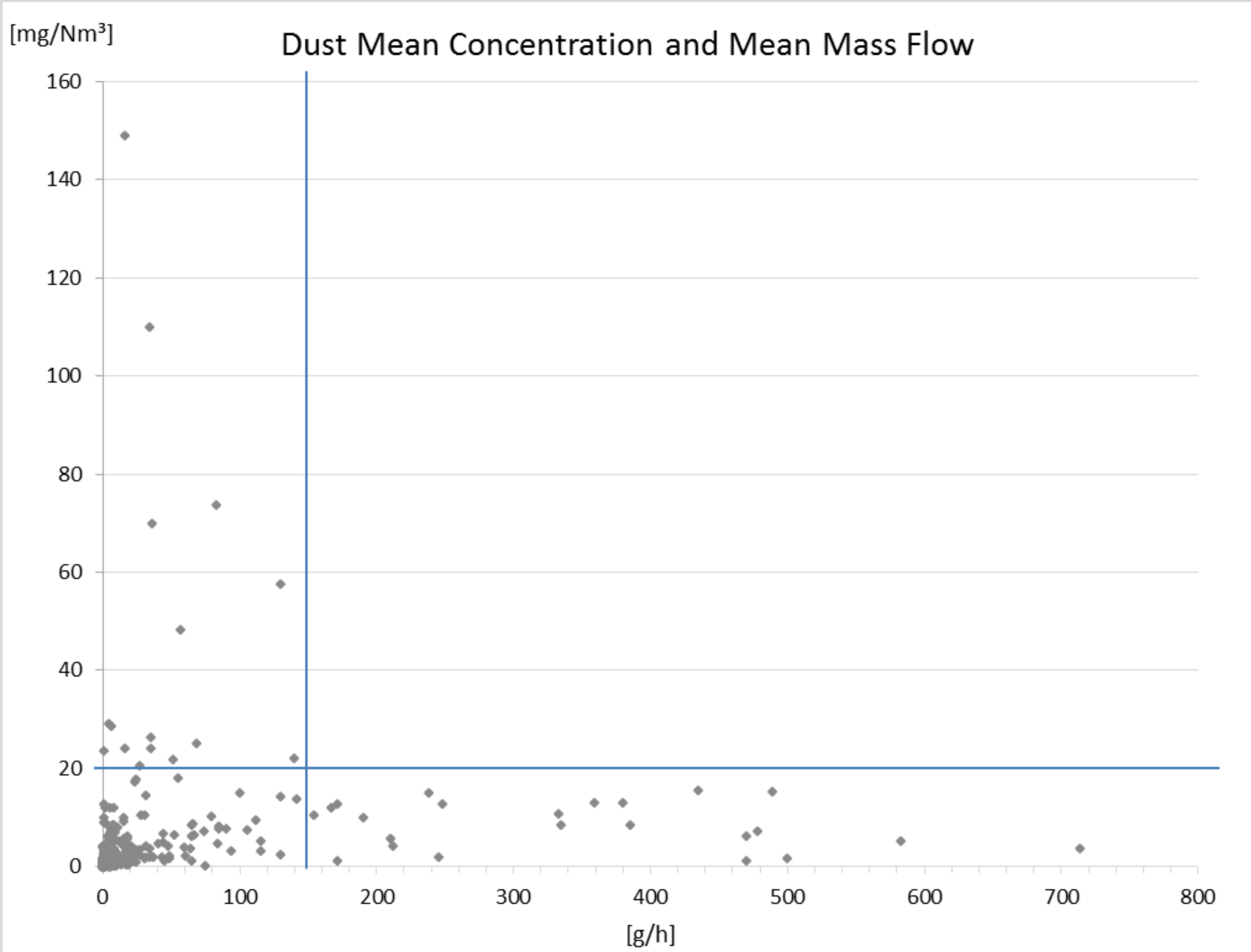
Abbreviation	Waste gas system	Number of parameters measured after the system
FF or F or CART or MF	Fabric filter or “filter” or cartridge filter or membrane filter (partly combined with scrubbers)	418
S	Scrubbers	155
None, without FF or F or CART, MF, ESP or S	No dust-specific abatement (without fabric filter, filter, cartridge filter, membrane filter, electrostatic precipitator or scrubber)	88
ESP, without S	Electrostatic precipitator, not in combination with other systems like scrubbers or fabric filters	5
CY	Cyclones (not combined with systems above)	14
Other	Other combination of less precisely described systems (“solvent recovery”, “N. N.”)	2
	Total	**682**

3.3 Dust concentration and related mass flow

Figure 41 shows all mean dust concentration values and the related mean mass flow data (682 data). For all except 31 data the mass flow of the source has been reported. A detailed list of data is provided in Annex 3 to Annex 6.

Mean dust concentrations are generally below 20 mg/Nm³ (98 % of data), most mean values are also below 10 mg/Nm³ (94 % of data); where a mean concentration of 20 mg/Nm³ was exceeded, the mean mass flow was below 150 g/h (all data). No data were reported with high concentrations and mass flows above 150 g/h.

Figure 41: Dust mean concentration and mean mass flow



(Ökopol 2016)

3.4 Dust emissions from sources with fabric filter systems

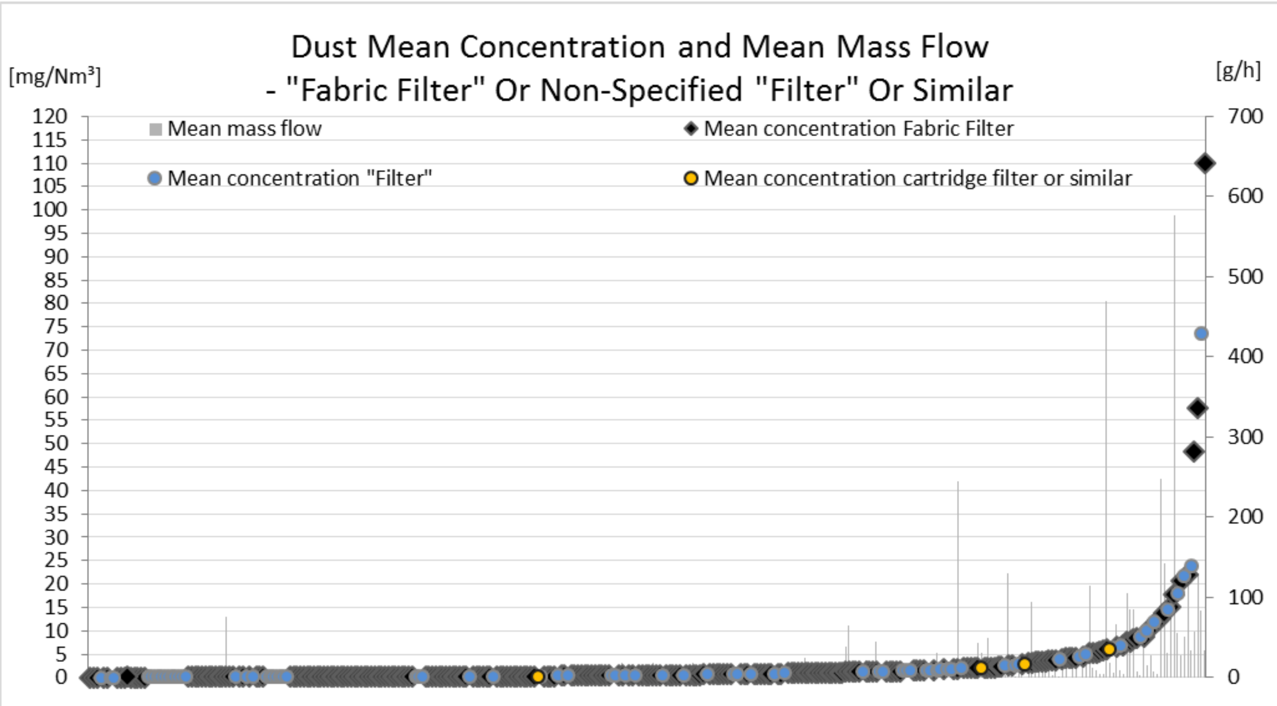
Data show that fabric filters and similar systems (478 data) are generally associated with dust mean concentration values below 5 mg/Nm³ (90 % of data). Where concentrations are higher, mean mass flows are below 150 g/h, except two data (with concentrations of 6.1 mg/Nm³ and 12.8 mg/Nm³).

These two higher mass flows (248 - 470 g/h) originate from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV) and from the production of special inorganic chemicals (IED Annex 1 no. 4.2 respectively no. 4.1.21 of 4. BImSchV).

Figure 42 shows dust emissions from sources with fabric filters (black rhombus). Where dust cleaning systems were indicated in the measurement reports as “filter” (without further specification), fabric filters are assumed (blue dot). Cartridge filters and sinter plate filters are plotted as similar systems (orange dots).

Information on waste gas treatment systems shows that fabric filters are the main filter in the large majority of installations, however, a few fabric filters a combined with other dust treatment systems like cyclons or scrubbers. Detailed information on each data set can be found in Annex 3.

Figure 42: Dust emissions from sources with fabric filters and similar systems



(Ökopol 2016)

3.5 Dust emissions from sources with scrubbers or dip tanks

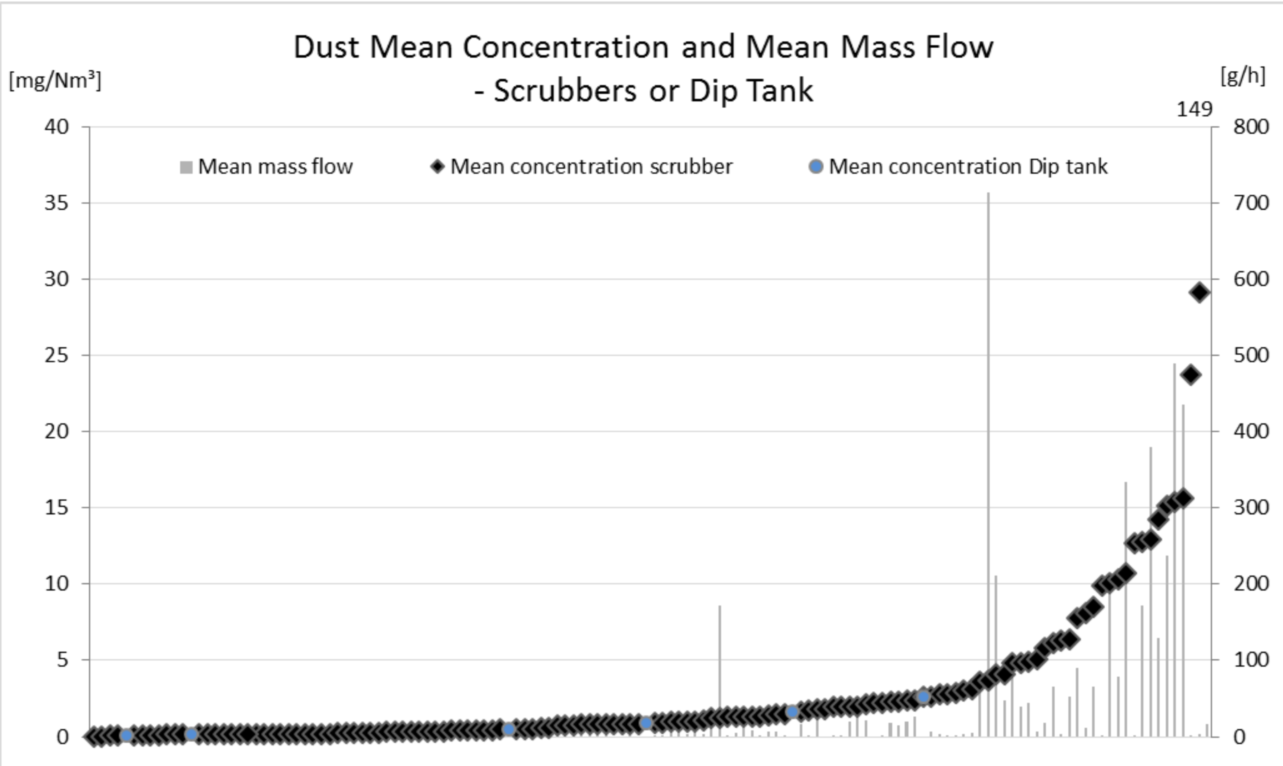
Figure 43 shows dust emissions from sources with scrubbers (black rhombus, 149 data) or with dip tanks (blue dot, 6 data). Detailed information on each data set can be found in Annex 4. In few cases where scrubbers are combined with fabric filters, data was reported in the previous chapter.

Data show that scrubbers or dip tanks are generally associated with dust concentrations below 10 mg/Nm³ (92 % of the data). Where concentrations are up to 20 mg/Nm³, the corresponding mass flow is below 150 g/h in six cases and below 500 g/h in another six cases.

Highest mass flows originate in two cases from the production of plastic materials (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV), in another two cases from the production of of oxygen-containing hydrocarbons (IED Annex 1 no. 4.1.b respectively no. 4.1.2 of 4. BImSchV) and in two cases from other production of organic chemicals (IED Annex 1 no. 4.1 respectively no. 4.1 of 4. BImSchV).

The highest concentration value is out of range but indicated in the figure (149 mg/Nm³). It has a low mass flow of 16 g/h and originates from a production of organic chemicals (IED Annex 1 no. 4.1.a respectively no. 4.1.1 of 4. BImSchV).

Figure 43: Dust emissions from sources with scrubbers or dip tanks



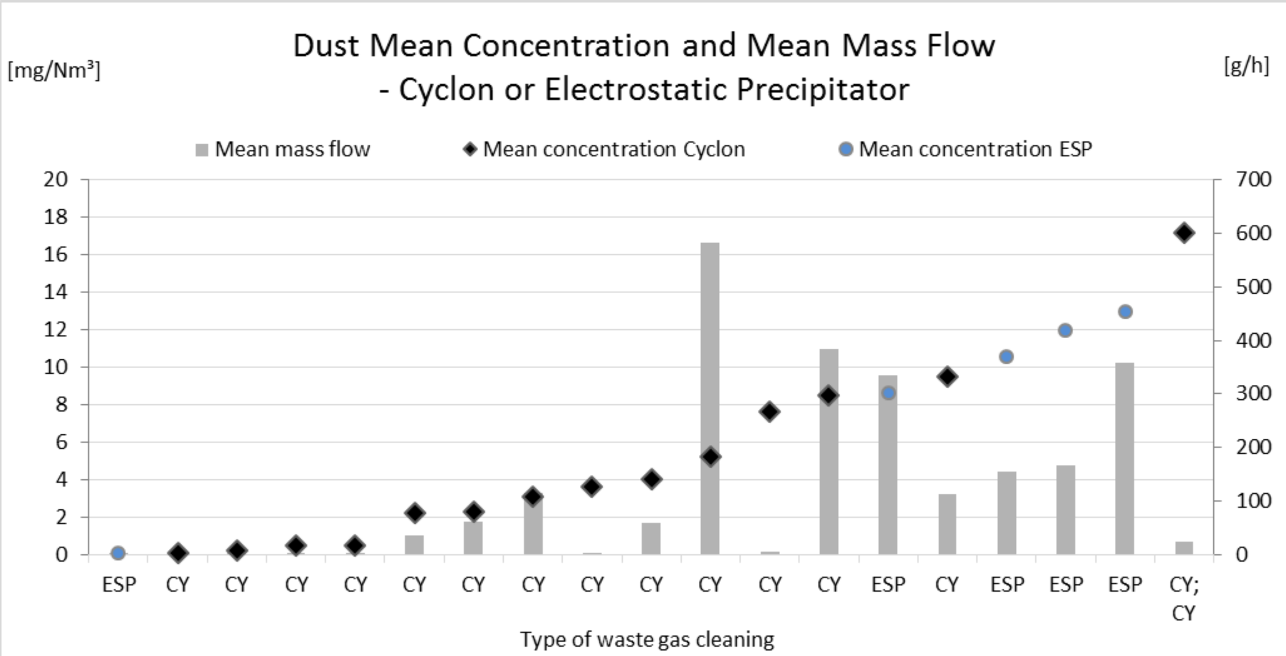
(Ökopol 2016)

3.6 Dust emissions from sources with cyclones or electrostatic precipitators

Figure 44 shows dust emissions from sources where only cyclones are installed (CY, black rhombus, 14 data sets) or electrostatic precipitators (ESP, blue dot, 5 data sets). Dust concentrations are below 20 mg/Nm³. Measurements after ESP show mainly values between 8 - 14 mg/Nm³; one value was below 1 mg/Nm³.

Detailed information on each data set can be found in Annex 5.

Figure 44: Dust emissions from sources with cyclones or electrostatic precipitator systems



(Ökopol 2016)

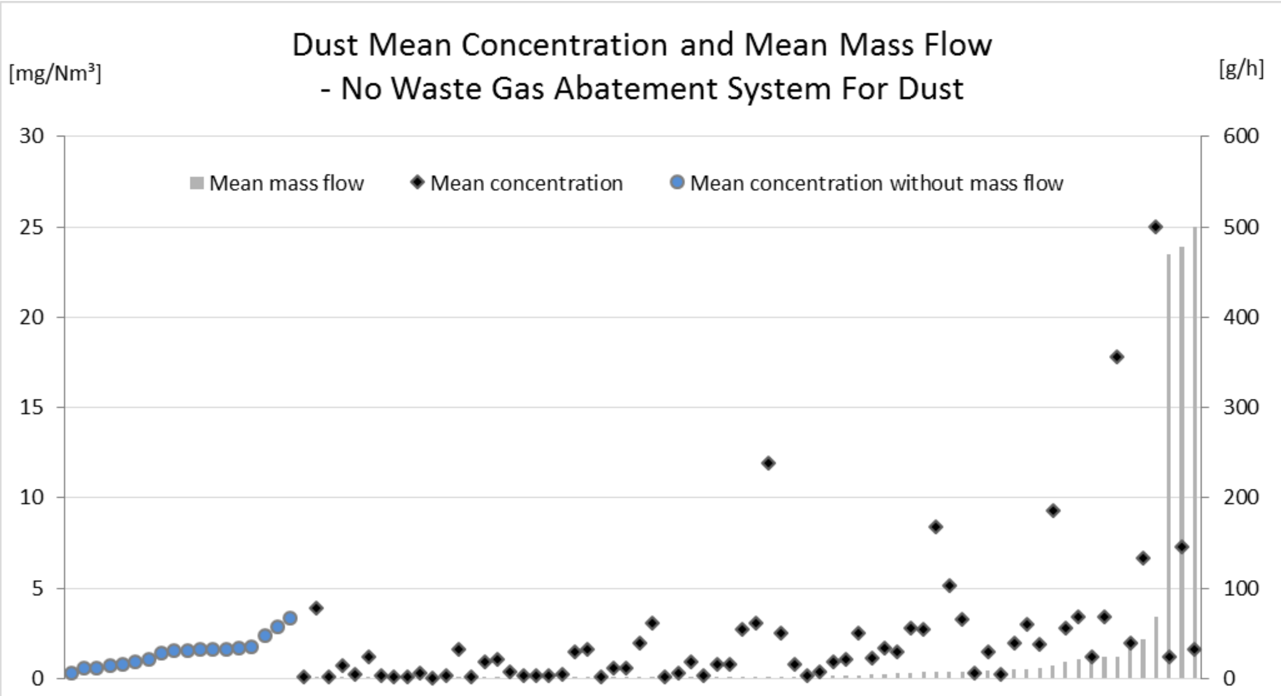
3.7 Dust emissions from sources without dust-specific waste gas treatment

Figure 45 shows dust emission data from sources where no waste gas treatment for dust is installed (neither mechanical filters nor scrubbers, 88 data sets). Data is sorted by mass flow. Data provided without mass flow is plotted first (blue dots).

Generally, dust concentrations are below 5 mg/Nm³ (91 % of data). Where concentrations are higher, they are generally associated with low mass flows < 100 g/h except one case (see before last bar in the chart) where a dust concentration of 7.3 mg/Nm³ is linked with a mass flow of 478 g/h. The data set originates from a cracker in the production of acids (IED Annex 1 no. 4.2.b respectively no. 4.1.13 of 4. BImSchV).

Detailed information on each data set can be found in Annex 6.

Figure 45: Dust emissions from sources without dust treatment system



(Ökopol 2016)

Two dust emission data were not plotted as the waste gas treatment system was either not specified (dust concentration of < 0.4 mg/Nm³) or it was not clear whether the waste gas treatment system involves a dust cleaning ("solvent recovery"; 32.9 mg/Nm³).

3.8 Conclusions for dust data

Dust data assessment shows:

- No dust-specific waste gas treatment is installed where mass flows are below 150 g/h.
- Where mass flows exceed 150 g/h, cyclons, electrostatic precipitators or fabric filters are installed.
- Emission values associated with fabric filters are generally below 5 mg/Nm³ (90 % of the data).
- Emission values associated with scrubbers are generally below 10 mg/Nm³ (92 % of data).
- The small number of measurements from installations where only cyclons or electrostatic precipitators are installed, shows concentrations below 20 mg/Nm³.

4 Total Organic Carbon (TOC)

4.1 TOC measurement

Concentrations of total organic carbon (TOC) are usually measured using a flame ionization detector (FID). The result refers to the carbon content of the organic compounds, not to the total volatile organic compound. In TOC measurement results, methane is included. Two methods are generally used:

- EN 12619:2013 - Stationary source emissions. Determination of the mass concentration of total gaseous organic carbon. Continuous flame ionisation detector method, or
- EN 13526:2000 - Stationary source emissions. Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes. Continuous flame ionisation detector method.

In some measurement reports, a VDI method was applied, which is equivalent to EN 12619:

- VDI 3481-3 - Gaseous emission measurement. Determination of volatile organic compounds, especially solvents, flame ionization detector (FID)

In one case, the following method was used to determine TOC:

- EN 25140:2010 - Stationary source emissions. Automatic method for the determination of the methane concentration using flame ionisation detection (FID).

Calculated (not measured) TOC values were not included in the assessment.

4.2 TOC treatment

Table 14 shows all waste gas treatment systems applied where TOC emissions are measured. The selection of "hot systems" (with thermal oxidation) or "cold systems" (with scrubbers) depends on the toxicity of the substances to be destroyed and on the energy needed to heat-up the waste gas volume. Where waste gas volumes are below 35 000 Nm^3/h and where toxic substances are emitted, thermal oxidation is applied, in particular where waste gas heat after the thermal oxidation can be used for processes onsite.

Table 14: Waste gas treatment systems applied where TOC emissions are measured

Abbreviation	Waste gas system	Number of parameters measured after the system
None	No waste gas treatment system	153
S	Scrubber	141
TO	Thermal oxidation or regenerative thermal oxidation	72
AC	Activated carbon	25
C or HE	Condensers/heat exchanger	24
COX	Catalytic oxidation	15
BF	Biofilter	2
Other	Other combination of less precisely described systems ("dust chamber", "recovery unit", "solvent recovery", "flare"; "cartridge filter", N. N.)	5
	Total	**437**

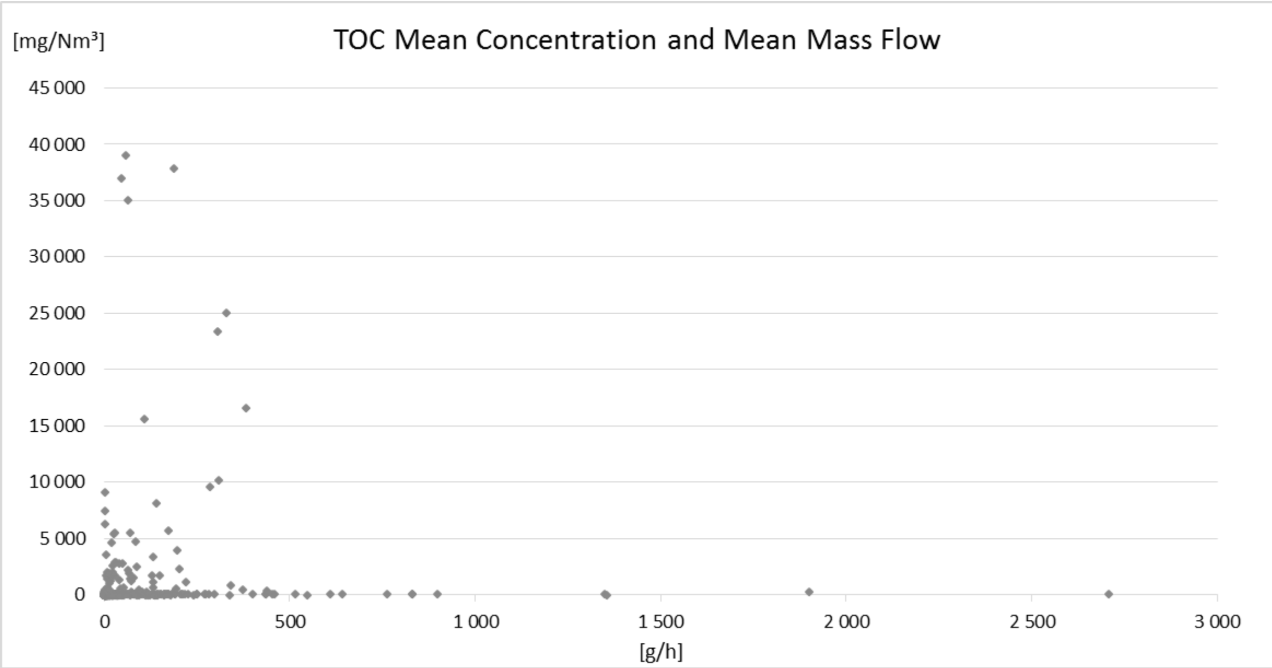
4.3 TOC concentration and related mass flow

Figure 46 shows mean concentration values of total organic carbon (TOC) and the related mean mass flow (437 values). Detailed data can be found in Annex 8 to Annex 12.

Data illustrate that TOC mean concentrations are generally below 40 mg/Nm³. Where concentrations are higher, they are linked with a low mean mass flow not exceeding 500 g/h, except five values.

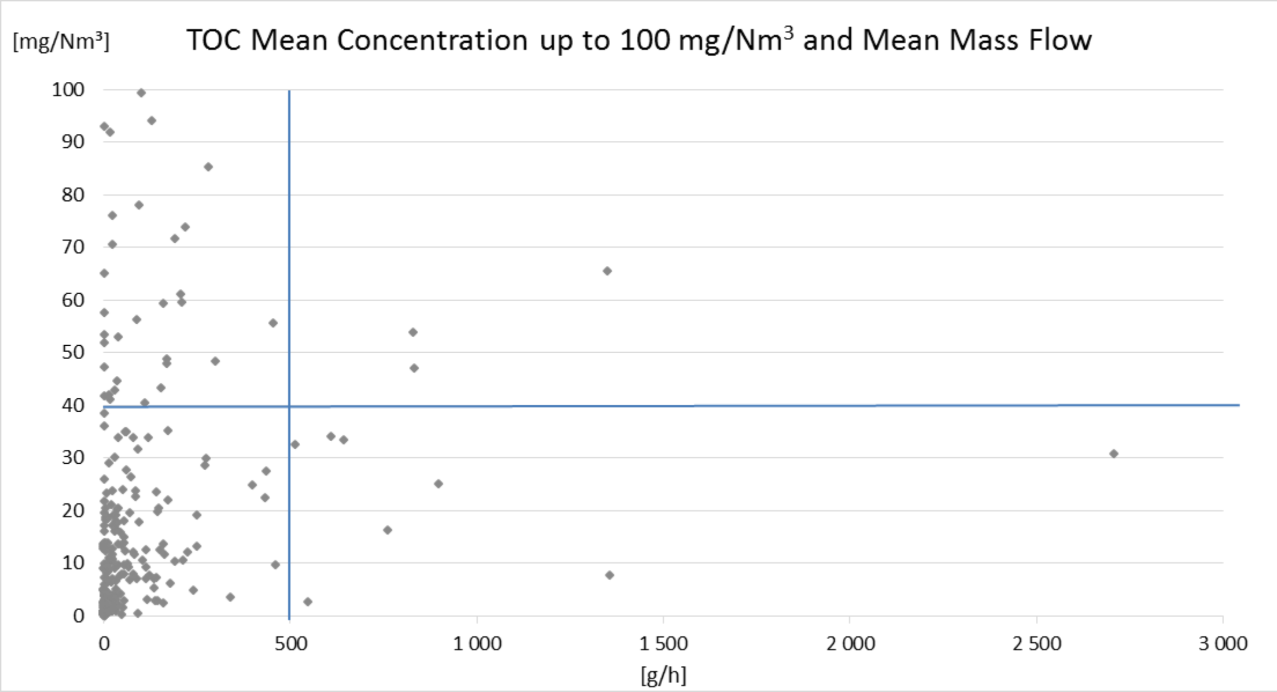
Five values where TOC mean concentrations above 40 mg/Nm³ and mean mass flows above 500 g/h were measured, originate in four cases from slab stock or moulded polyurethane foam production (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV). They use hydrocarbons (e.g. pentane) as blowing agents. No waste gas abatement system is installed at these four sources (covered by the Polymer BREF which does not include a BATAEL for TOC). One data set originates from the production of surface-active agents and surfactants (IED Annex 1 no. 4.1.k respectively no. 4.11 of 4. BImSchV).

Figure 46: TOC mean concentration and mean mass flow



(Ökopol 2016)

Figure 47: TOC mean concentration and mean mass flow (reduced scale up to 100 mg/Nm³)



Note: Concentration values above 100 mg/Nm³ are cut off; all cut-off values but two have mass flows below 500 g/h.
(Ökopol 2016)

4.4 TOC emissions from sources with thermal oxidation

Figure 48 shows emissions from sources with thermal oxidation (dark rhombus, 72 data sets) or with catalytic oxidation system (orange rhombus, 15 data sets). The type of waste gas treatment system is indicated below the value. Detailed information on each data set can be found in Annex 8.

Thermal oxidation systems (TO) are used alone or in combination with fabric filters (FF), SCR, DeDiox systems (DD), quenches (Q) and/or scrubbers (S).

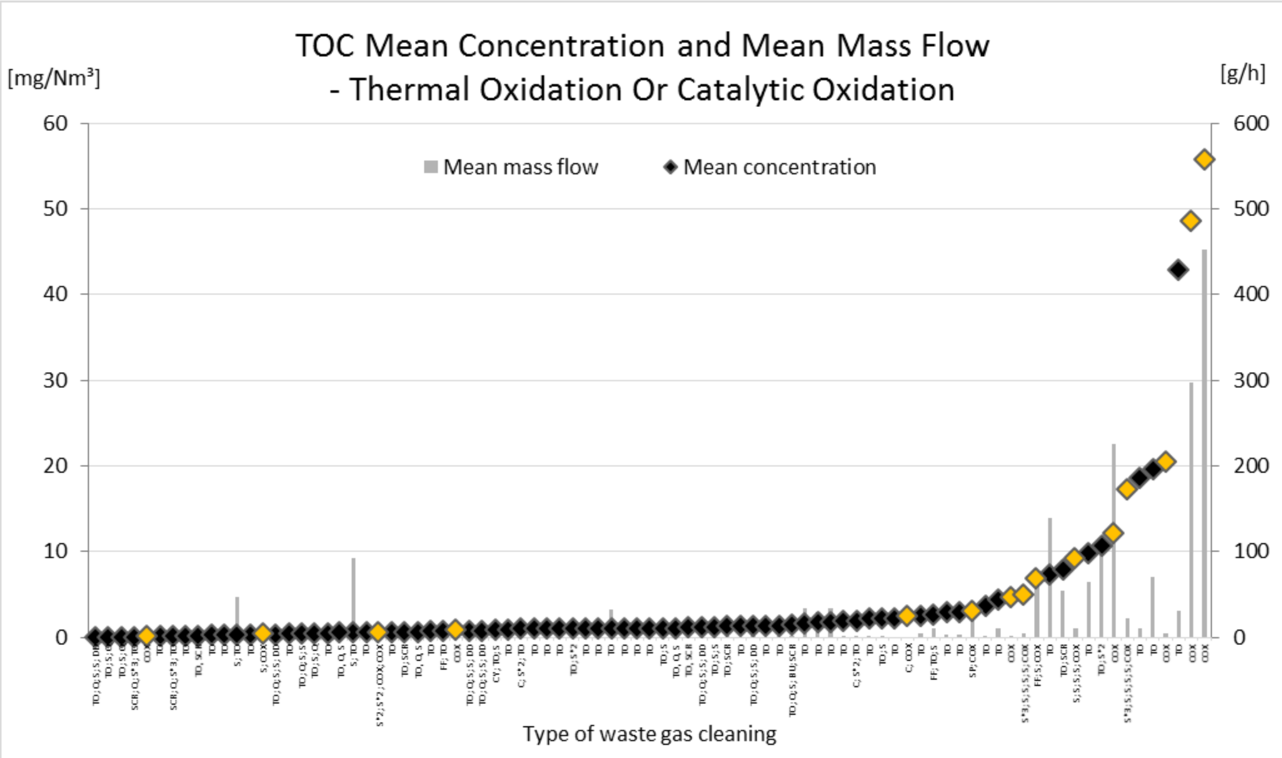
Catalytic oxidation systems (COX) are used alone or in combination with condensers (C), fabric filters (FF), scrubbers (S) or sinter-plate filters (SP) (see abbreviations in the graph and detailed data in Annex 8 to Annex 10).

Data show that TOC emission values associated with thermal oxidation systems (TO or RTO systems) are generally below 5 mg/Nm³ (90 % of the data).

A high share of TOC emissions associated with catalytic oxidation (orange rhombus) can rather be found at the upper end of the graph. Around 50 % of associated values are below 5 mg/Nm³ , 90 % below 20 mg/Nm³.

About half of the data with thermal oxidation is associated with waste gas volumes below 5 000 m³/h, the other half shows waste gas volumes between 5 000 - 22 000 m³/h, with one case, where thermal oxidation is installed for 32 100 m³/h (plastic pellet production). Two cases of 150 000 - 170 000 m³/h are related to the production of oxygen-containing hydrocarbons (phthalic anhydride).

Figure 48: TOC concentration and mass flow from thermal oxidation or catalytic oxidation



(Ökopol 2016)

4.5 TOC emissions from sources with activated carbon filter or biofilter

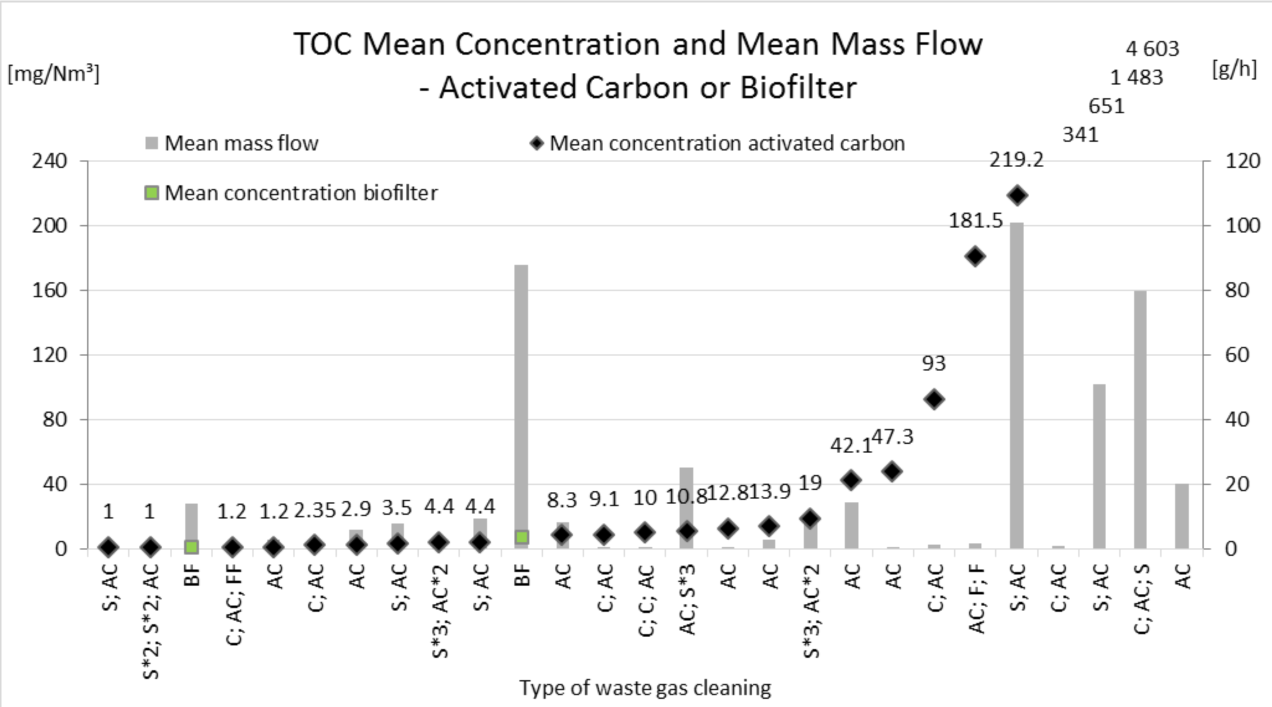
Figure 49 shows TOC emissions from sources with activated carbon filters (dark rhombus) or a biofilter (green square). To reduce the scale, the four highest concentration values are indicated in the graph but not plotted. Detailed data can be found in Annex 9.

Most activated carbon filter systems are associated with TOC emission values < 50 mg/Nm³ (74 % of data).

The biofilter systems were measured with TOC emission concentrations of 1.1 and 7.2 mg/Nm³.

Largest waste gas volume treated with these filters is around 2 500 m³/h, and no mass flow exceeds 101 g/h.

Figure 49: TOC concentrations and mass flow from activated carbon filters or biofilters



Note: Four concentration values with activated carbon are out of range but indicated in the graph.

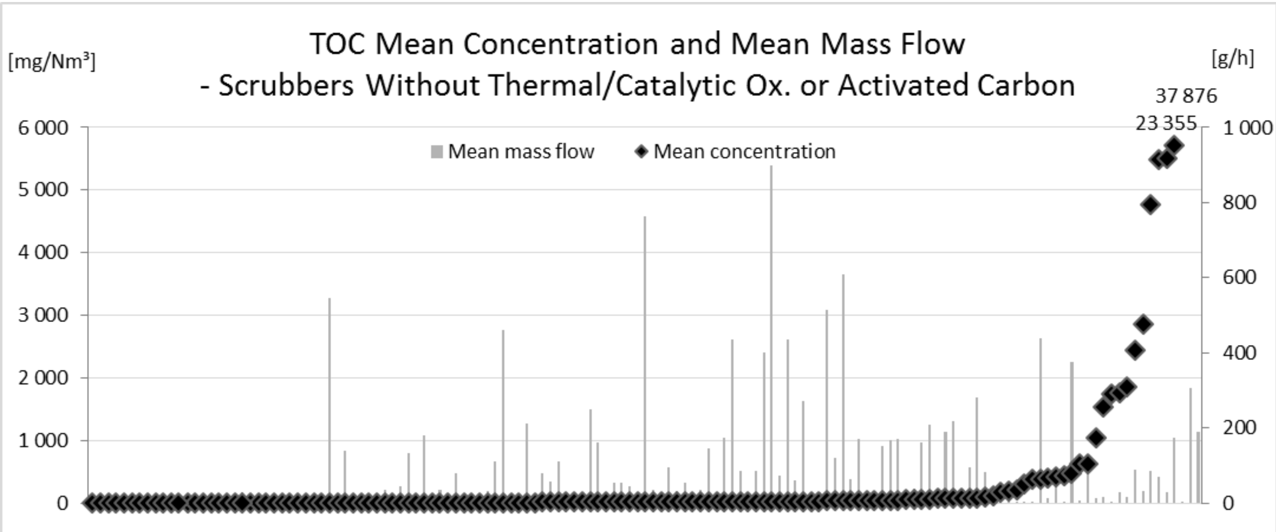
(Ökopol 2016)

4.6 TOC emissions from sources with scrubbers

Figure 50 and 51 show TOC emission values from sources with scrubbers. Only scrubbers are plotted where neither thermal or catalytic oxidation nor activated carbon filters are installed. The two highest concentration values are not plotted but indicated in the graph. For detailed data see Annex 10.

Data show that scrubbers are generally associated with TOC concentrations < 40 mg/Nm³ (70 % of data), half of the data is < 20 mg/Nm³. Where emission concentrations are higher, they are all linked with mass flows below 500 g/h.

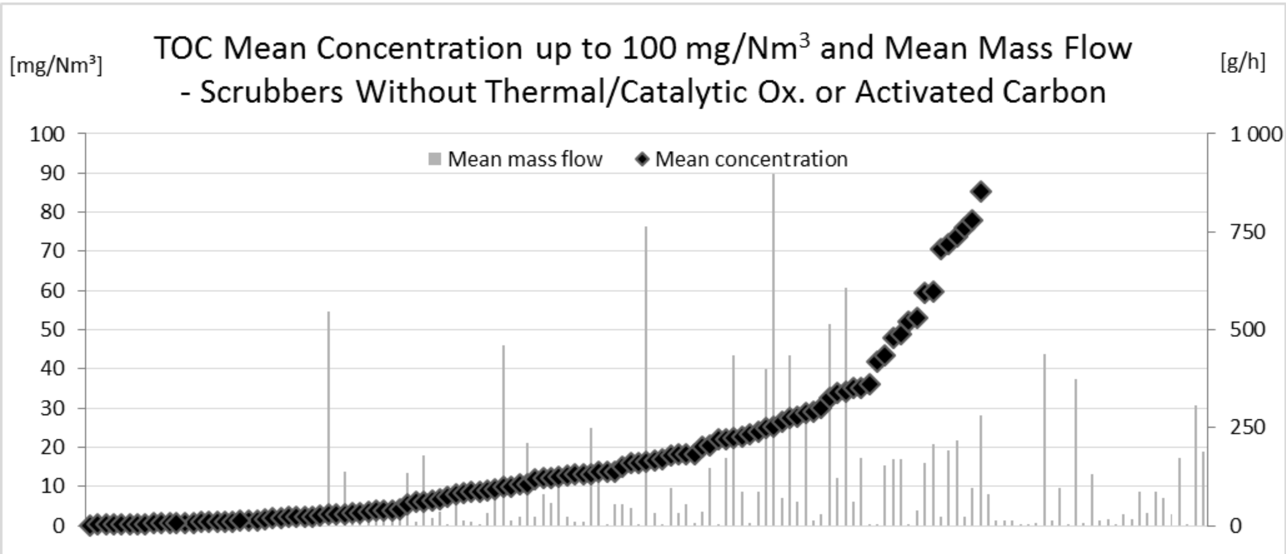
Figure 50: TOC concentration and mass flow from scrubbers (without thermal/catalytic oxidation or activated carbon system)



Note: Two concentration values above 6 000 mg/Nm³ are out of range but indicated.

(Ökopol 2016)

Figure 51: TOC concentration and mass flow from scrubbers (without thermal/catalytic oxidation or activated carbon system), reduced scale up to 100 mg/Nm³

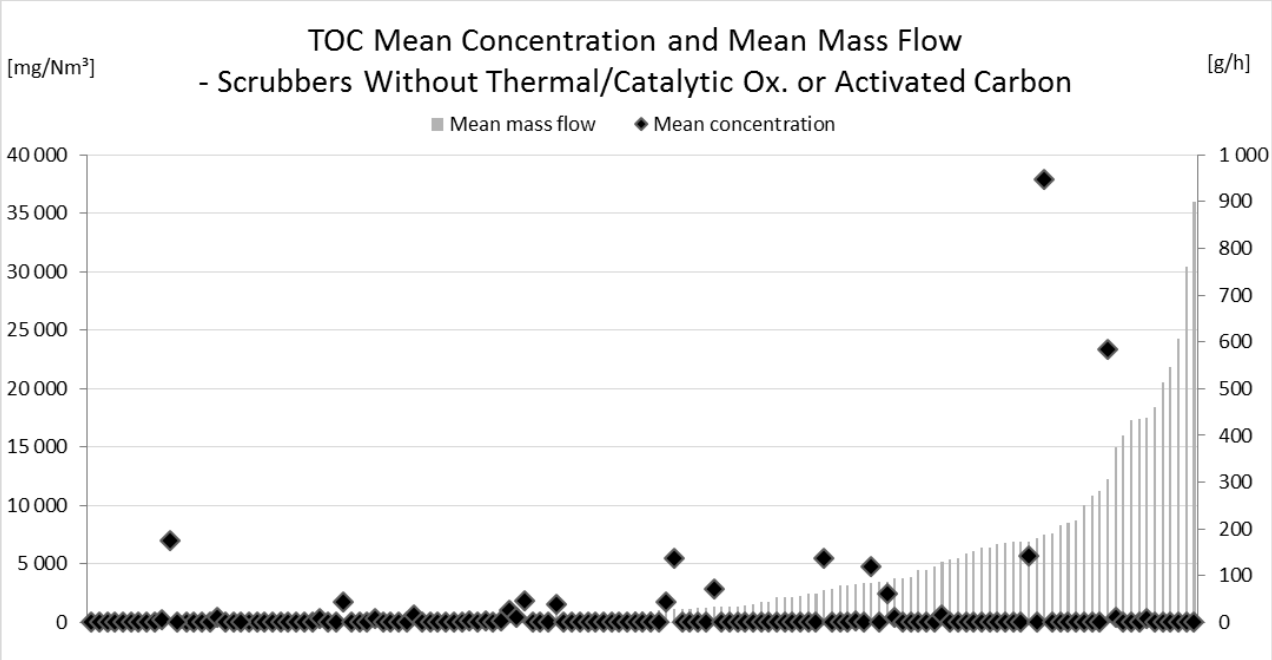


Note: Concentration values above 100 mg/Nm³ are out of range.

(Ökopol 2016)

Figures 52 to 54 show TOC emissions from scrubbers, sorted by mass flow. Around 200 out of a total of about 900 values are associated with rather high waste gas volumes (> 10 000 - 52 000 Nm³/h).

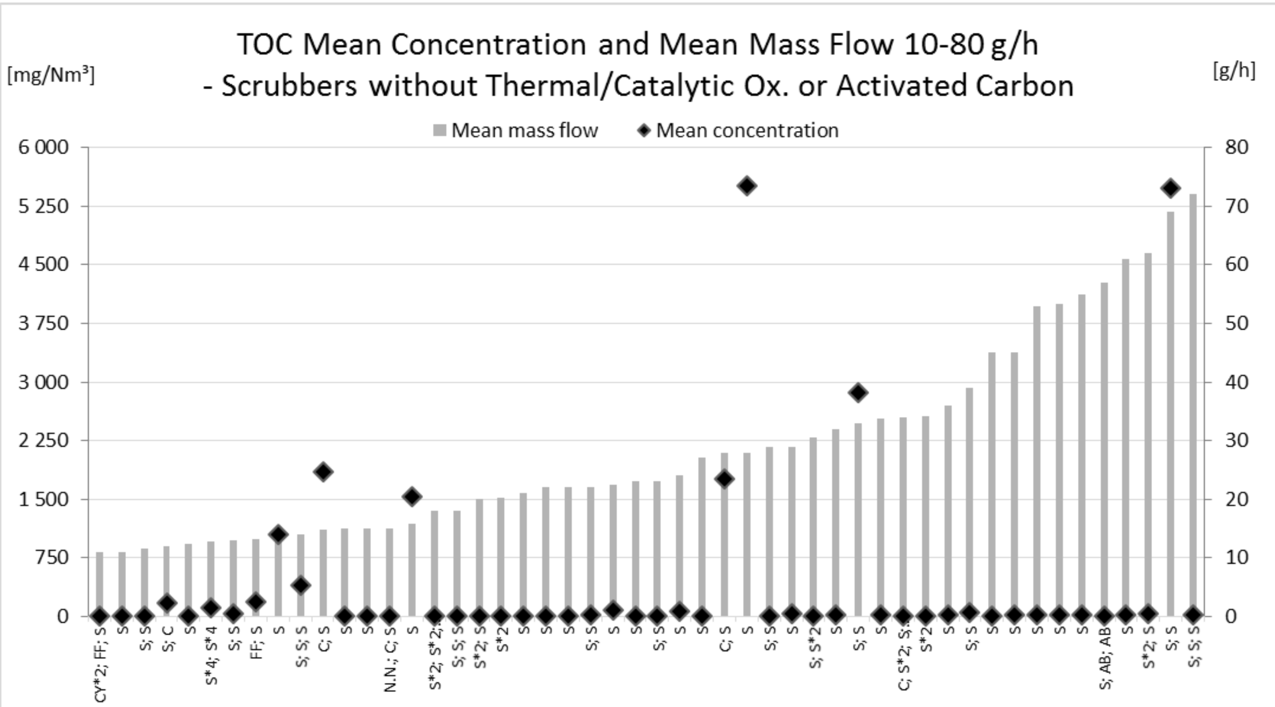
Figure 52: TOC concentrations associated with scrubbers (without thermal oxidation, catalytic oxidation or activated system), sorted by TOC mass flow (bars)



(Ökopol 2016)

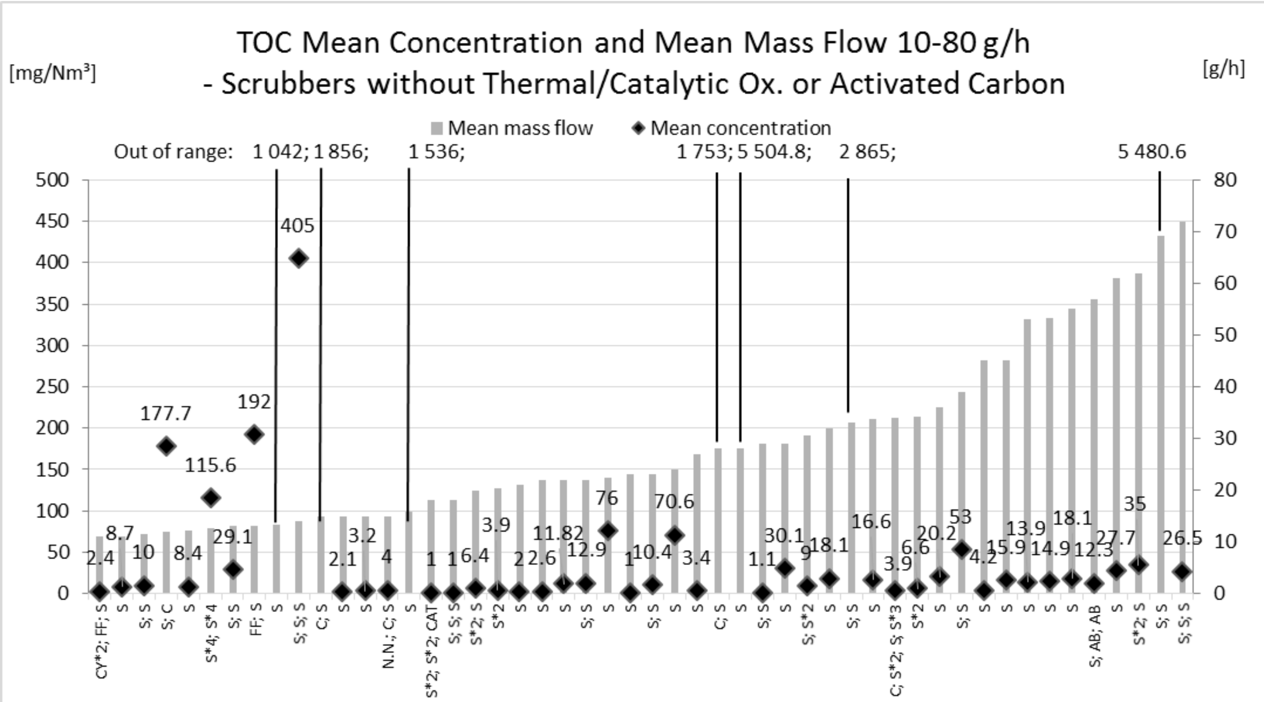
Figure 53 and 54 show TOC concentrations associated with scrubbers for mass flows of 10 - 80 g/h. In Figure 54, the same figure is presented with reduced scale up to 500 mg/Nm³ (seven data cut off).

Figure 53: TOC concentrations associated with scrubber systems (without oxidation or activated system), sorted by TOC mass flow data of 10 - 80 g/h (bars) with reduced scale up to 6 000 mg/Nm³



(Ökopol 2016)

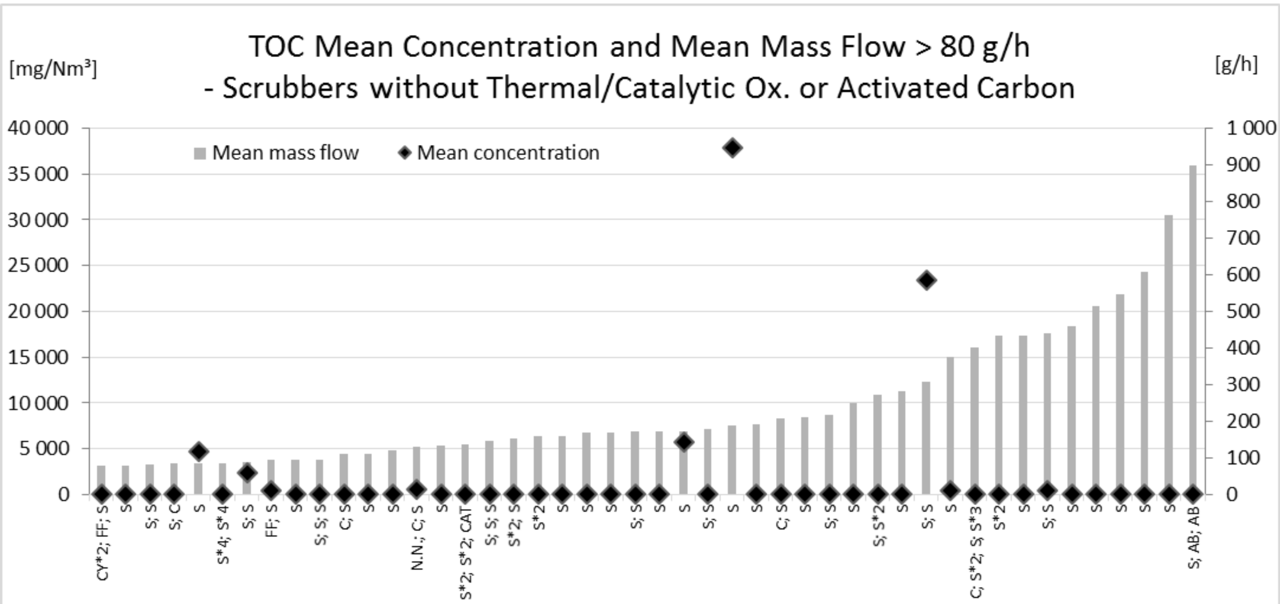
Figure 54: TOC concentrations associated with scrubber systems (without oxidation or activated system), sorted by TOC mass flow data of 10 - 80 g/h (bars) with reduced scale up to 500 mg/Nm³ (seven data out of range)



(Ökopol 2016)

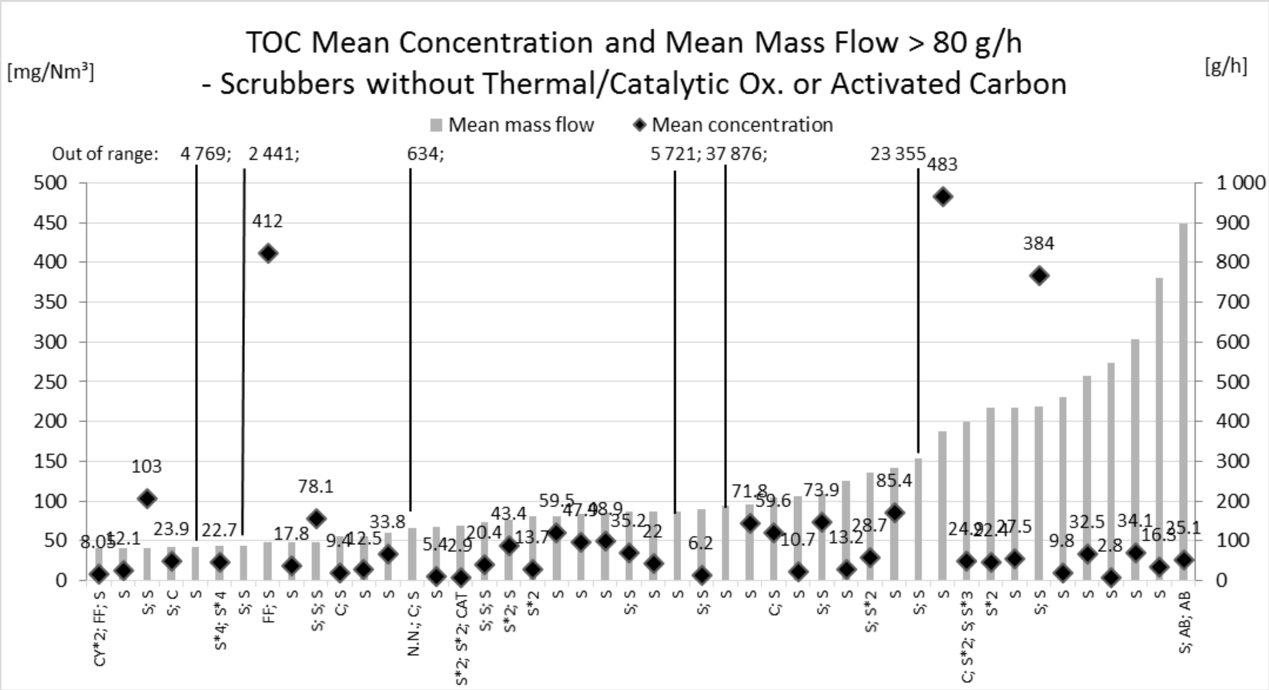
Figure 55 shows TOC concentrations associated with scrubbers for mass flows above 80 g/h. In Figure 56, the scale is reduced to 500 mg/Nm³ (six TOC concentration values are cut off).

Figure 55: TOC concentrations associated with scrubber systems (without oxidation or activated system), sorted by TOC mass flow data above 80 g/h (bar)



(Ökopol 2016)

Figure 56: TOC concentrations associated with scrubber systems (without oxidation or activated system), sorted by TOC mass flow data above 80 g/h (bar) with reduced scale up to 500 mg/Nm³ (six data out of range)



(Ökopol 2016)

4.7 TOC emissions from sources without TOC treatment system

Figure 57 shows TOC measurements from sources where no type of waste gas abatement system is installed. Data is sorted by mass flow. Detailed information on each data set can be found in Annex 11. Note that Annex 12 includes data on other TOC treatment systems not discussed here.

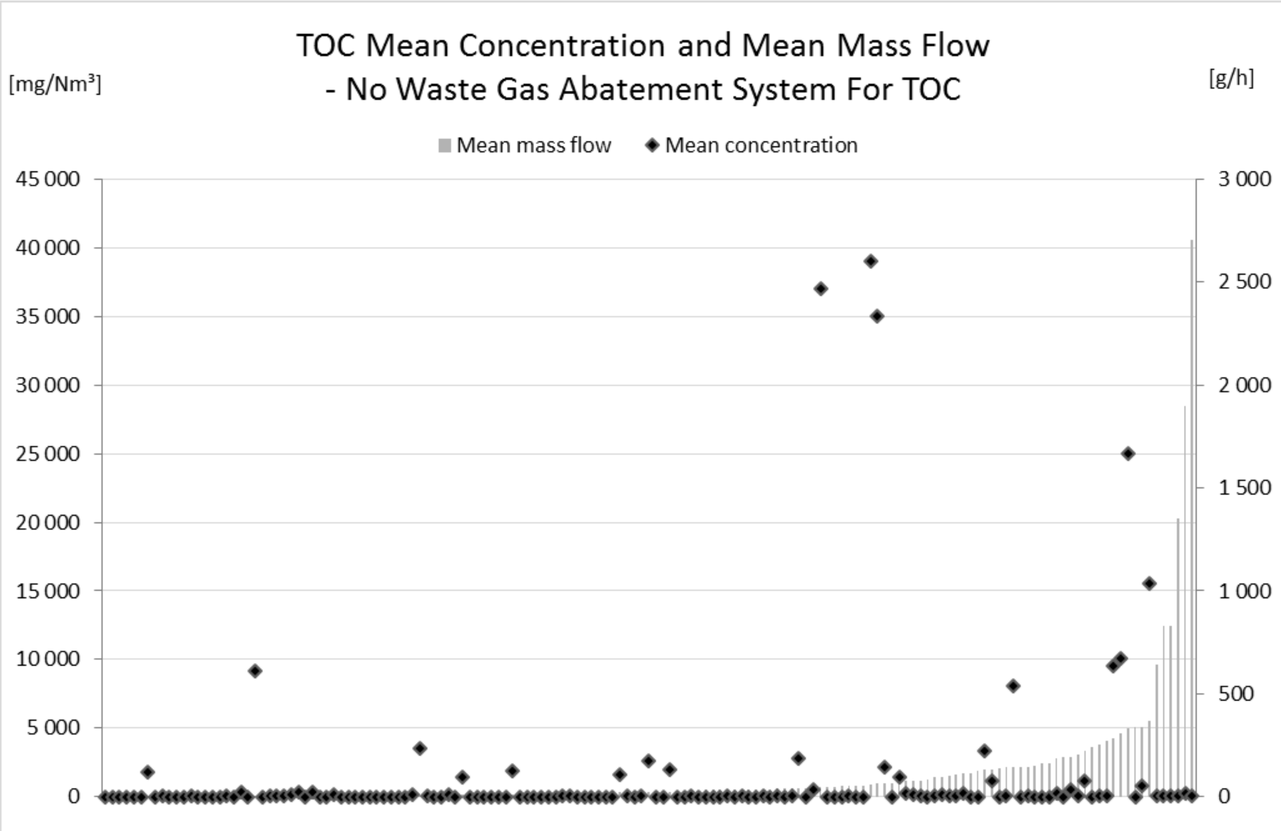
The large majority of emission data from installations without TOC treatment system shows a low mass flow < 150 g/h. Where the mass flow is above 500 g/h, emission concentrations do not exceed 40 mg/Nm³, except the four data mentioned above, originating from slab stock or moulded polyurethane foam production where hydrocarbons (e.g. pentane) are used as blowing agents (see four bars on right side before the last bar).

Figure 58 also shows TOC measurements from sources where no waste gas treatment for TOC is installed: there is either no waste gas system installed, or the system includes only mechanical treatment like cyclones, fabric filters, electrostatic precipitators or cartridge filters. Data is sorted by mass flow. All except six mass flows are below 500 g/h. Where mass flows are higher, emission concentrations do not exceed 40 mg/Nm³, except the four data mentioned above, originating from slab stock or moulded polyurethane foam production where hydrocarbons (e.g. pentane) are used as blowing agents.

Three highest concentration values (30 000 - 40 000 mg/Nm³) are linked with low mass flows (40 - 70 g/h) and originate from the production of oxygen-containing hydrocarbons (no waste gas cleaning installed).

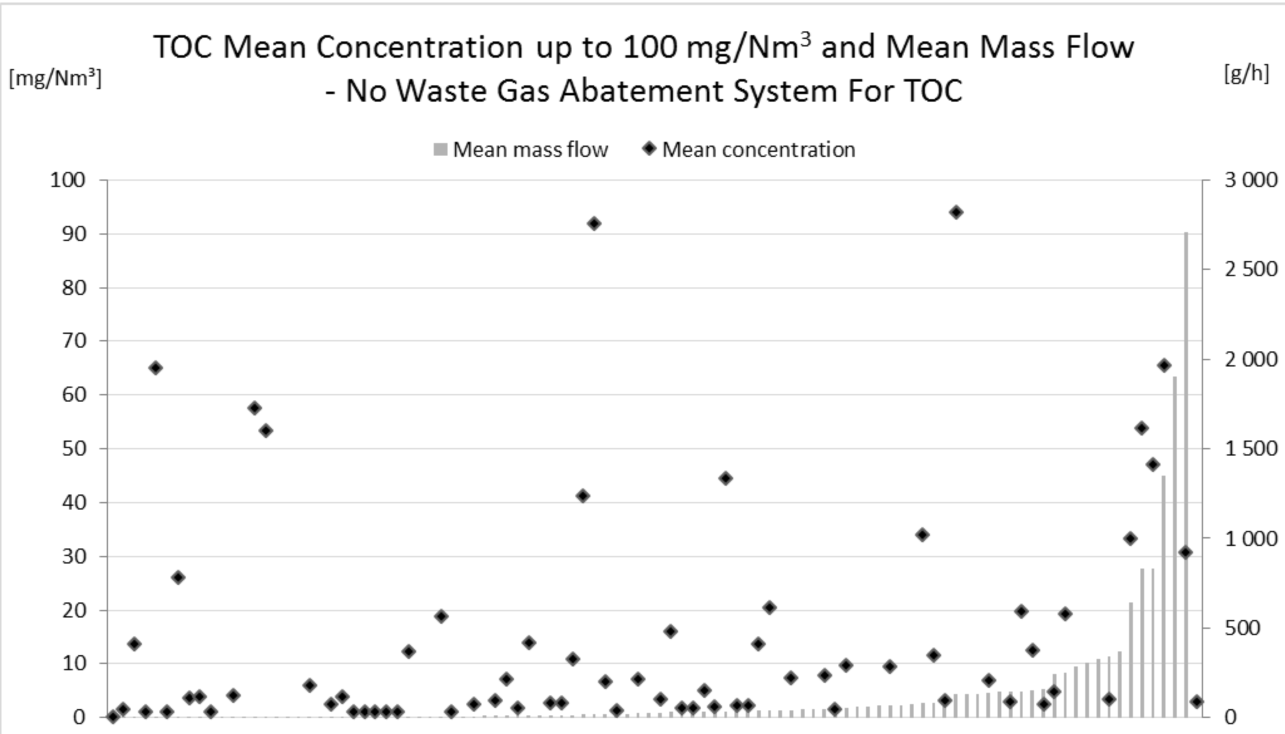
Detailed data can be found in the Annex 11.

Figure 57: TOC concentration and mass flow without waste gas abatement system for TOC



(Ökopol 2016)

Figure 58: TOC concentration and mass flow without waste gas abatement system for TOC, reduced scale up to 100 mg/Nm³



(Ökopol 2016)

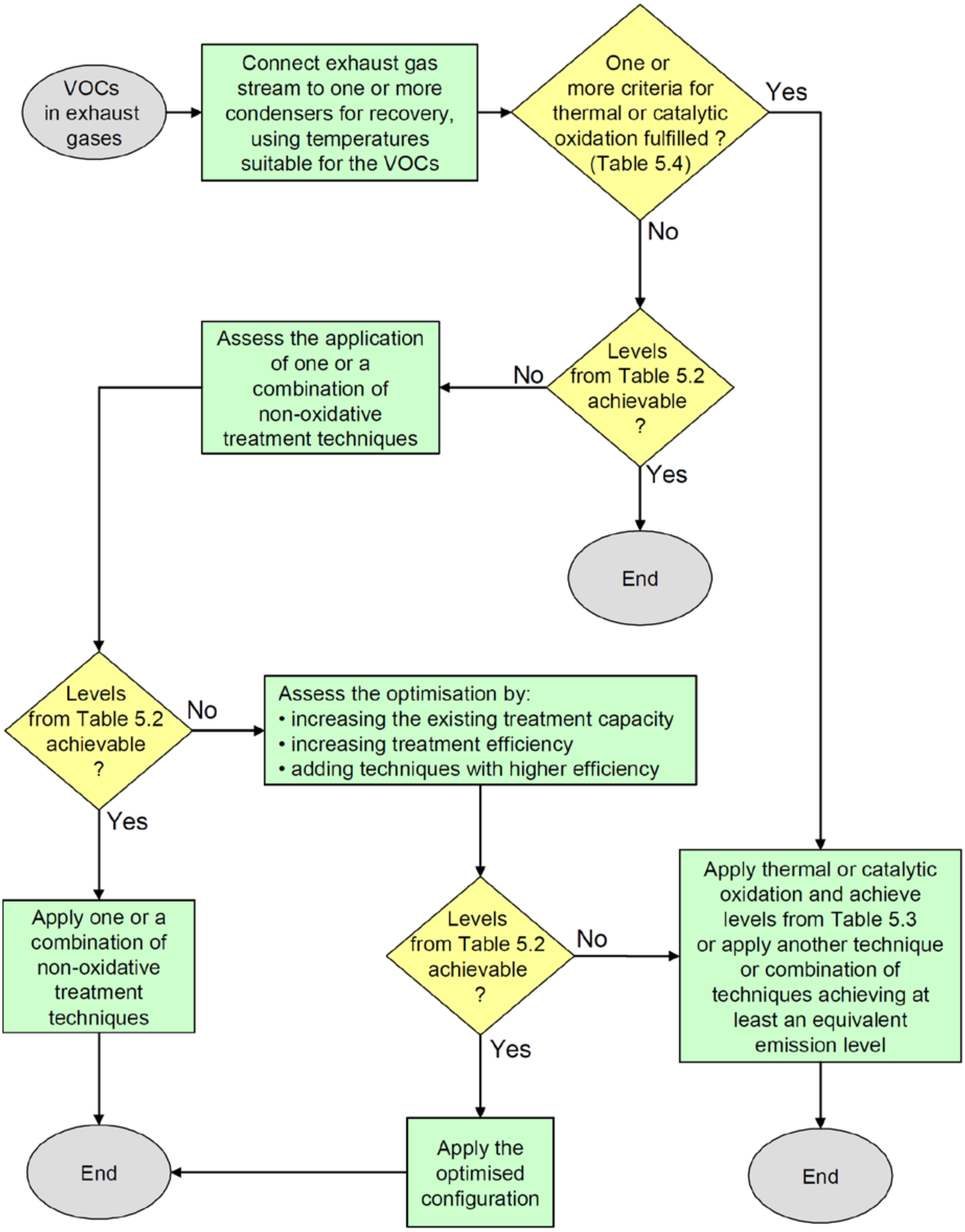
4.8 Conclusions for TOC data

TOC data assessment shows:

- Where no TOC-specific waste gas treatment is installed mean mass flows are below 150 g/h;
- Where mean mass flows exceed 150 g/h, scrubber, thermal or catalytic oxidations or biofilters/activated carbon filters are installed for TOC abatement.
- Biofilters or activated carbon filters are installed where waste gas volumes are below 3 000 m^3/h; associated mean emission values are generally below 50 mg/Nm^3 (74 % of data).
- Thermal and catalytic oxidations are generally installed for waste gas volumes up to about 35 000 m^3/h, with few exeptions where higher volumes are treated; usually scrubbers are installed for larger volumes;
- Mean concentration values associated with thermal oxidation are generally below 5 mg/Nm^3 (90 % of the data).
- Mean concentration values associated with catalytic oxidation are partly below 5 mg/Nm^3 (50 %) and generally below 20 mg/Nm^3 (90 % of data).
- Mean concentration values associated with scrubbers are partly below 20 mg/Nm^3 (50 % of data) and generally below 40 mg/Nm^3 (70 % of data of data).
- No statement can be made whether thermal or catalytic oxidation systems were installed to reduce CMR substances.
- TOC emissions of installations producing plastic materials (polymers, synthetic fibres and cellulose-based fibres, IED Annex 1 no. 4.1.h) cannot be covered by the scope of the WGC BREF.
- TOC emissions from the production of surface-active agents and surfactants (IED Annex 1 no. 4.1.k respectively no. 4.11 of 4. BImSchV) may need specific consideration regarding inclusion in the scope.

Due to the different performances of thermal oxidation and other abatement systems, selection criteria for separate BAT should be defined, taking into account e.g. energy consumption and the toxicity of the emitted substances. An example of a decision tree with selection criteria is provided in the Reference Document on BAT for the Manufacture of Organic Fine Chemicals (OFC BREF, see Figure 59).

Figure 59: BAT for the selection of VOC recovery/abatement techniques (OFC BREF 2006)



(OFC BREF 2006, p. 384)

Related ("Table 5.4") selection criteria for catalytic and thermal oxidation/incineration:

- exhaust gas contains very toxic, carcinogenic or CMR category 1 or 2 substances, or
- autothermal operation is possible in normal operation, or
- overall reduction of primary energy consumption is possible in the installation (e.g. secondary heat option) (OFC BREF 2006, p. 384)

5 Nitrogen oxides (NOx)

5.1 NOx measurement

NOx concentrations are generally measured with chemiluminescence method EN 14792. About 5 % of the data was measured with an ion chromatographic method according to DIN 33963 or VDI 2456.

- EN 14792:2006 - Stationary source emissions - Determination of mass concentration of nitrogen oxides
- VDI 2456 - Stationary source emissions - Reference method for determination of the sum of nitrogen monoxide and nitrogen dioxide - Ion chromatography method

5.2 NOx treatment

Table 15 shows all waste gas treatment systems applied where NOx emissions are measured.

NOx emission data originate in 89 cases from “hot systems” where thermal oxidation is installed, whereof 7 are equipped with SCR, the others have no scrubbers or NOx-specific abatement system.

64 data originate from “cold systems” where scrubbers (and no thermal oxidation systems) are installed – in five cases the scrubbers are combined with catalytic oxidations. 5 data originate from “cold systems” without thermal oxidation or scrubbers but using catalytic oxidation.

53 data originate from such cold systems without thermal oxidation or scrubbers where in 25 cases fabric filters, cyclons “filters” or “solvent recovery” (not further specified) are installed and in 28 cases no treatment.

Table 15: Waste gas treatment systems applied where NOx emissions are measured

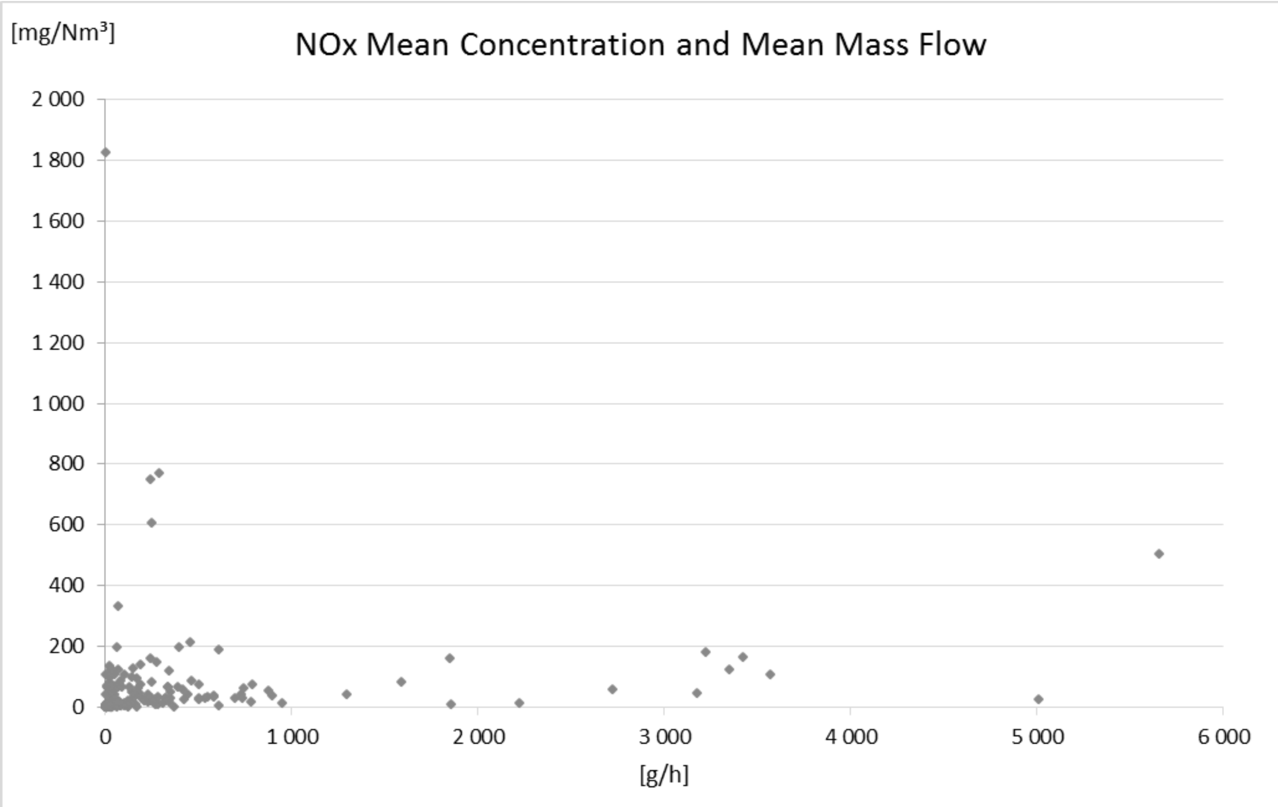
Abbreviation	Waste gas system	Number of parameters measured after the system
S	Scrubbers without SNCR or COX	56
S;SNCR	Scrubbers and selective non-catalytic reduction	3
S;COX	Scrubbers and catalytic oxidation	5
COX	Catalytic oxidation without scrubbers	6
SCR	Selective catalytic reduction	7
DeNOx	NOx reduction, not specified (SCR or SNCR)	1
CY or FF or F	Cyclons or fabric filters or “filter” without SCR, SNCR, DeNOx, S, COX	16
TO or BU or flare	Thermal oxidation or “burner” or “flare” without SCR, SNCR, DeNOx, S, COX	77
None	No waste gas treatment	28
Other	Other combination of less precisely described systems (“filter”, “solvent recovery”, N. N.)	8
	Total	**211**

5.3 NOx concentration and related mass flow

Figure 60 shows all NOx concentration values (211 data) and the related mass flow. For all except 21 data, the mass flow of the source has been reported. For a detailed list of data see Annex 13 to Annex 16.

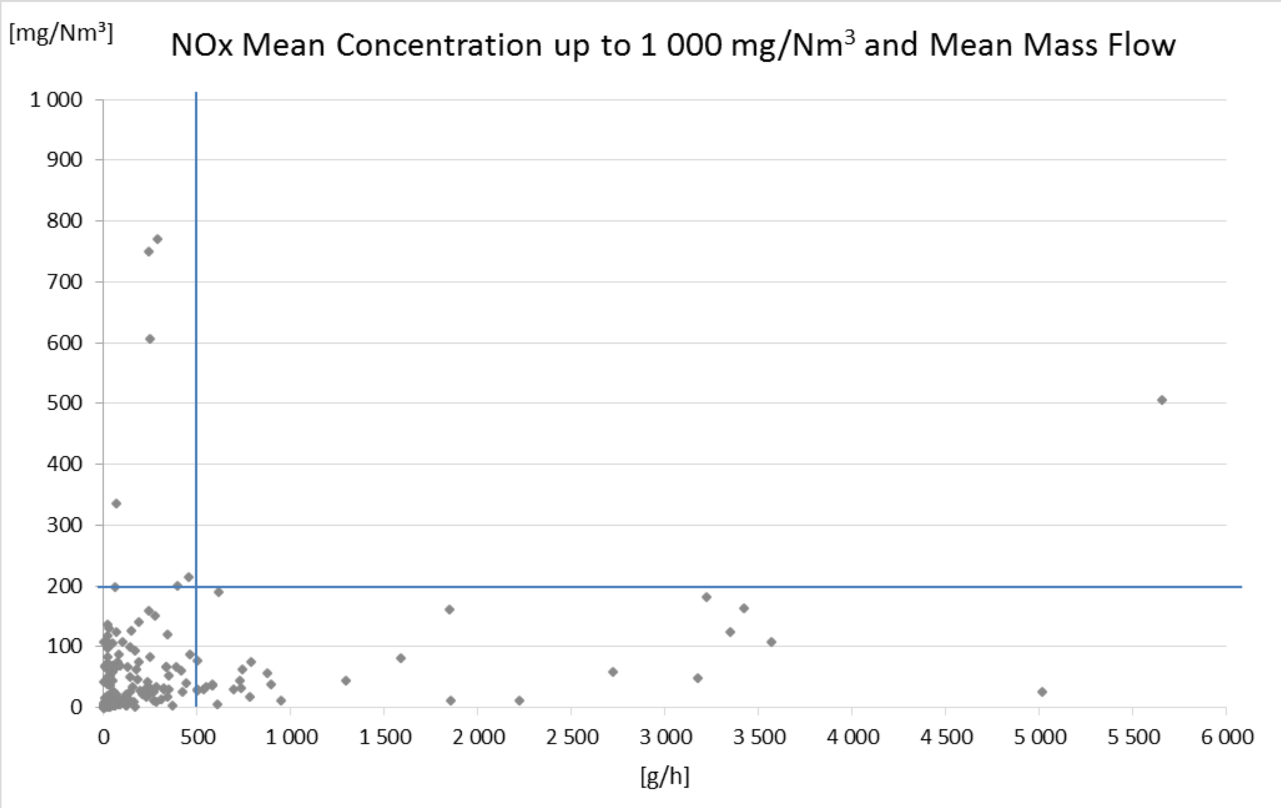
NOx concentrations are generally below 200 mg/Nm³. Where 200 mg/Nm³ is exceeded, the mass flow is below 500 g/h, except one data set with 5 654 g/h and a corresponding concentration value of 505 mg/Nm³, originating from a fertilizer production (IED Annex 1 no. 4.3 respectively no. 4.1.17 of 4. BImSchV).

Figure 60: NOx mean concentration and mean mass flow



(Ökopol 2016)

Figure 61: NOx mean concentration and mean mass flow, reduced scale up to 1 000 mg/Nm³



(Ökopol 2016)

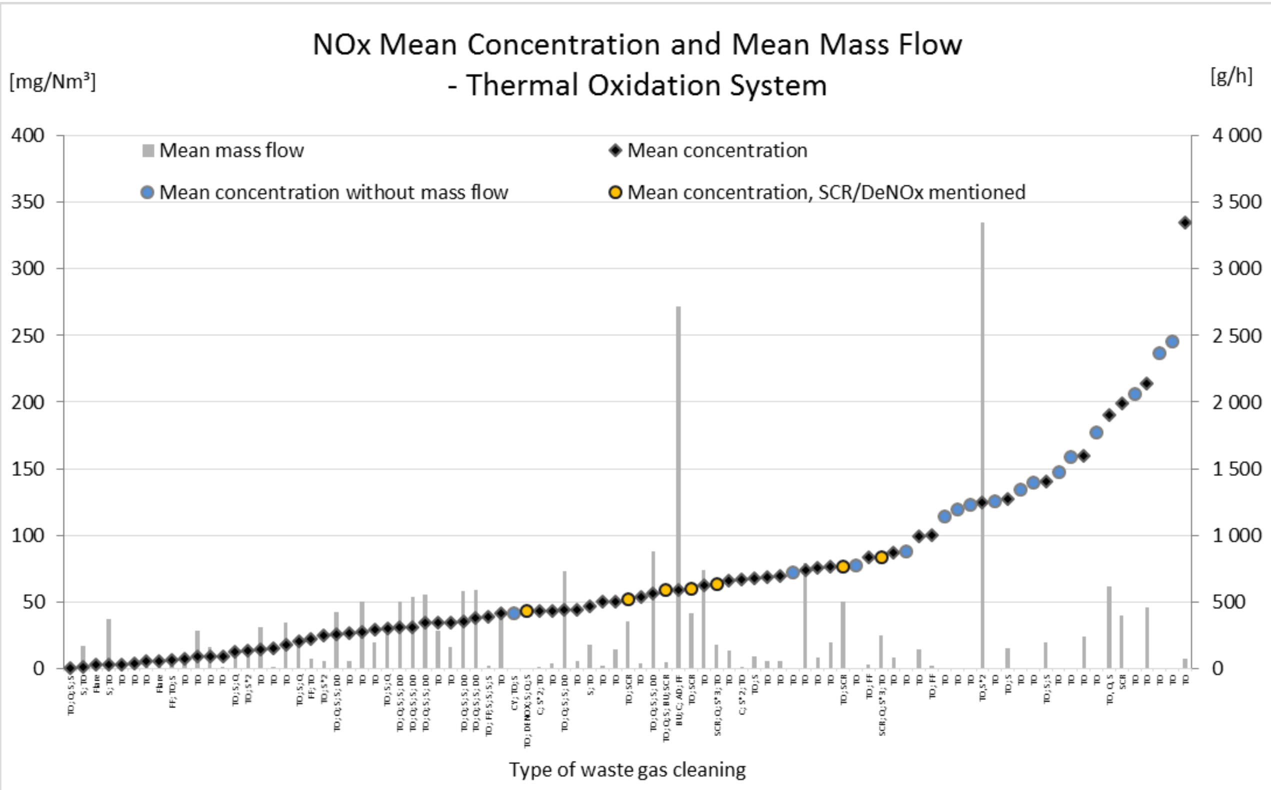
5.4 NOx emissions from sources with thermal oxidation

Figure 62 shows NOx emissions associated with thermal oxidation (black rhombus, 89 data sets). Where no mass flow was provided, concentrations are plotted as blue dot. Where information about a selective catalytic oxidation system was provided, concentrations are plotted as orange dots. For detailed data see Annex 13.

Data show that thermal oxidation systems are generally associated with NOx concentrations below 100 mg/Nm³ (76 % of the data). Where SCR systems are installed, associated NOx emissions values are generally below 80 mg/Nm³.

Where emission values are > 100 mg/Nm³, mass flows are generally below 0.5 kg/h (76 % of data). Highest NOx emissions were measured from production processes where nitrogen-containing products are produced (fertilizers production, IED Annex 1 no. 4.3 respectively no. 4.1.17 of 4. BImSchV, and nitrogenous hydrocarbons (IED Annex 1 no. 4.1.d respectively no. 4.1.4 of 4. BImSchV).

Figure 62: NOx mean concentration and mass flow associated with thermal oxidation



(Ökopol 2016)

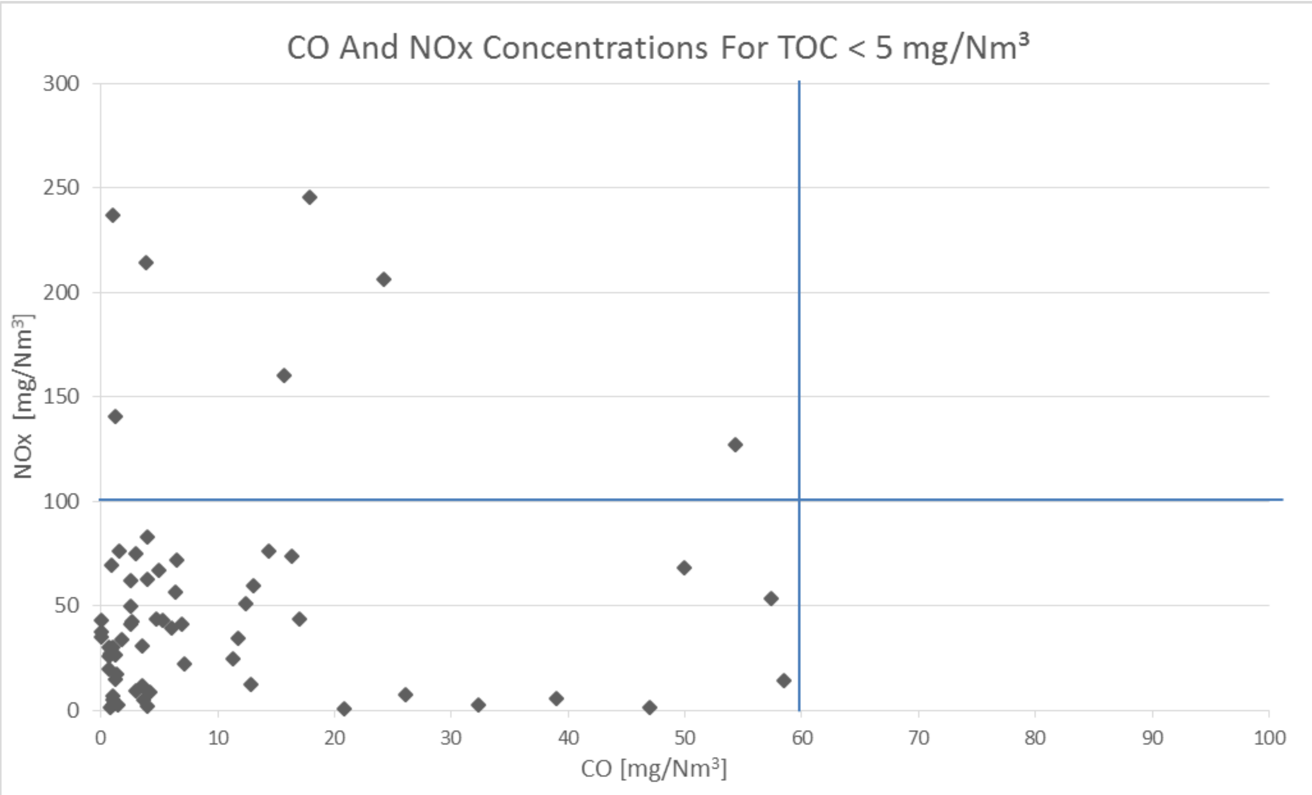
5.5 NOx and CO emissions from sources with thermal or catalytic oxidation

Where thermal or catalytic oxidation systems are used for TOC abatement, NOx and CO are emitted as cross-media effect. NOx emissions rise with increasing temperature (e.g. applied to achieve low TOC emissions); CO emissions originate from incomplete combustion, e.g. if NOx emissions are kept low with a low air-fuel ratio (reduced oxygen). An optimized combustion achieves low values for all three parameters.

Figure 63 shows NOx and carbon monoxide (CO) emissions for thermal oxidation or catalytic oxidation systems where TOC mean concentrations are below 5 mg/Nm^3 (63 data sets). For detailed data see Annex 14.

Data show that thermal/catalytic oxidation is generally associated with mean CO concentrations below 60 mg/Nm^3 (all data) and mean NOx emissions below 100 mg/Nm^3 (89 % of the data). Where higher NOx emissions were measured, they do not exceed 250 mg/Nm^3, while corresponding CO emissions are below 30 mg/Nm^3.

Figure 63: NOx and CO mean concentrations from sources with thermal or catalytic oxidation systems and TOC emissions below 5 mg/Nm^3



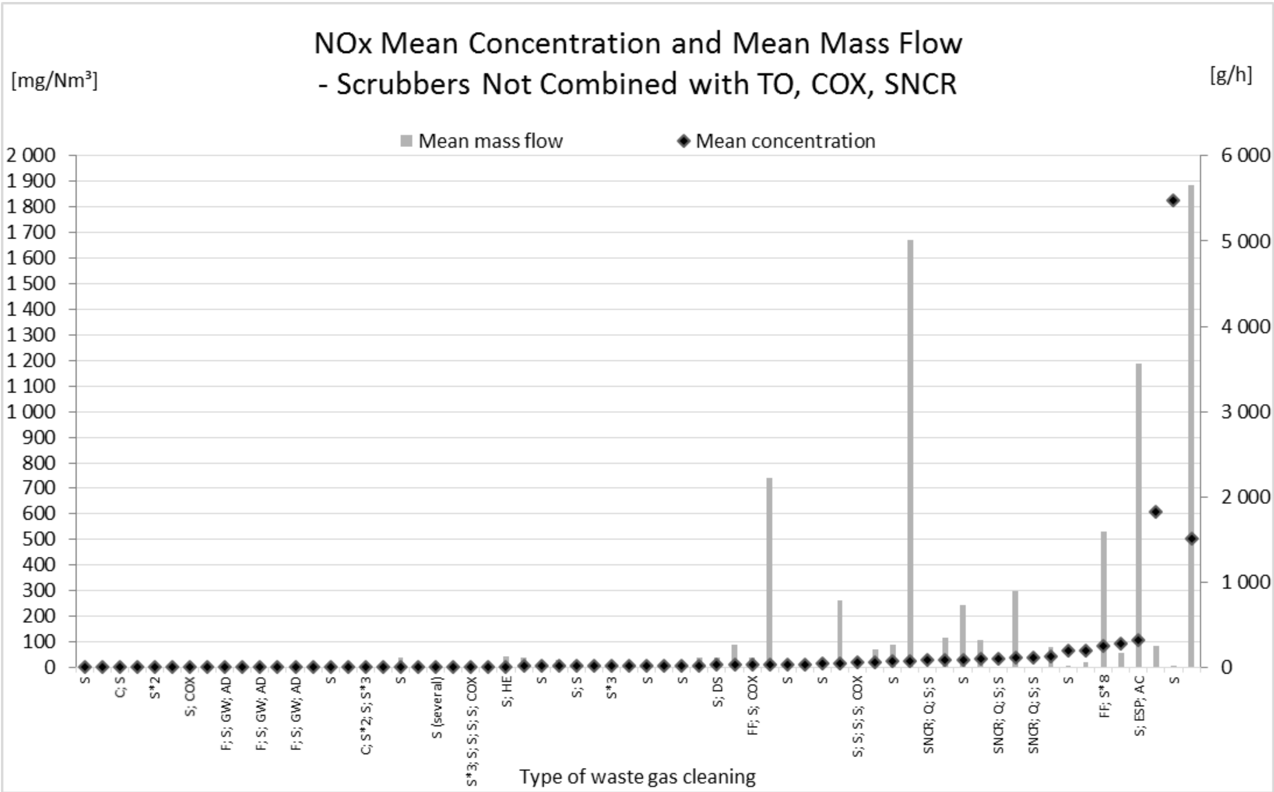
(Ökopol 2016)

5.6 NOx emissions from sources with scrubbers

Figure 64 shows NOx emissions from sources with scrubbers, where these are not combined with thermal oxidation or catalytic oxidation systems (64 data sets). For detailed data see Annex 15.

Data show that scrubbers are generally associated with NOx emission values below 100 mg/Nm³ (93 % of the data). Where mean concentrations are higher, the NOx emission is linked with production processes containing high amounts of nitrogen in the raw gas like fertiliser production (IED Annex 1 no. 4.3 respectively no. 4.1.17 of 4. BImSchV) and the production of nitrogenous hydrocarbons (IED Annex 1 no. 4.1.d respectively no. 4.1.4 of 4. BImSchV).

Figure 64: NOx mean concentration and mass flow from scrubbers without thermal oxidation



(Ökopol 2016)

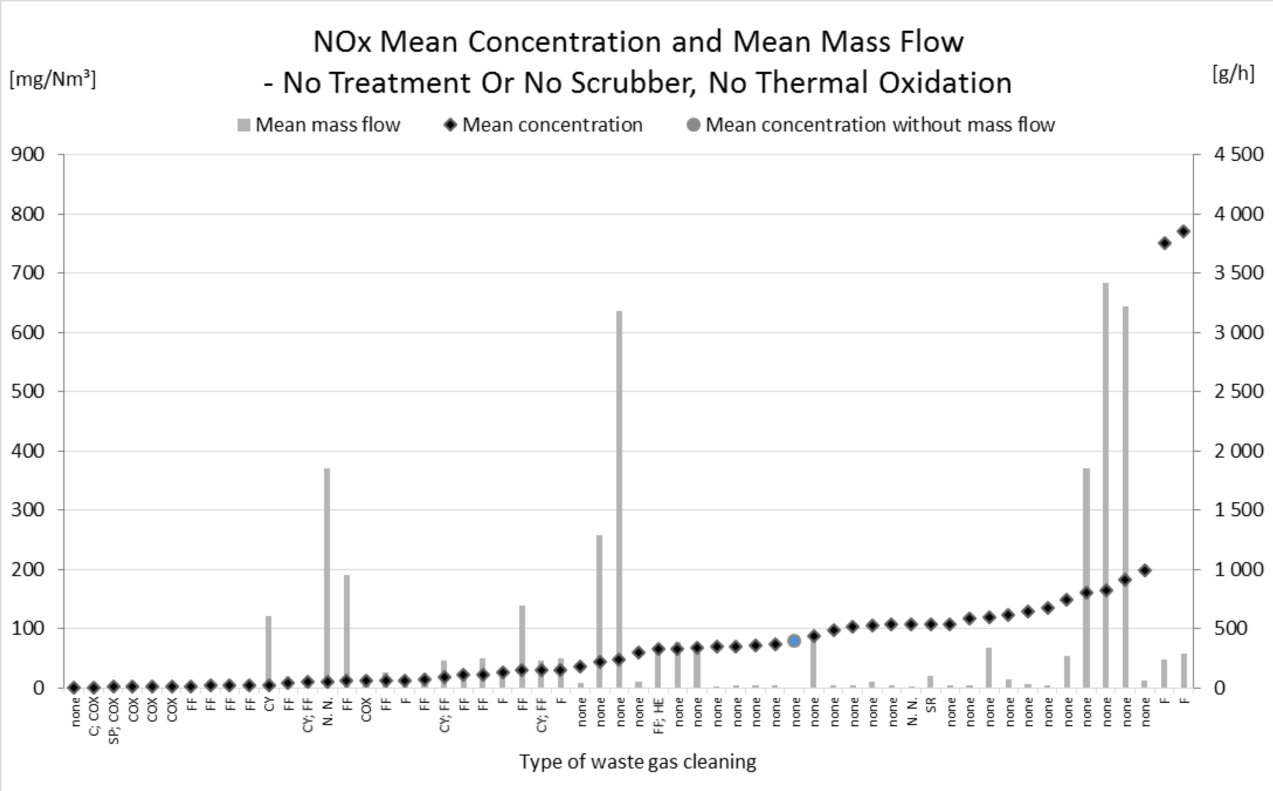
5.7 NOx emissions from sources without thermal oxidation or scrubbers

Figure 65 shows NOx emissions from sources where no thermal oxidation or scrubber is installed. For detailed data see Annex 16.

Data show that NOx mean emission values are generally below 200 mg/Nm³ (97 % of the data). In the two cases where mean emission concentration values are higher than 200 mg/Nm³, the corresponding mean mass flow is below 300 g/h. Emissions originate from the production of trichlorosilane.

Where mean mass flows exceed 500 g/h, emissions originate from the production of fertilizers (in two cases) and from the production of other inorganic basic chemicals (one case).

Figure 65: NOx mean concentrations from sources without thermal oxidation or scrubbers



(Ökopol 2016)

5.8 Conclusions for NOx data

NOx data assessment shows:

- Emissions values need seperate assessment for oxidation (incineration) processes generating NOx emissions and chemical processes where NOx emissions originate from the process.
- Where no NOx abatement systems is installed, the mean mass flows are below 500 g/h.
- Where mass flows exceed 500 g/h, SCR, SNCR or scrubbers are installed for NOx abatement;
- Thermal or catalytic oxidations are generally installed for waste gas volumes up to about 35 000 m^3/h.
- NOx emissions associated with thermal or catalytic oxidation are generally below 100 mg/Nm³ (76 % of the data); where SCR systems are installed, associated NOx emissions are generally below 80 mg/Nm³.
- Thermal or catalytic oxidation systems achieving TOC emissions below 5 mg/Nm³ are generally associated with NOx mean emissions below 100 mg/Nm³ and CO mean emission below 60 mg/Nm³.
- Scrubbers are generally associated with NOx mean emissions below 100 mg/Nm³.
- NOx emissions of installations producing nitrogen-based fertilisers (IED Annex 1 no. 4.3) cannot be covered by the scope of the WGC BREF.
- NOx emissions from installations producing nitrogeous hydrocarbons (IED Annex 1 no. 4.1.d) need specific consideration for inclusion in the scope fo the WGC BREF.

6 Ammonia (NH_3)

6.1 NH_3 measurement

NH_3 concentrations are measured with several methods, predominantly with method VDI 3496 (absorption in sulphuric acid), followed by VDI 2461 (indophenol method), also mentioned as DIN 38405; other methods are "own methods" of measurement companies, e.g. using photometric determination and in two cases EN ISO 11732, also using spectrophotometric analysis.

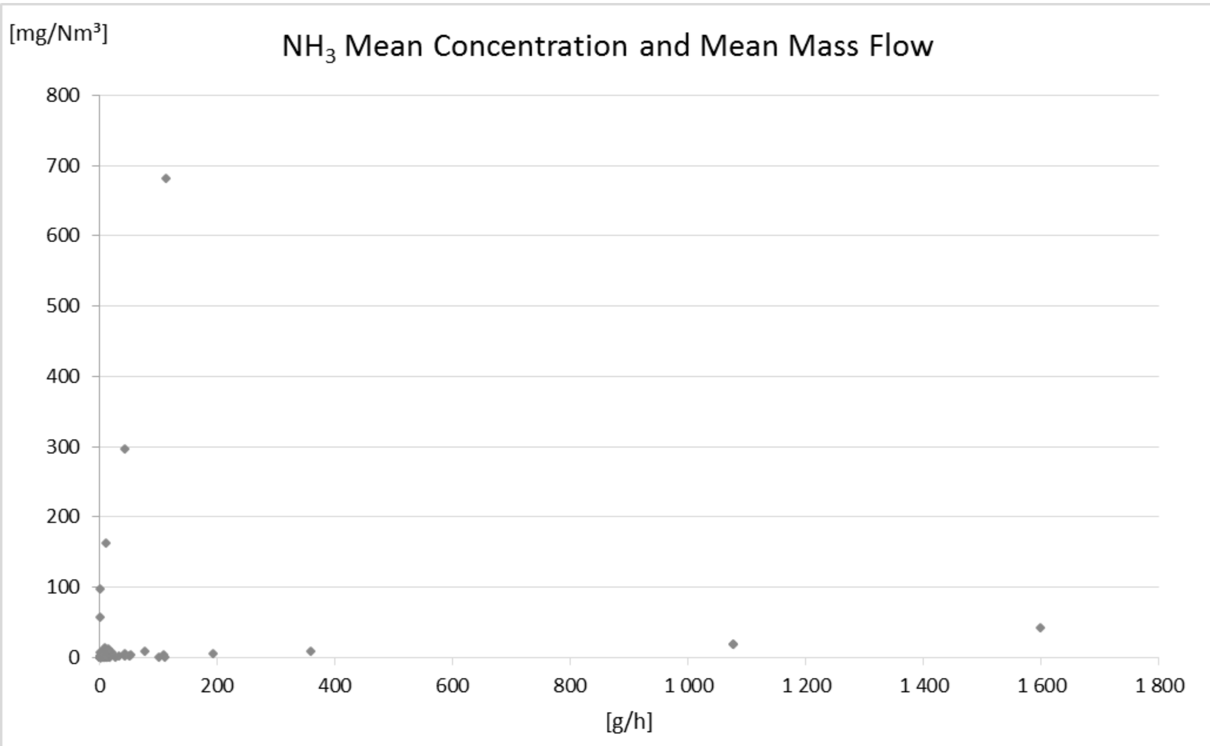
- VDI 3496 Bl. 1:1992 - Gaseous emission measurement; determination of basic nitrogen compounds seizable by absorption in sulphuric acid.
- VDI 2461 Bl. 1:1974 - Gaseous Air Pollution Measurement; Measurement Of Ammonia Gas Concentration; Indophenol Method, equivalent with
- DIN 38405-E5-1 - Indophenol blue method.
- EN ISO 11732:1997-09 - Water quality - Determination of ammonium nitrogen by flow analysis (control flow analysis CFA and flow injection analysis FIA) and spectrometric detection.

6.2 NH_3 concentration and related mass flow

Figure 66 show all NH_3 concentrations values (78 data sets) and the related mass flow. For all except three data, the mass flow of the source has been reported. Figure 67 shows the same data with a reduced scale up to concentrations values of 100 mg/Nm³. For a detailed list of data see Annex 17 to Annex 19.

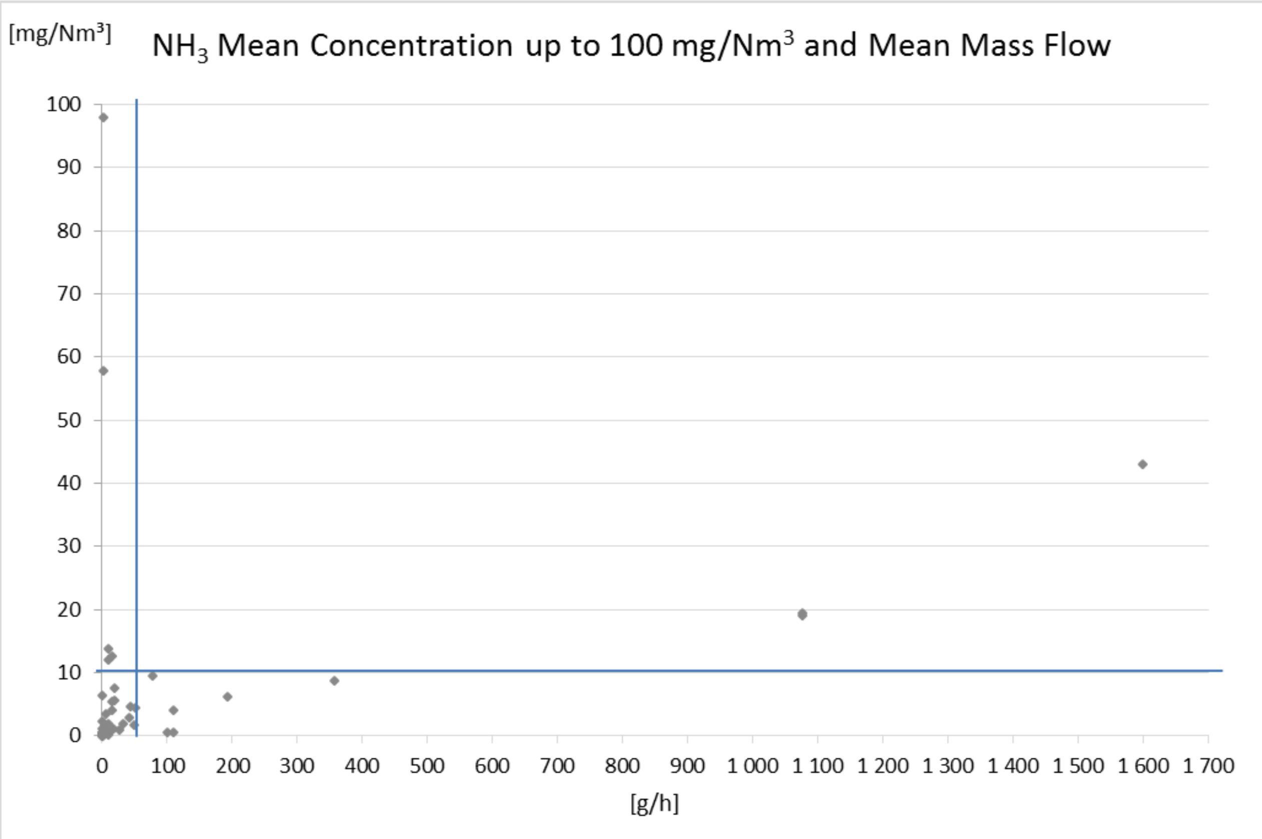
NH_3 mean concentrations are generally below 10 mg/Nm³ (86 %). Where mean concentrations are above 10 mg/Nm³, the majority of mean mass flows is below < 150 g/h. Three cases where the mass flow is between 1 076 to 1 599 g/h, with corresponding emission concentrations of 19.1 to 43 mg/Nm³, originate from the production of PVC polymers (IED Annex 1 no. 4.1. h resp. no. 4.1.8 of 4. BImSchV).

Figure 66: NH_3 mean concentration and mean mass flow



(Ökopol 2016)

Figure 67: NH_3 mean concentration and mean mass flow with reduced scale up to 100 mg/Nm³



Note: Three values with concentrations of 163 - 682.34 mg/Nm³ and mass flows of 11 - 113.5 g/h are cut off.

(Ökopol 2016)

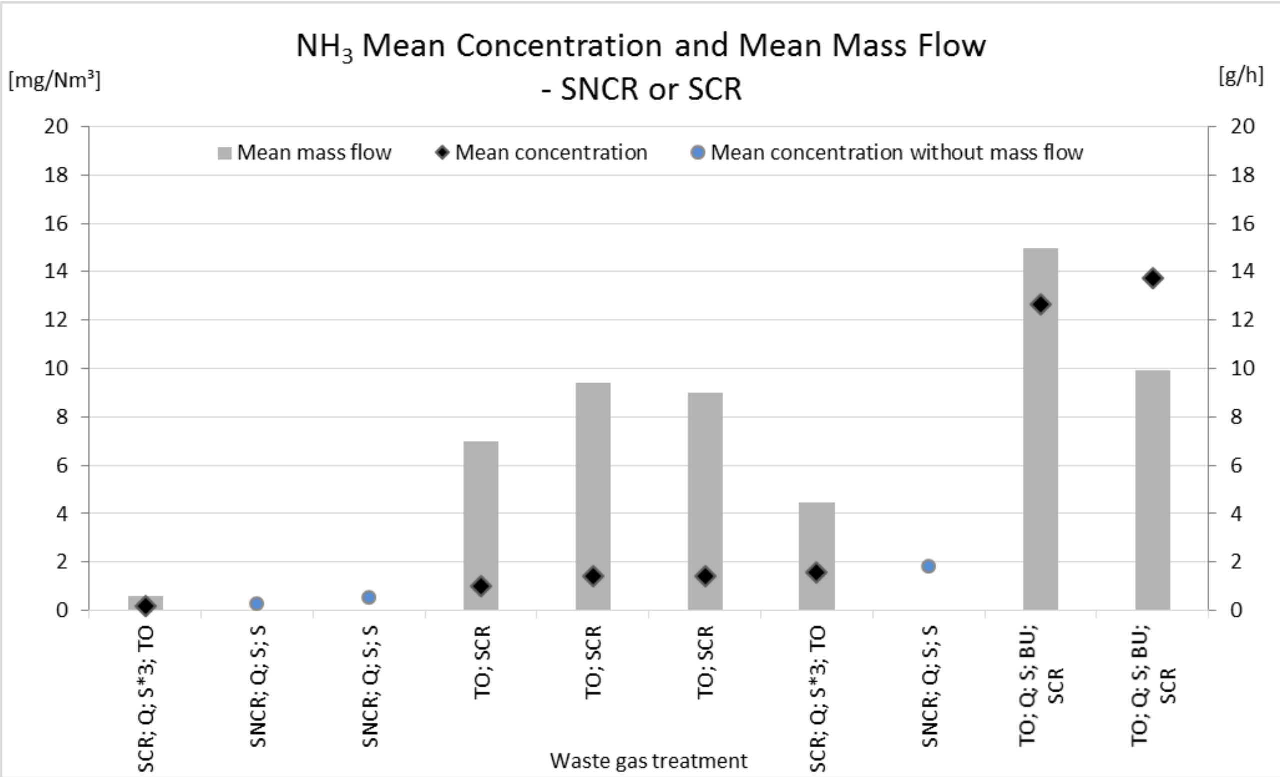
6.3 NH_3 emissions from sources with SNCR or SCR

Figure 68 shows NH_3 concentrations (rhombus) and mass flow (bars) from sources with SNCR or SCR ("ammonia slip"). Data is sorted by increasing concentration. Data provided without mass flow is plotted with blue dots. For a detailed list of data see Annex 17.

The majority of NH_3 mean emission concentrations associated with SNCR and SCR is below 3 mg/Nm³.

In two cases mean emission concentrations between 12 - 14 mg/Nm³ were measured (production of aromatic hydrocarbons containing fluorine, IED Annex 1 no. 4.1 f respectively no. 4.1.1 of 4. BImSchV).

Figure 68: NH_3 mean concentration and mass flow from sources with SNCR or SCR



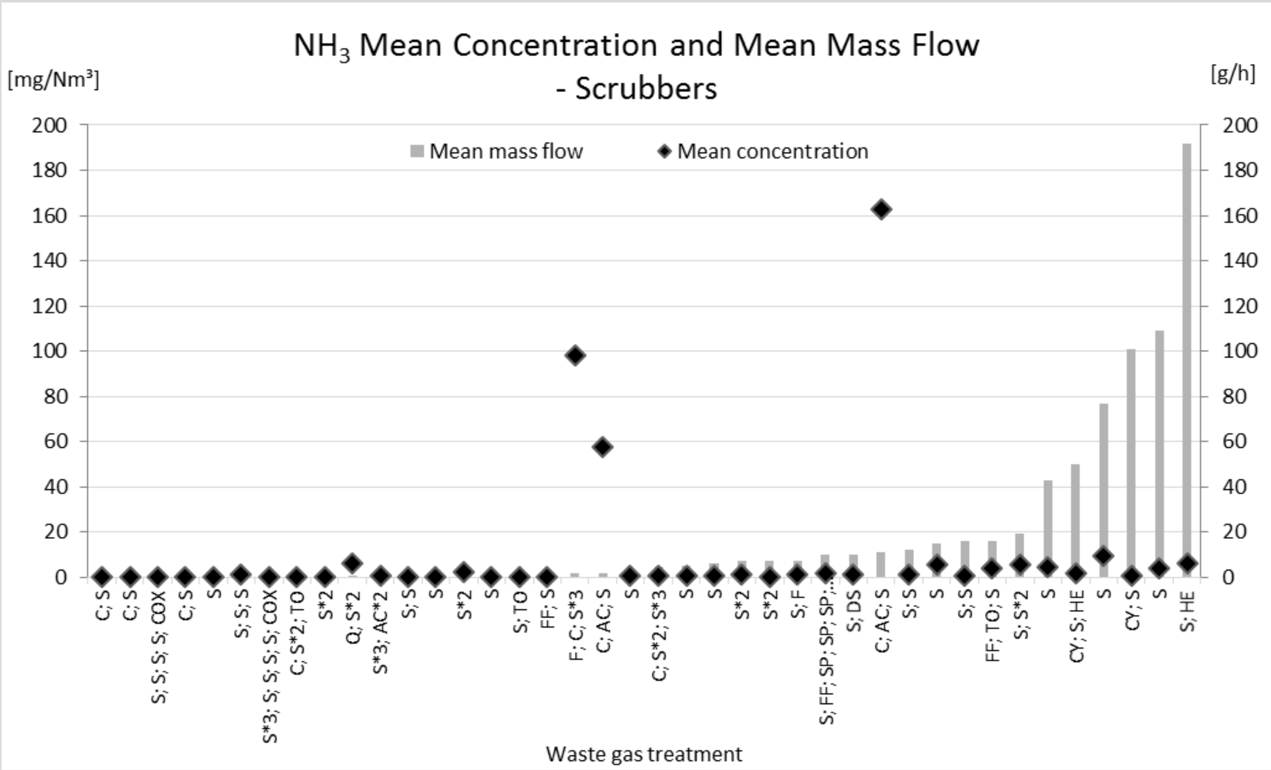
(Ökopol 2016)

6.4 NH_3 emissions from sources with scrubbers

Figure 69 shows NH_3 emission data from sources with scrubbers (40 measurements). Data is sorted by increasing mass flow. For a detailed list of data see Annex 18.

NH_3 mean concentrations associated with scrubbers are generally below 10 mg/Nm³ (93 % of data). In three cases with higher concentrations (57.8/97.9/163 mg/Nm³), mass flows were low (1.8 - 11 g/h). These highest mean emissions originate from the production of flame retardands (no. 4.1 of 4. BImSchV) and the production of aromatic amino compounds (IED Annex 1 no. 4.1. d respectively no. 4.1.4 of 4. BImSchV).

Figure 69: NH_3 mean concentration and mass flow from sources with scrubbers



(Ökopol 2016)

6.5 NH_3 emissions from sources without SCR, SNCR or scrubbers

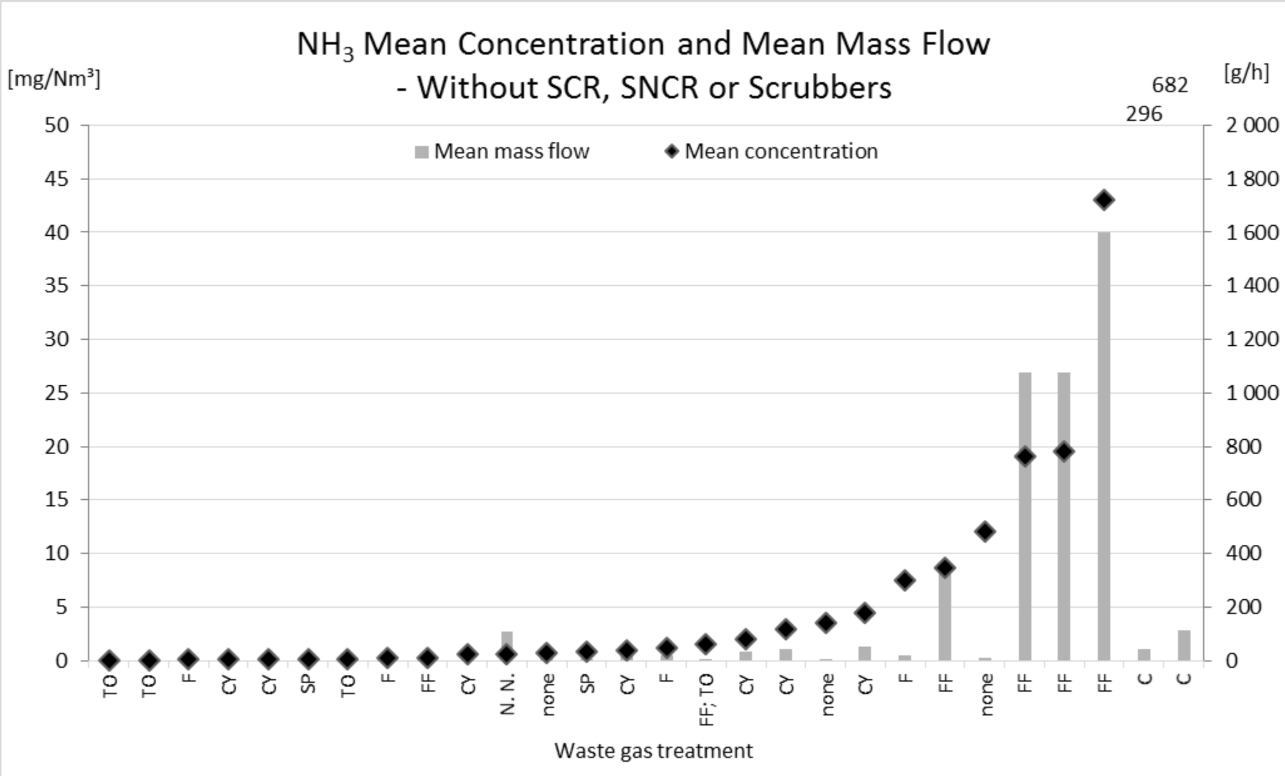
Figure 70 shows NH_3 emission data from sources without SCR, SNCR or scrubbers. Data is sorted by mass flow values. For a detailed list of data see Annex 19.

NH_3 emissions measured at sources without SCR, SNCR or scrubbers have generally mean mass flows below 100 g/h (86 % of data). Where higher mass flows occur, they are linked with low mean concentrations below 20 mg/Nm³.

Three cases with mean mass flows of 1 076 to 1 599 g/h and mean emission concentrations of 19.1 to 43 mg/Nm³ originate from the production of PVC polymers (IED Annex 1 no. 4.1. h resp. no. 4.1.8 of 4. BImSchV), where ammonia is emitted.

In another case, a mass flow of 113.5 g/h was measured, linked with a mean emission concentration of 682 mg/Nm³. It is linked with the production of fertilizers (IED Annex 1 no. 4.3 respectively no. 4.1.18 of 4. BImSchV).

Figure 70: NH_3 mean concentration and mass flow from sources without SCR, SNCR or scrubbers, reduced scale up to 50 mg/Nm³



Note: Two highest concentration values are out-of-range but indicated in the graph

(Ökopol 2016)

6.6 Conclusions for NH_3 data

NH_3 data assessment shows:

- NH_3 emissions originate from processes or from SCR/SNCR abatement systems (ammonia slip).
- Where no abatement system for NH3 is installed, mass flows are below 100 g/h.
- Where mass flows exceed 100 g/h, scrubbers are installed for NH_3 abatement.
- Scrubbers are generally associated with NH_3 emissions below 10 mg/Nm³.
- Emissions resulting from SCR/SNCR (ammonia slip) are mostly below 3 mg/Nm³.
- Emissions of NH_3 from installations for the production of PVC polymers (IED Annex 1 no. 4.1. h respectively no. 4.1.8 of 4. BImSchV) or from the production of fertilizers (IED Annex 1 no. 4.3 respectively no. 4.1.18 of 4. BImSchV) cannot be covered by the scope of the WGC BREF.
- Emissions from the production of flame retardands (no. 4.1 of 4. BImSchV) and the production of aromatic amino compounds (IED Annex 1 no. 4.1. d respectively no. 4.1.4 of 4. BImSchV) may need specific consideration to be covered in the scope of the WGC BREF.

7 Sulphur dioxides (SO_x)

7.1 SOx measurement

SOx concentrations are generally measured with method EN 14791, using ion chromatography and determining SO_2. The concentration of SO_3 is usually added the the result by using a fix process-specific factor. Additionally, VDI 2462 was used (thiosulfate method), as well as “NDIR” (non-dispersive infrared method).

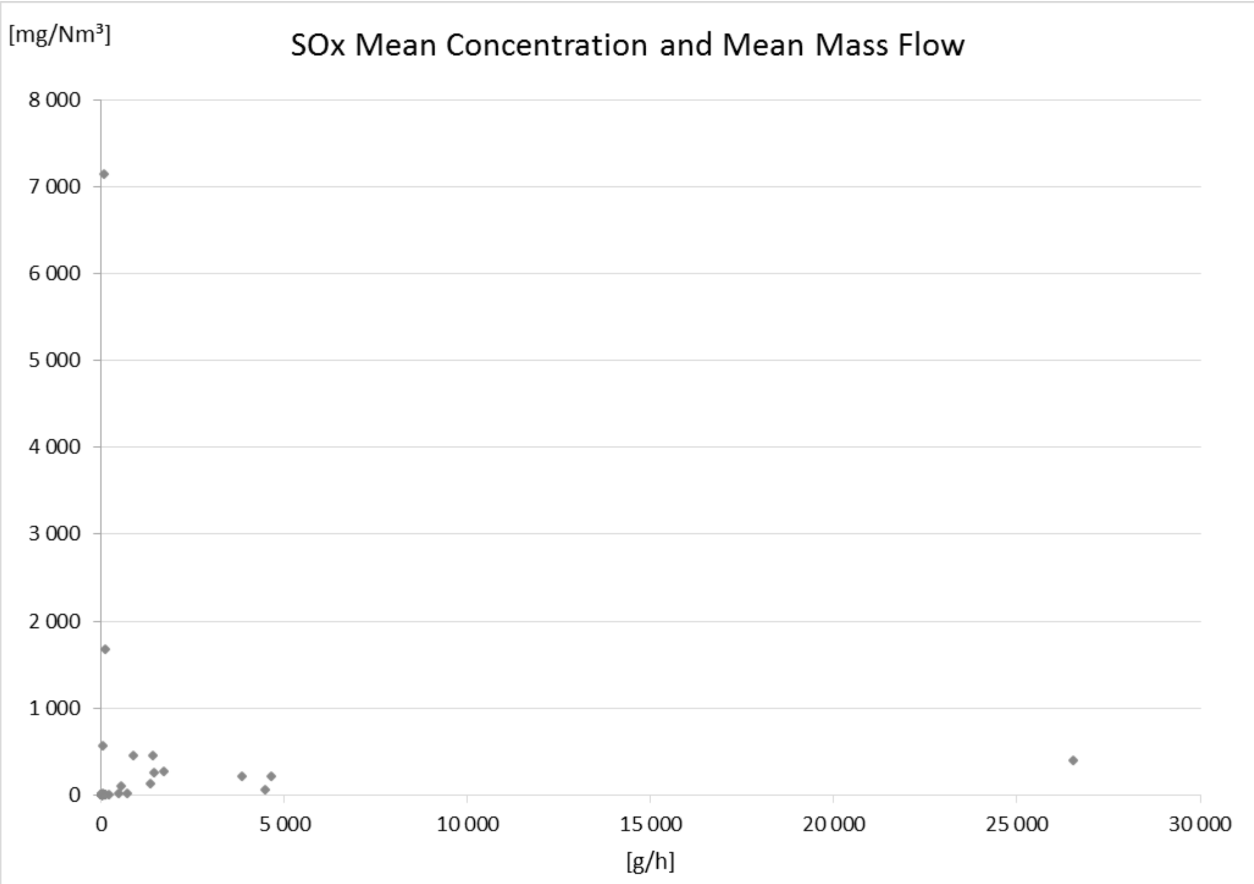
- EN 14791:2006 - Stationary source emissions - Determination of mass concentration of sulphur dioxide.
- VDI 2462-1 - Gaseous emission measurement; determination of sulphur dioxide concentration; iodometric thiosulfate method.

7.2 SOx concentration and related mass flow

Figure 71 show all SOx concentration values (92 data) and the related mass flow. For all except 15 data, the mass flow of the source has been reported. Figure 72 shows the same data with reduced scale, cutting of concentration value abov 2 000 mg/Nm³ and one mass flow above 5 000 g/h. For a detailed list of data see Annex 20 and Annex 21.

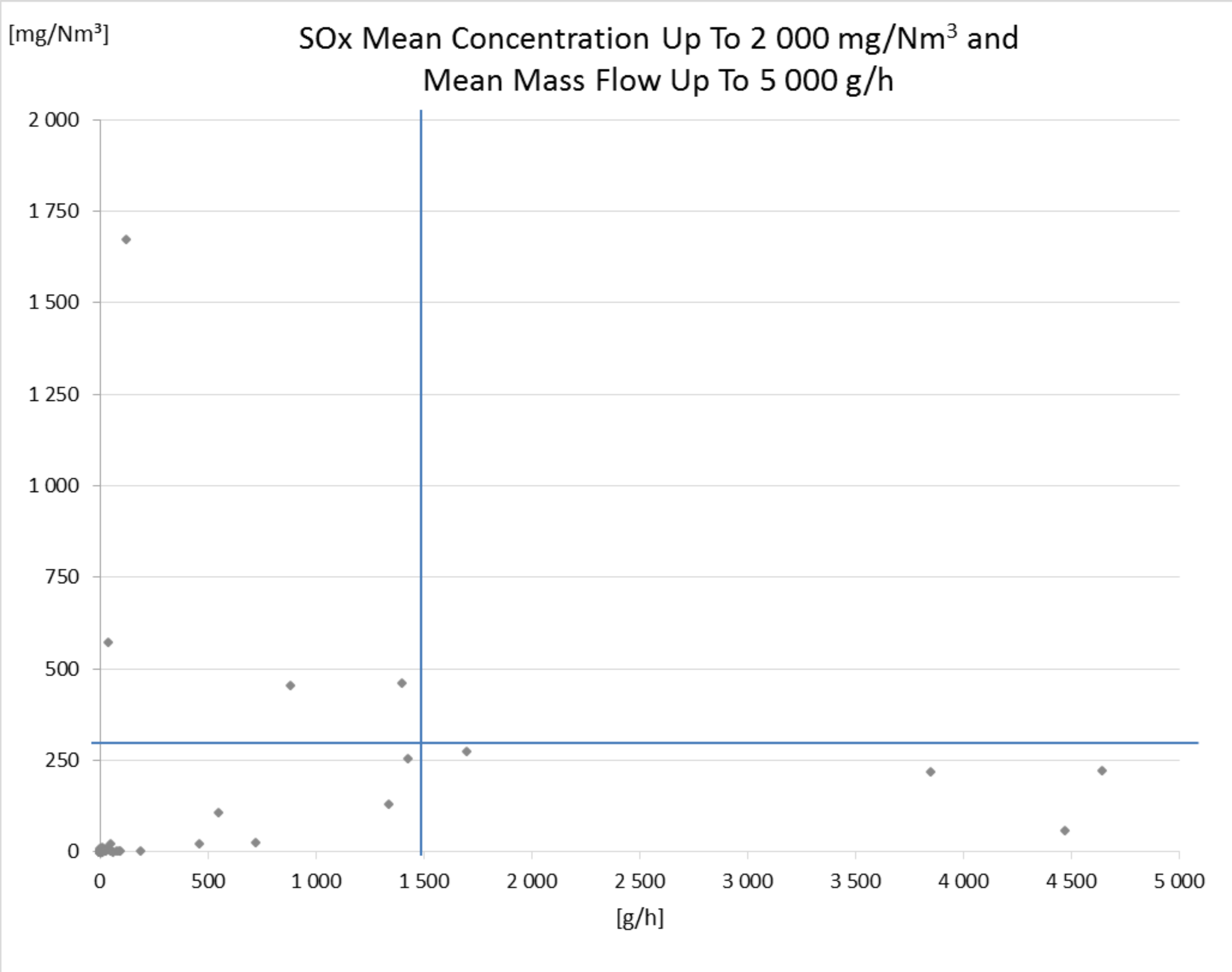
SOx concentrations are generally below 25 mg/Nm³ (86 %). Where concentrations are above 300 mg/Nm³, mass flows do not exceed 1 500 g/h, except one measurement with 403.4 mg/Nm³ and 26 546 g/h resulting from a sulphuric acid production (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV).

Figure 71: SOx mean concentration and mean mass flow



(Ökopol 2016)

Figure 72: SOx mean concentration and mean mass flow with reduced scale up to 2 000 mg/Nm³ and 5 000 g/h



Note: One value with a concentration of 7 151.9 mg/Nm³ and a mass flow of 63 g/h is cut off.

(Ökopol 2016)

7.3 SOx emissions from sources with scrubbers

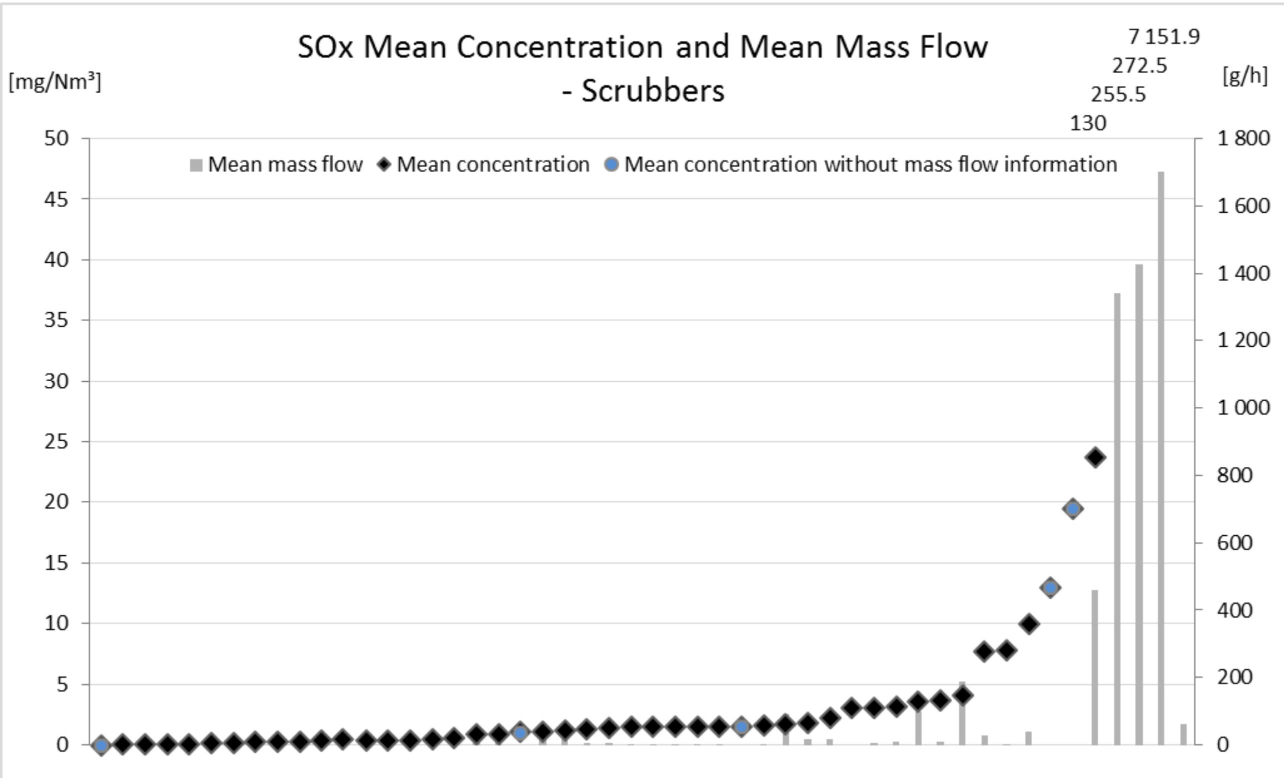
Figure 73 shows SOx emission data from sources where scrubbers are installed (50 data sets). Data is sorted by increasing concentration values. Four highest concentrations are out-of-range but indicated in the graph. For a detailed list of data see Annex 20.

Data show that SOx emission values associated with scrubbers are generally below 25 mg/Nm³ (92 % of the data). In four cases where concentration values are higher than 25 mg/Nm³, the mass flow is below 1 500 g/h, except for one data with a mass flow of 1 700 g/h.

Data with highest mass flows between 1 340 and 1 700 g/h originate from the production of sodium hydrogen sulphate (4.1 of 4. BImSchV) and from the production of cement additives (4.1.8 of 4. BImSchV).

The highest concentration value of 7 151.9 mg/Nm³ (with a mass flow of 63 g/h) originates from the production of alcane sulphonates (production of surface-active agents and surfactants according to IED Annex 1 no. 4.1. k) respectively 4.1.11 of 4. BImSchV).

Figure 73: SOx mean concentration and mass flow from sources with scrubbers



Note: Four highest concentration values are out-of-range but indicated in the graph

(Ökopol 2016)

7.4 SOx emissions from sources without scrubbers

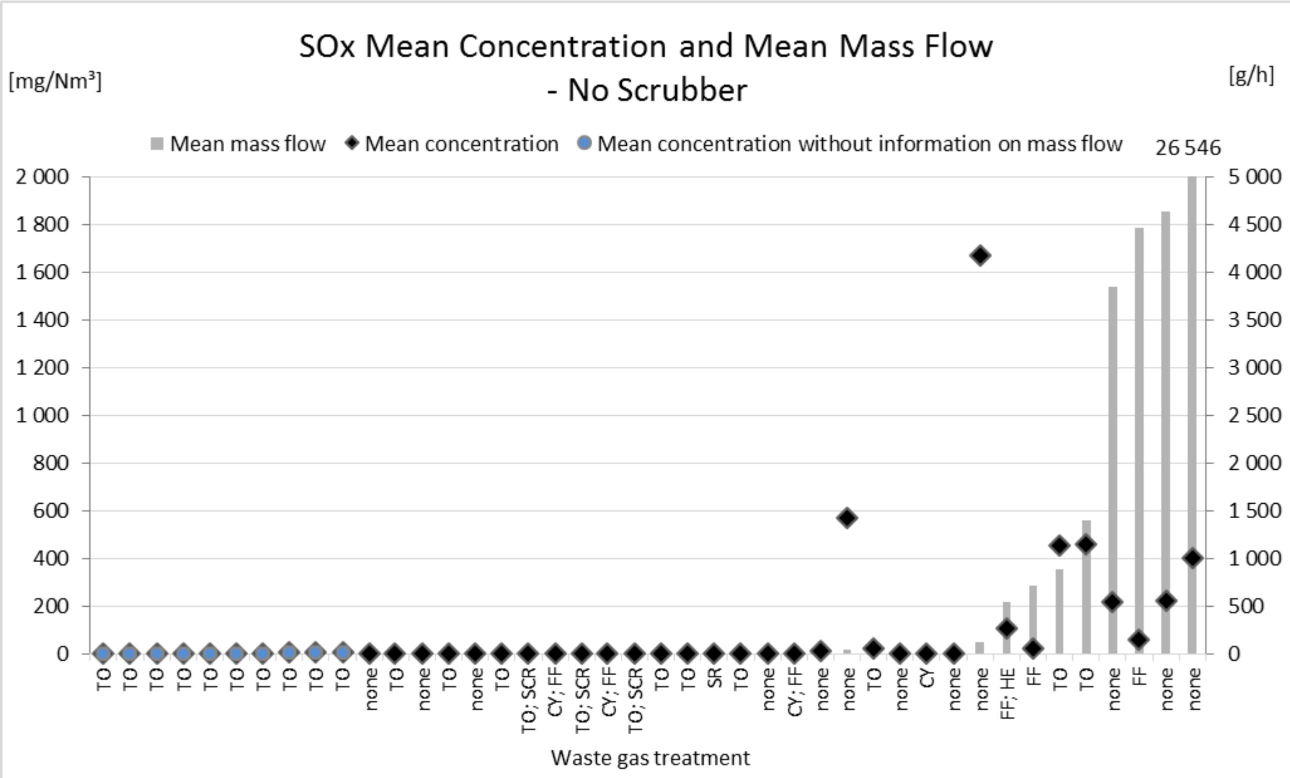
Figure 74 shows SOx emission data from sources where no waste gas treatment for SOx is installed (no waste gas treatment or no scrubber, 42 data). Data is sorted by mass flow. Data provided without mass flow is plotted first (blue dot). The highest mass flow value is out-of-range but indicated in the graph. For a detailed list of data see Annex 21.

Data show that SOx emission values from sources where no scrubbers are installed have either concentrations below 300 mg/Nm³ (88 % of data) or mass flows below 1 500 g/h, except one value.

The emission of 403.4 mg/Nm³ with a mass flow of 26 546 g/h originates from a cracker in the production of sulphuric acids (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV).

Three mass flows range between 3 848 and 4 641 g/h, with corresponding concentrations between 57.7 and 222 mg/Nm³. Two originate from the production of aromatic hydrocarbons (IED Annex 1 no. 4.1. a resp. no. 4.1.1 of 4. BImSchV) and one from the production of other inorganic substances (no. 4.1.21 of 4. BImSchV).

Figure 74: SOx mean concentration and mass flow from sources without scrubbers, reduced scale up to 5 000 g/h



Note: The highest mass flow value is out-of-range but indicated in the graph

(Ökopol 2016)

7.5 Conclusions for SOx data

SOx data assessment shows:

- Abatement of sulphur oxides emissions is either realized with scrubbers or with process-integrated techniques (e.g. in sulphuric acid production).
- Where no abatement system for SOx is installed, mass flows are below 1 500 g/h.
- Scrubbers are generally associated with mean SOx emissions below 25 mg/Nm³.
- Emissions from the production of sulphuric acids (IED Annex 1 no. 4.2. b respectively no. 4.1.13 of 4. BImSchV) cannot be covered by the scope of the WGC BREF.
- Emissions from the production of sodium hydrogen sulphate (4.1 of 4. BImSchV) and from the production of cement additives (4.1.8 of 4. BImSchV) need specific consideration for inclusion in the scope.

8 Hydrogen chloride (HCl)

8.1 HCl measurement

HCl concentrations are all measured with method EN 1911. EN 1911 allows three alternative analytical techniques for the determination of the chloride content in chloride containing absorption solutions obtained during sampling: ion-exchange chromatography, photometry and potentiometry. Where the analytical technique was specified, EN ISO 10304 was used.

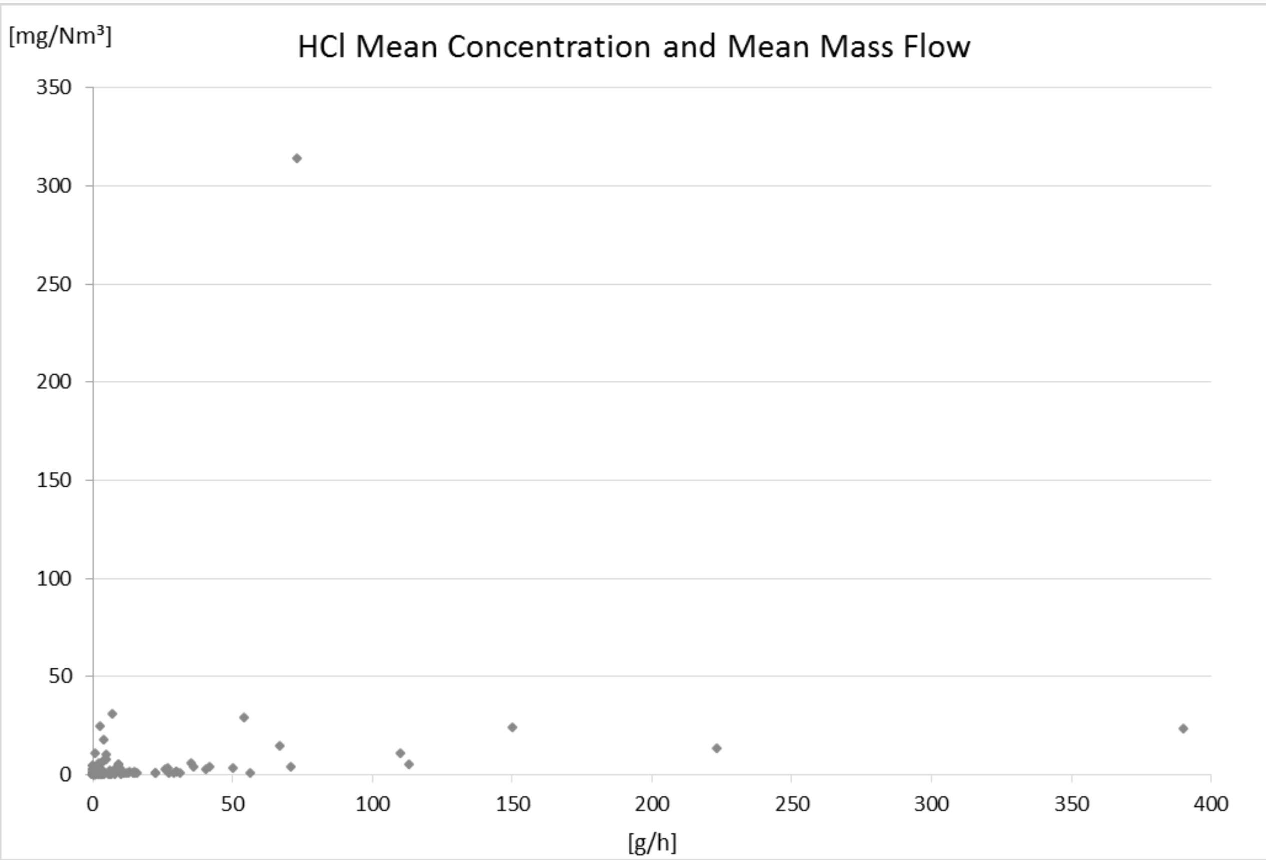
- EN 1911:2010 - Stationary source emissions. Determination of mass concentration of gaseous chlorides expressed as HCl
- EN 10403:2009 - Water quality Determination of dissolved anions by liquid chromatography of ions

8.2 HCl concentration and related mass flow

Figure 75 shows all HCl concentration values (177 data) and the related mass flow. For all except 12 data, the mass flow of the source has been reported. For a detailed list of data see Annex 22 to Annex 24.

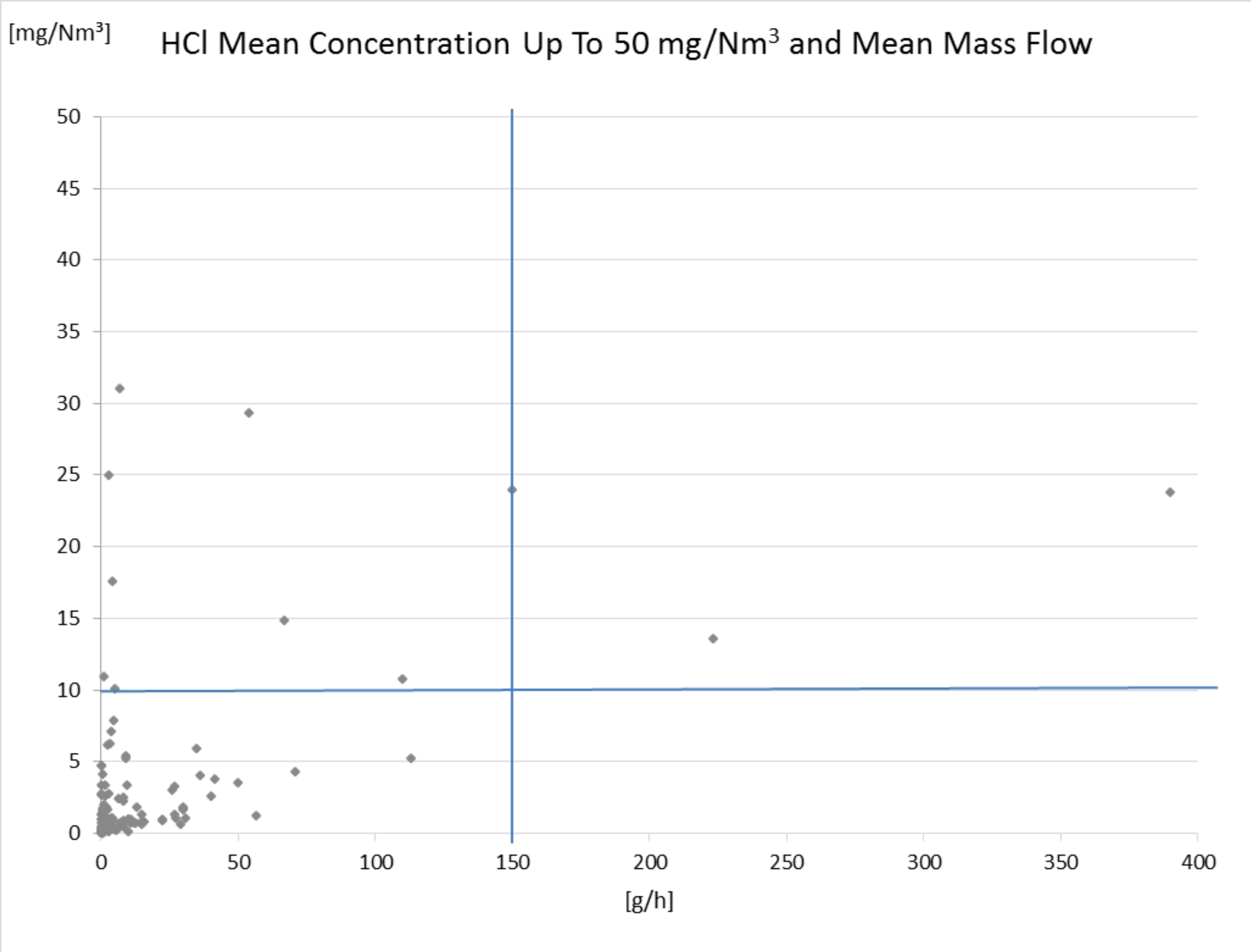
The figure shows that HCl concentrations are generally below 10 mg/Nm³ (93 %). If concentrations above 10 mg/Nm³ were measured, mass flows are generally below 150 g/h. Exceptions are two data sets with concentrations of 10 - 25 mg/Nm³ and corresponding mass flows of 200 - 400 g/h, originating from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV).

Figure 75: HCl mean concentration and mean mass flow



(Ökopol 2016)

Figure 76: HCl mean concentration and mean mass flow with reduced scale up to 50 mg/Nm³



Note: One values with 314 mg/Nm³ and a mass flow of 73 g/h is cut off.

(Ökopol 2016)

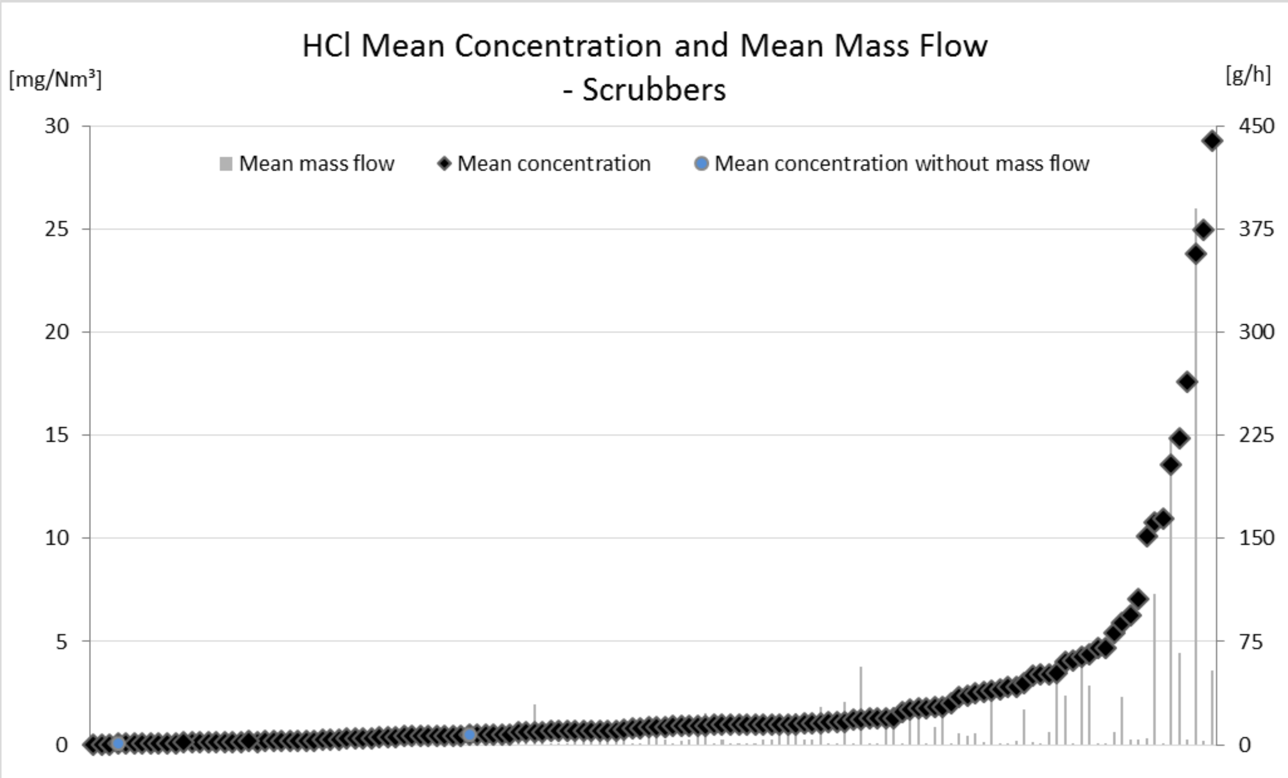
8.3 HCl emissions from sources with scrubbers

Figure 77 shows HCl emission data from sources where scrubbers are installed (139 data). Data is sorted by increasing concentration values. For a detailed list of data see Annex 23.

Data show that HCl emission values associated with scrubbers are generally associated with mean concentrations below 5 mg/Nm³ (91 % of the data).

In the cases where mean concentration values are higher, the mean mass flow is equal or below 150 g/h except for two data. These two cases report mean concentrations of 13.6 mg/Nm³ and 23.8 mg/Nm³ with mean mass flows higher than 150 g/h (223 g/h and 390 g/h). Waste gases originate from a centralized thermal oxidation plant connected to the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV).

Figure 77: HCl mean concentration and mass flow from scrubbers



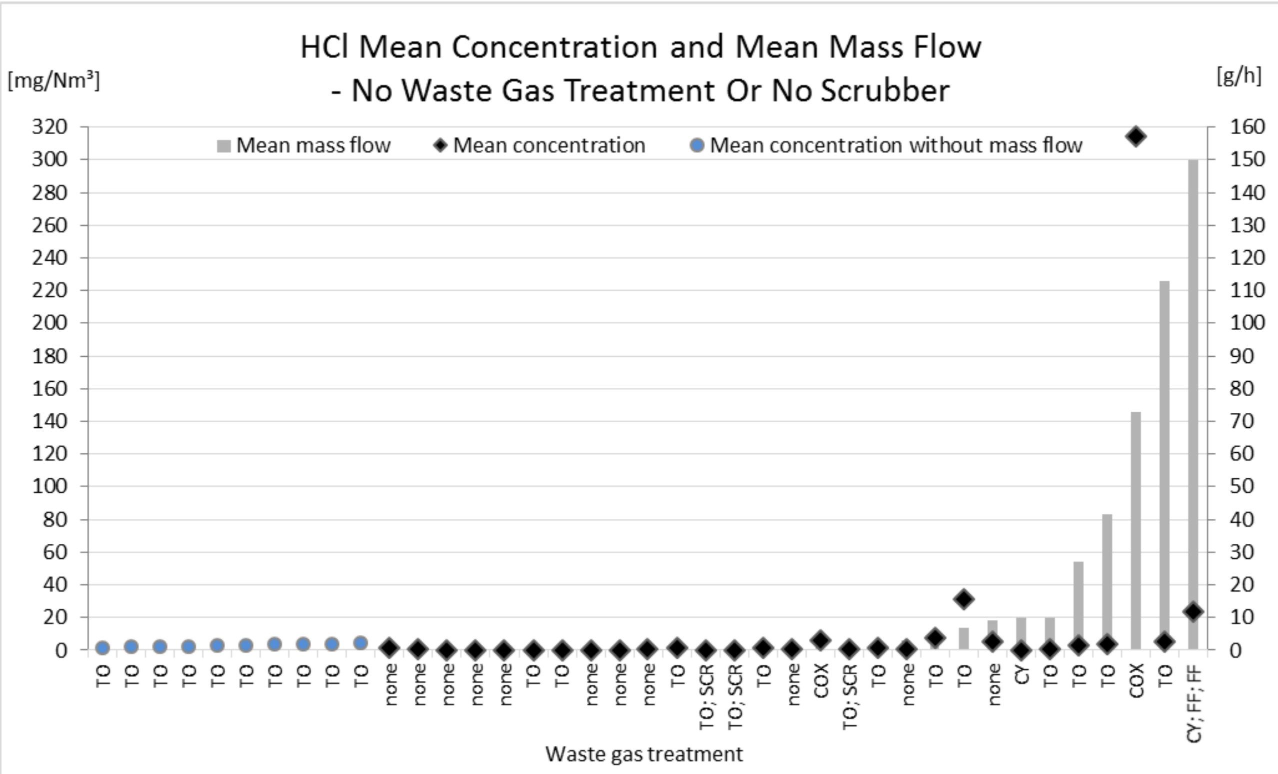
(Ökopol 2016)

8.4 HCl emissions from sources without scrubbers

Figure 78 shows HCl emission data from sources where no waste gas treatment for HCl is installed (no waste gas treatment or no scrubber). Data is sorted by mean mass flow. Data provided without mass flow are plotted first (blue dot). For a detailed list of data see Annex 23. Note that Annex 24 includes data from sources with other systems, not discussed here.

The graph shows that where no waste gas treatment for HCl is installed, mean mass flows are generally below 10 g/h and mean concentrations below 10 mg/Nm³. In two cases where the mean concentrations are 24 and 314 mg/Nm³ and corresponding mean mass flows 150 g/h and 73 g/h, emissions originate from the production of Grignard reagents (IED Annex 1 no. 4.1.g respectively no. 4.1.7 of 4. BImSchV) and from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV).

Figure 78: HCl mean concentration and mass flow from sources without scrubber or no treatment



(Ökopol 2016)

8.5 Conclusions for HCl data

HCl data assessment shows:

- Where no abatement system for HCl is installed in general the mean mass flow is below 10 g/h and the mean concentrations below 10 mg/Nm3, in two cases no abatement is installed for mass flows < 150 g/h.
- Scrubbers are generally associated with HCl emissions below 5 mg/Nm³.
- Emissions from the production of the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV) may need a specific assessment to be covered by the scope of the WGC BREF.
- Emissions from the production of Grignard reagents (IED Annex 1 no. 4.1.g respectively no. 4.1.7 of 4. BImSchV) may need a specific assessment to be covered by the scope of the WGC BREF.

9 Hydrogen fluoride (HF)

9.1 HF measurement

HF concentrations are all measured with method VDI 2470 applying absorption:

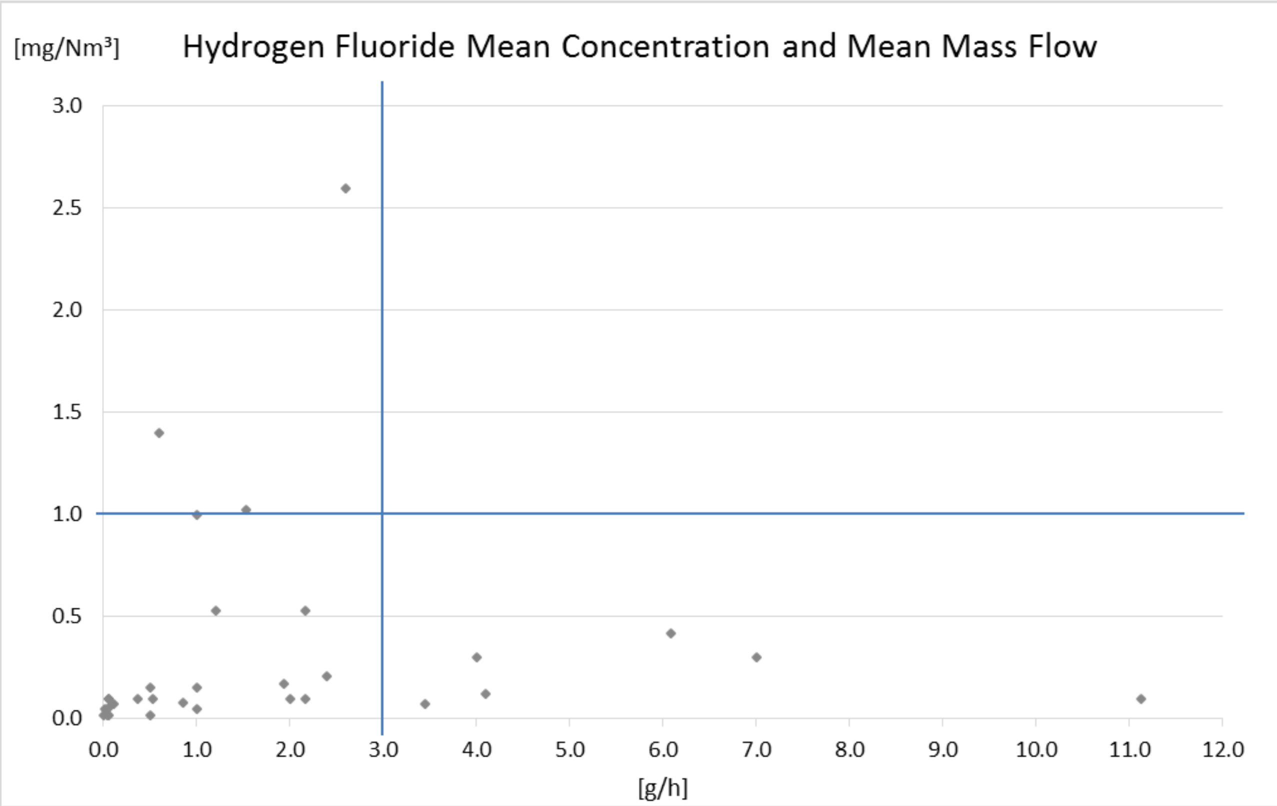
- VDI 2470 Bl. 1:1975 (confirmed 2011) - Gaseous emission measurement; measurement of gaseous fluorine compounds; absorption method.

9.2 HF concentration and related mass flow

Figure 79 shows all HF mean concentration values (41 data sets) and the related mass flow. For all but ten data, the mass flow of the source has been reported. For a detailed list of data see Annex 25 and Annex 26.

HF mean concentrations are generally below 1 mg/Nm³ (93 % of data). Where mean concentrations are higher than 1 mg/Nm³, the mass flows does not exceed 3 g/h.

Figure 79: HF mean concentration and mean mass flow



(Ökopol 2016)

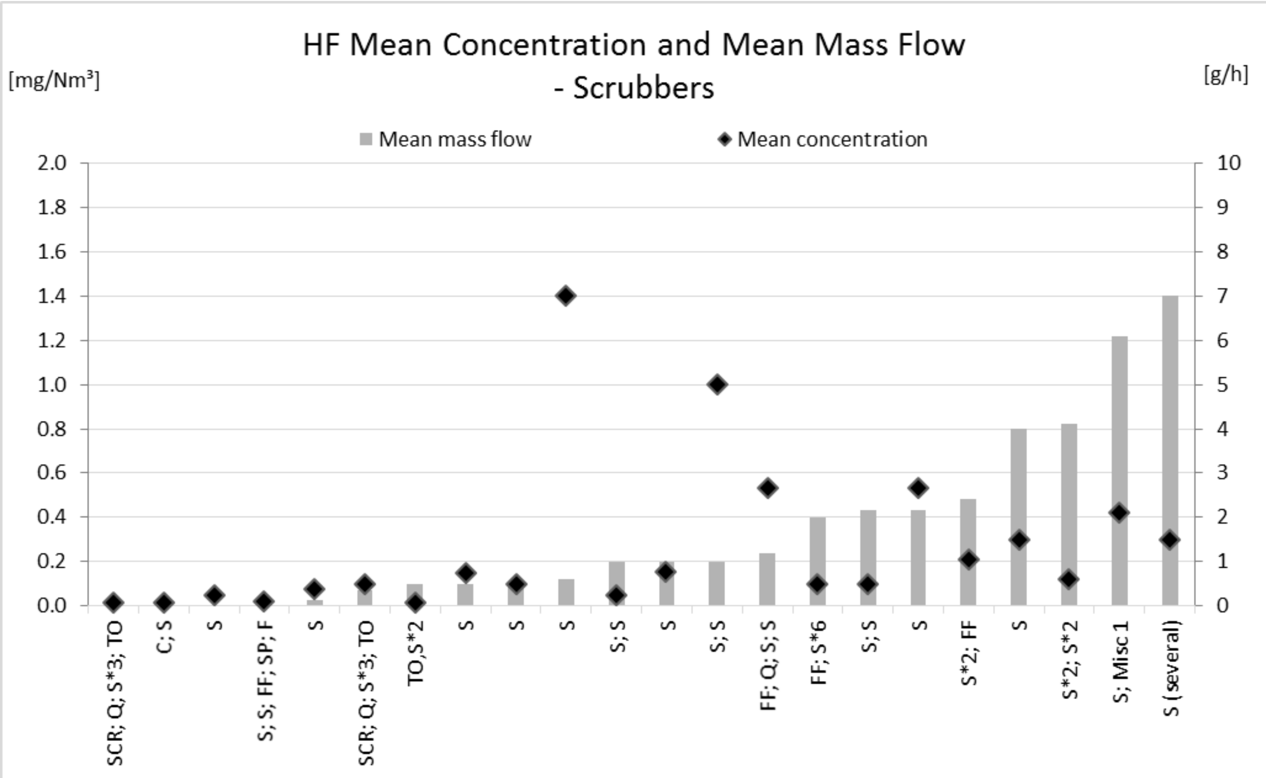
9.3 HF emissions and related waste gas treatment

Figure 80 shows HF emission data from sources where scrubbers are installed. Data is sorted by increasing mass flow.

Data show that HF emission values from sources with scrubbers are generally associated with mean emission concentrations equal or below 1 mg/Nm³ (95 % of data). For a detailed list of data see Annex 25.

One value was measured with a mean concentration of 1.4 mg/Nm³, combined with a low mean mass flow of 0.6 g/h. It originates from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV).

Figure 80: HF mean concentration and mass flow from sources with scrubbers

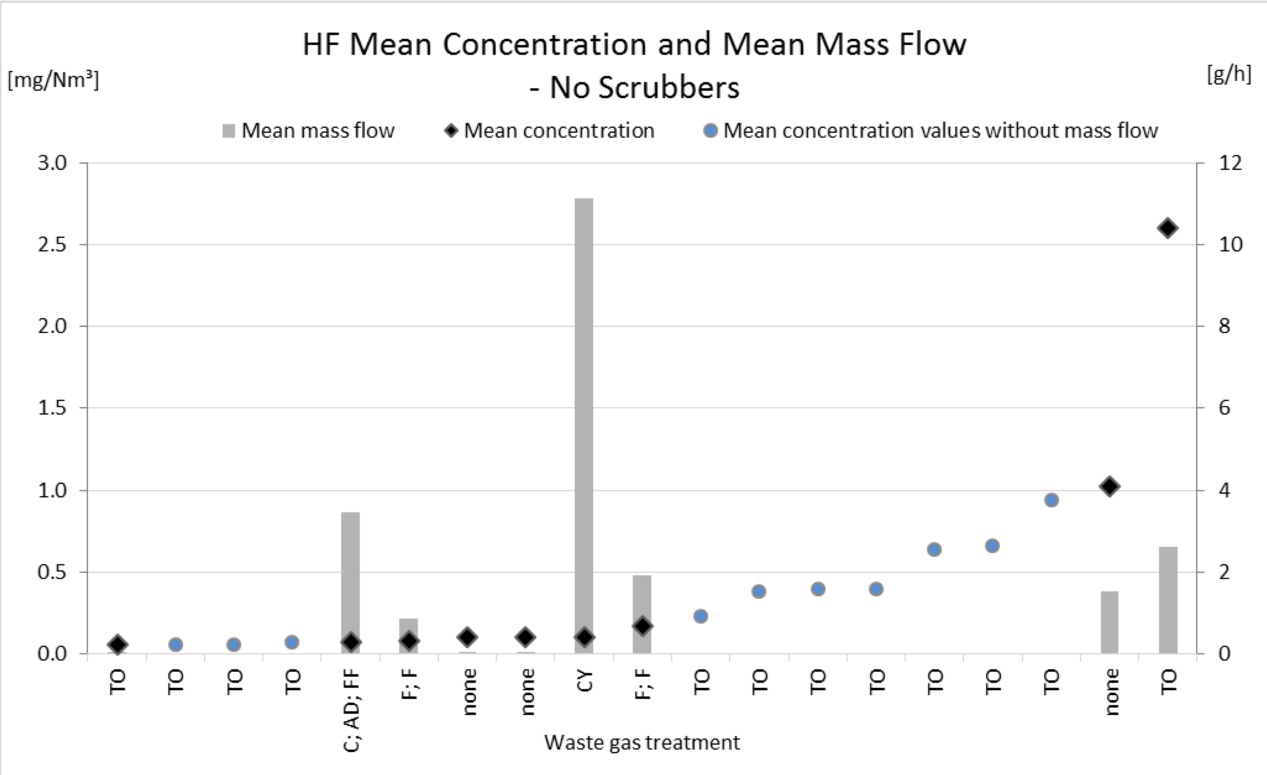


(Ökopol 2016)

Figure 81 shows HF emission data from sources where no scrubbers are installed. As little information about mass flows is available, data is sorted by increasing mean concentration values. For a detailed list of data see Annex 25.

Data show that HF emissions froum sources where no scrubbers are installed are generally $\leq$ 1 mg/Nm³ (95 % of data). Where a higher mean concentration was measured (2.6 mg/Nm³) the mean mass flow was below 3 g/h (2.6 g/h). It originates from the production of of basic plant health products and of biocides (IED Annex 1 no. 4.4 respectively no. 4.1.18 of 4. BImSchV).

Figure 81: HF mean concentration and mass flow from sources without scrubbers



(Ökopol 2016)

9.4 Conclusions for HF data

HF data assessment shows:

- Where no abatement system for HF is installed, the mass flow in general is below 3 g/h (or no mass flow was reported but the concentrations was below 1 mg/Nm³).
- Scrubbers are generally associated with HF emissions below 1 mg/Nm³.
- Emissions from the production of the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV) may need a specific assessment to be covered by the scope of the WGC BREF.
- Emissions from the production of non-metals, metal oxides or other inorganic compounds (IED Annex 1 no. 4.2.e respectively no. 4.1.16 of 4. BImSchV) may need a specific assessment to be covered by the scope of the WGC BREF.

10 Hydrogen bromide (HBr)

10.1 HBr measurement

HBr concentrations are generally measured with method EN 1911-3; in one case, VDI 3488 was applied, using methyl orange.

- EN 1911:2010 - Stationary source emissions. Determination of mass concentration of gaseous chlorides expressed as HCl
- VDI 3488 Bl. 1:1979 (confirmed 2015) - Gaseous emission measurement; measurement of chlorine and oxides of chlorine; methyl orange method

10.2 HBr concentration, mass flow and waste gas treatment system

Table 16 shows all HBr concentrations values (9 data) and the related mass flow. For all values, the mass flow of the source has been reported. All mean concentrations include at least one result below the limit of detection (LOD). Hydrogen bromide concentrations are all below 1.0 mg/Nm³. In six of nine cases, scrubbers are installed.

In Table 16, the second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow. The seventh and eighth column indicate the mean mass flow, and the ninth and tenth column show the mean concentration value.

Table 16: Hydrogen bromide emissions and related treatment system

#	Type of installa-tion	Waste gas system		Hydrogen bromide Measurement method	Mean Volume Flow (*) [m³/h]	HBr Mean Mass Flow		HBr Mean Concentration	
						Value	Unit	Value	Unit
1	4.1.10	S	S*2; S	Based on VDI 3488 Bl. 1	2 180	0.02	g/h	<0.02	mg/m³
2	4.1.19	S	TO; SCR	EN 1911-3	7 000	0.7	g/h	<0.2	mg/m³
3	4.1.19	S	TO; SCR	EN 1911-3	7 000	0.55	g/h	<0.2	mg/m³
4	4.1.19	S	TO; SCR	EN 1911-3	7 000	0.6	g/h	<0.2	mg/m³
5	4.1.2	C	SCR; Q; S*3; TO	Based on EN 1911-3	2 985	0.45	g/h	<0.3	mg/m³
6	4.1	C	TO, S*2	EN 1911-3	34 008	4	g/h	<0.3	mg/m³
7	4.1.2	C	SCR; Q; S*3; TO	Based on EN 1911-3	2 805	0.5615	g/h	<0.4	mg/m³
8	4.1.10	C	S; S; S	EN 1911, EN 14791	3 601	0.75	g/h	<0.4	mg/m³
9	4.1	C	S; S; S	EN 1911:2010	24 850	11.25	g/h	<0.9	mg/m³

10.3 Conclusions for HBr data

HBr data assessment shows:

- In general emission concentrations are below 1 mg/Nm³.
- To achieve 1 mg/Nm³, scrubbers are installed in two thirds of the sources.

11 Chlorine (Cl_2)

11.1 Chlorine measurement

Chlorine concentrations are measured with method VDI 3488 using methyl orange for analysis.

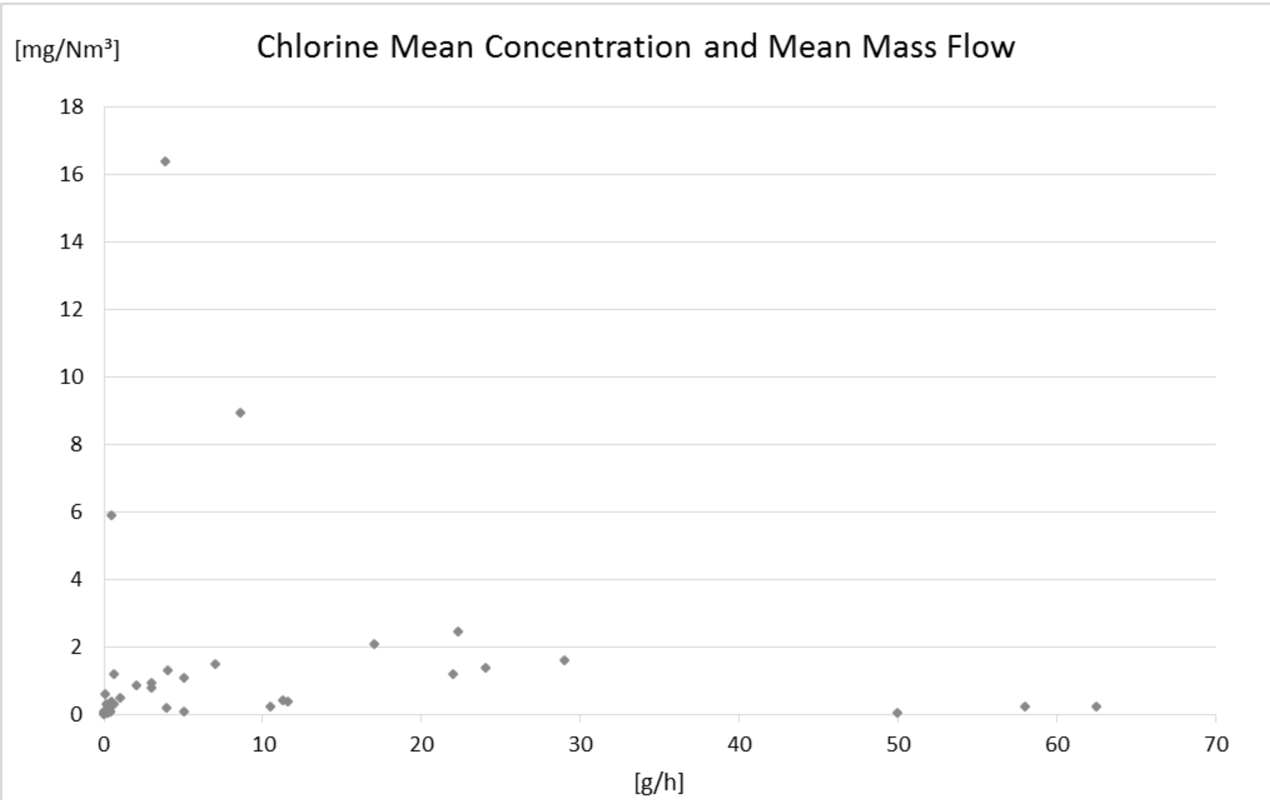
- VDI 3488 Bl. 1:1979 (confirmed 2015) - Gaseous emission measurement; measurement of chlorine and oxides of chlorine; methyl orange method.

11.2 Chlorine concentration and related mass flow

Figure 82 shows all chlorine mean concentration values (41 data) and the related mass flow. For all data, the mass flow of the source has been reported. For a detailed list of data see Annex 27 and Annex 28.

Chlorine mean concentrations are generally below 3 mg/Nm³ (93 % of data). Where mean concentrations are higher than 3 mg/Nm³, mean mass flows do not exceed 5 g/h.

Figure 82: Chlorine mean concentration and mean mass flow



(Ökopol 2016)

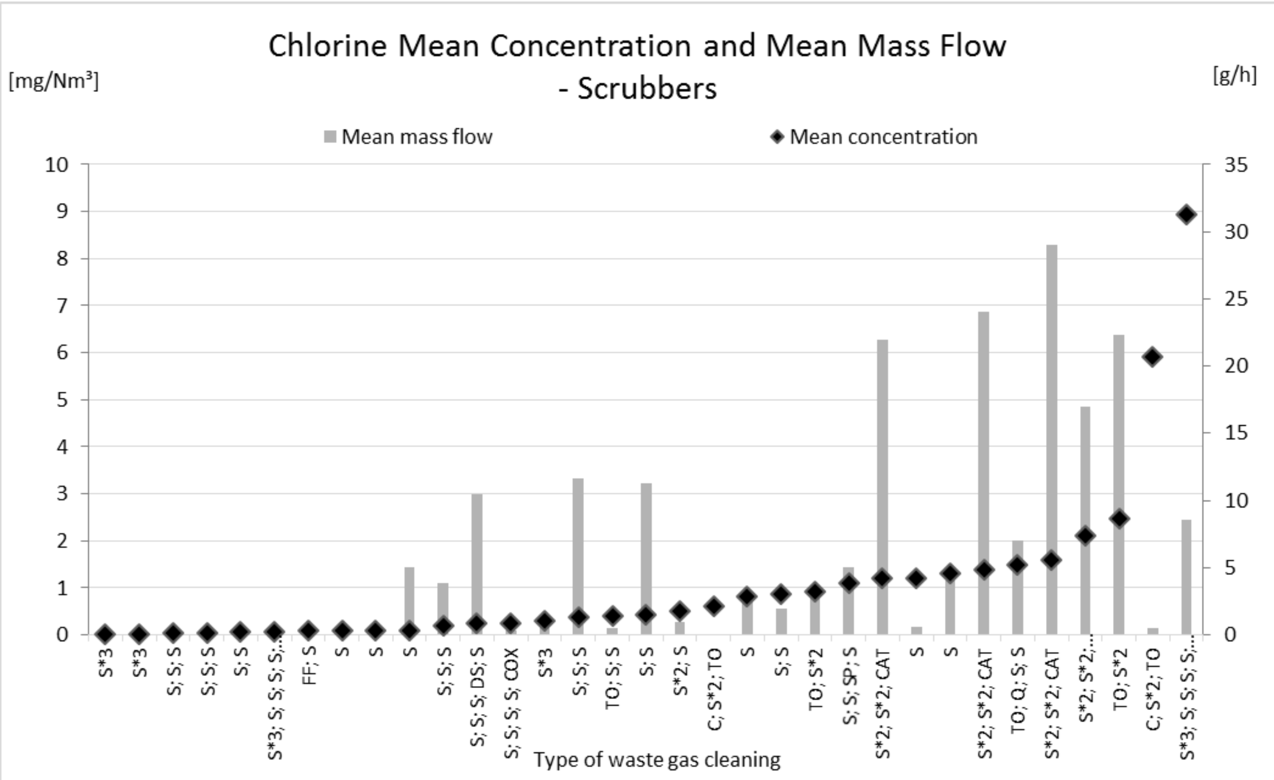
11.3 Chlorine emissions and related waste gas treatment

Figure 83 shows chlorine emission data and related waste gas treatment systems from sources with scrubbers. Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 27.

Data show that scrubbers (33 data sets) are generally associated with chlorine mean concentrations below 3 mg/Nm³ (94 % of the data).

Two mean concentration values were measured above 3 mg/Nm³, combined with mass flows below 10 g/h. One data set with a concentration value of 8.93 mg/Nm³ and a mass flow of 8.6 g/h originates from the production of plant protection products (IED Annex 1 no. 4.4 respectively no. 4.1.18 of 4. BImSchV). The other data set with a concentration value of 16.4 mg/Nm³ and a mass flow of 3.83 g/h originates from the production of organometallic compounds (IED Annex 1 no. 4.1.g respectively no. 4.1.7 of 4. BImSchV).

Figure 83: Chlorine mean concentration and mass flow with scrubbers

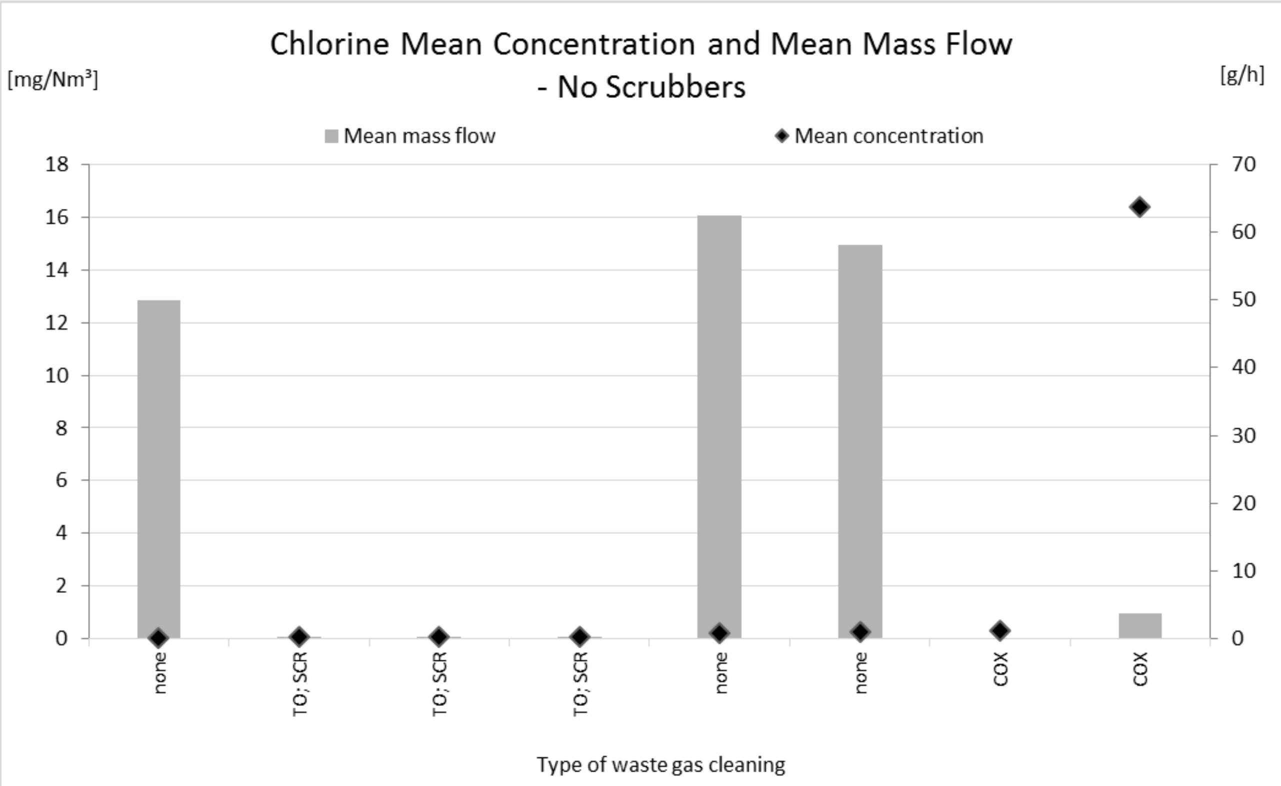


(Ökopol 2016)

Figure 84 shows chlorine emission data and related waste gas treatment systems from sources where no scrubbers are installed. Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 28.

Data show chlorine emission concentrations from sources where no scrubbers are installed (8 data sets). Emissions have generally mean mass flows below 5 g/h (5 data sets). High mean mass flows of 50 - 70 g/h originate from the productions of chloralkali or the production of alcoholates, with corresponding mean emission concentrations below 1 mg/Nm³ (3 data sets).

Figure 84: Chlorine mean concentration and mass flow from sources without scrubbers



(Ökopol 2016)

11.4 Conclusions for chlorine data

Chlorine (Cl_2) data assessment shows:

- Where no abatement system for chlorine is installed, the mass flow is in general below 5 g/h, or the mean concentration is below 1 mg/Nm³.
- Scrubbers are generally associated with mean chlorine emissions below 3 mg/Nm³.

12 Methanol (CH_4O)

12.1 Methanol measurement

Methanol (CH_4O) is among the most important solvents used in the chemical industry. Methanol concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds – Fundamentals.

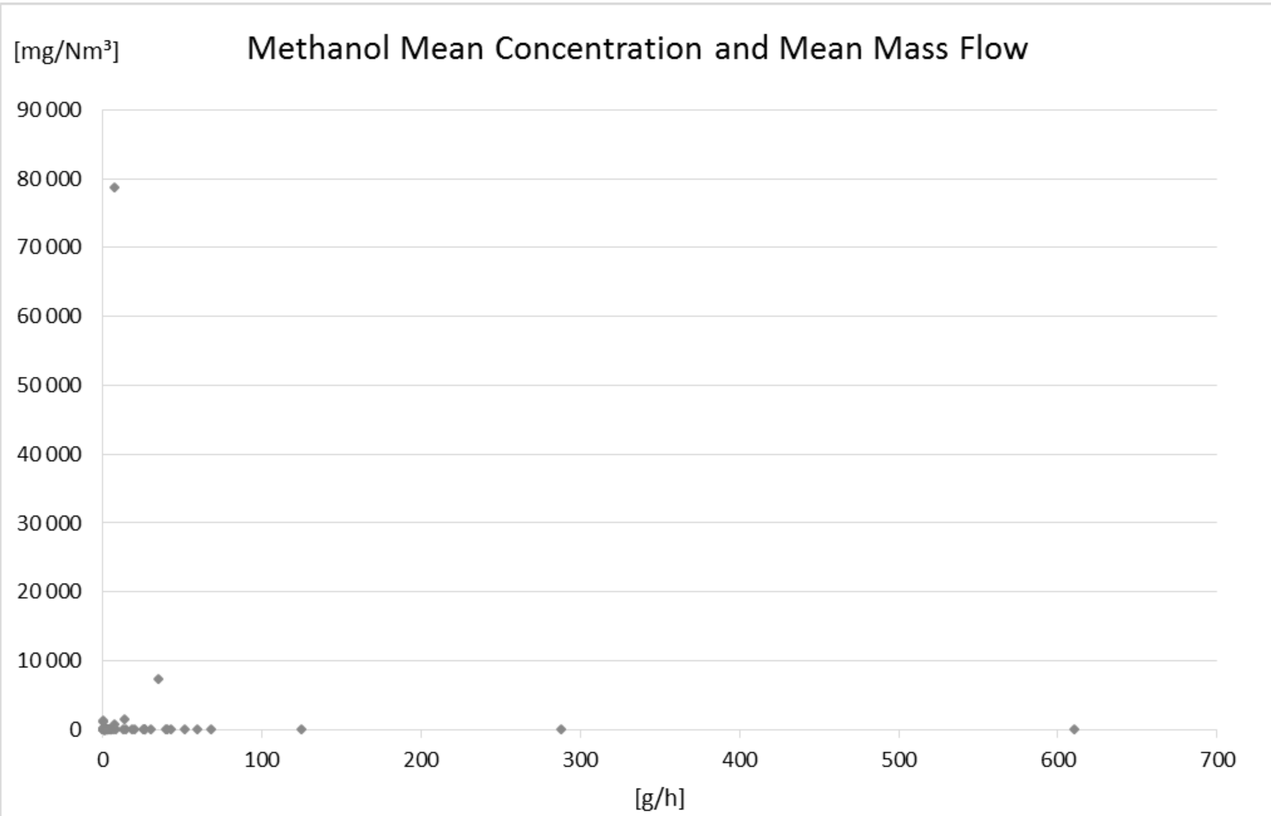
12.2 Methanol concentration and related mass flow

Figure 85 shows all methanol mean concentration values (80 data sets) and the related mass flow. Figure 86 shows the same data with a reduced scale up to 50 mg/Nm³ (10 data are cut off). For all data, the mass flow of the source has been reported. For a detailed list of data see Annex 29 to Annex 31.

Methanol mean concentrations are generally equal or below 20 mg/Nm³ (83 % of data). Where mean concentrations are higher than 20 mg/Nm³, mass flows do not exceed 30 g/h.

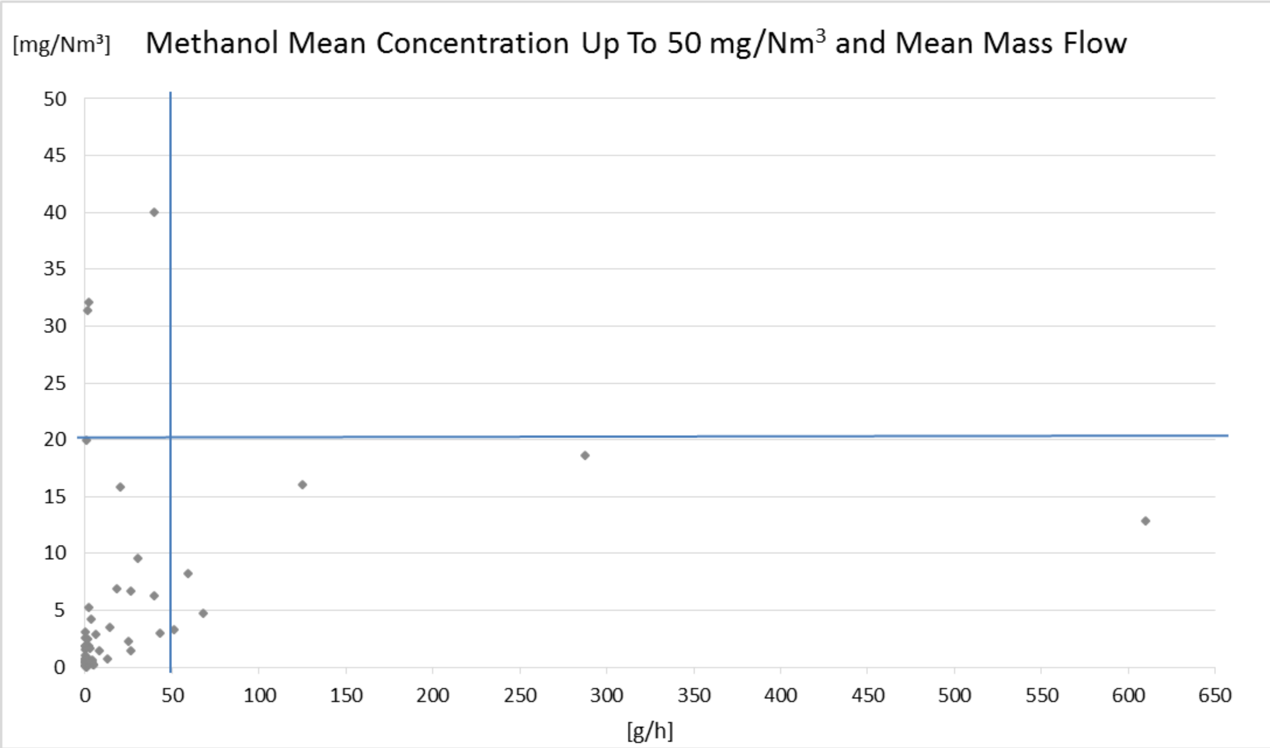
The highest mean concentration value is 78 725 mg/Nm³ with a corresponding mean mass flow of 7 g/h; it originates from the measurement of a methanol storage tank in the production of halogenated hydrocarbons (IED Annex 1 no. 4.1.f respectively no. 4.1.6 of 4. BImSchV).

Figure 85: Methanol mean concentration and mean mass flow



(Ökopol 2016)

Figure 86: Methanol mean concentration and mean mass flow with reduced scale up to 50 mg/Nm³



Note: 10 data with concentrations above 50 mg/Nm³ and mass flows between 0.05 g/h and 39.7 g/h are cut off.

(Ökopol 2016)

12.3 Methanol emissions and related waste gas treatment

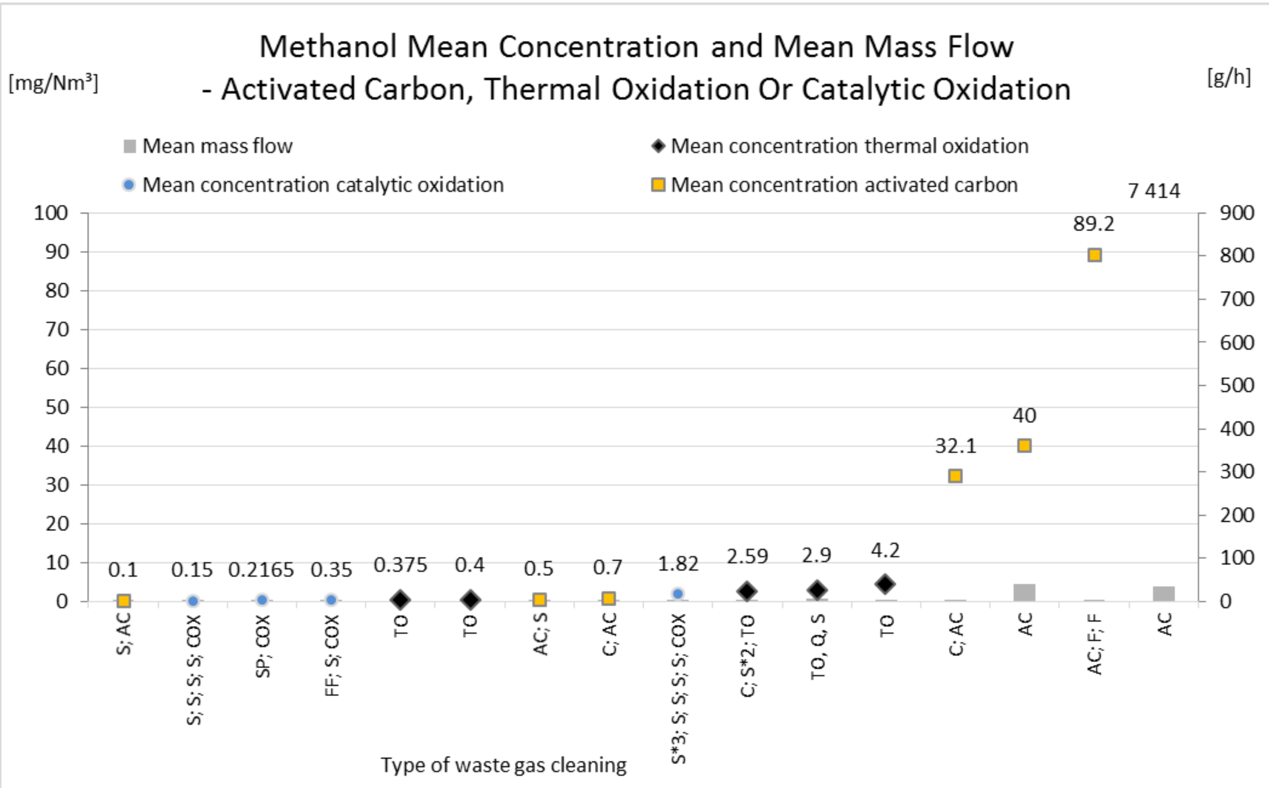
Figure 87 shows methanol emission data and related waste gas treatment systems from sources where thermal oxidation, catalytic oxidation or activated carbon treatment is installed. Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 29.

Data show that thermal oxidation or activated carbon filters are generally associated with mean methanol emission concentrations below 5 mg/Nm³ (75 % of the data).

Four mean concentration values are above 5 mg/Nm³, combined with mass flows below 40 g/h. The highest mean concentration value (7 414 mg/Nm³) is combined with a low mean mass flow of 35 g/h (not plotted but indicated in Figure 87).

Two of the highest mean concentration values originate from the production of melamin formaldehyde resins and of epoxy resin granulate (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV). The other two data originate from the production of antibiotica and of amino compounds (IED Annex 1 no. 4.1 respectively no. 4.1 of 4. BImSchV).

Figure 87: Methanol mean concentration and mass flow with activated carbon, thermal oxidation or catalytic oxidation



Note: The highest concentration value is out-of-range but indicated in the graph

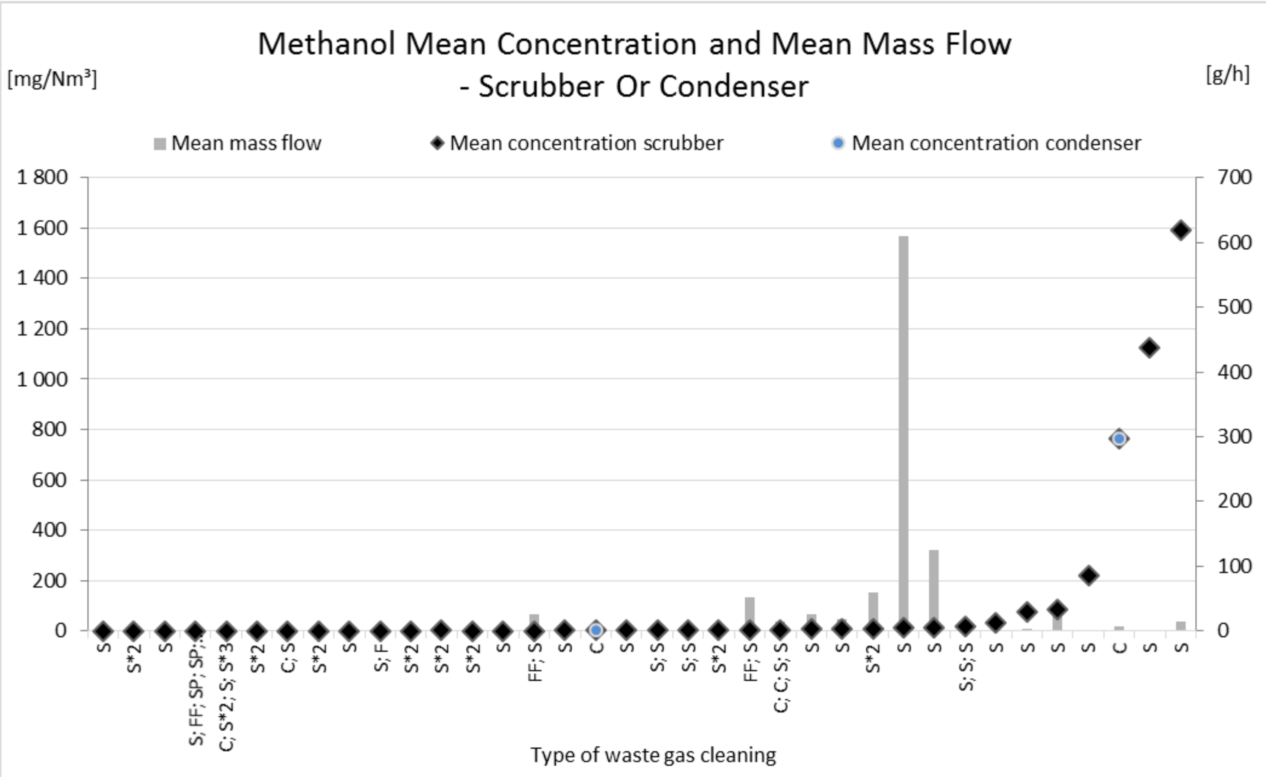
(Ökopol 2016)

Figure 88 shows mean methanol emission data and related waste gas treatment systems from sources with scrubbers or condensers. Figure 89 shows the same data with a reduced scale up to 240 mg/Nm³. Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 30.

Data show that scrubbers or condensers are generally associated with mean methanol emissions below 20 mg/Nm³ (81 % of the data). Seven mean concentration values were measured > 20 mg/Nm³, generally with mass flows below 10 g/h, except two values, originating from the production of biodiesel and from trials of the production of pharmaceutic chemicals.

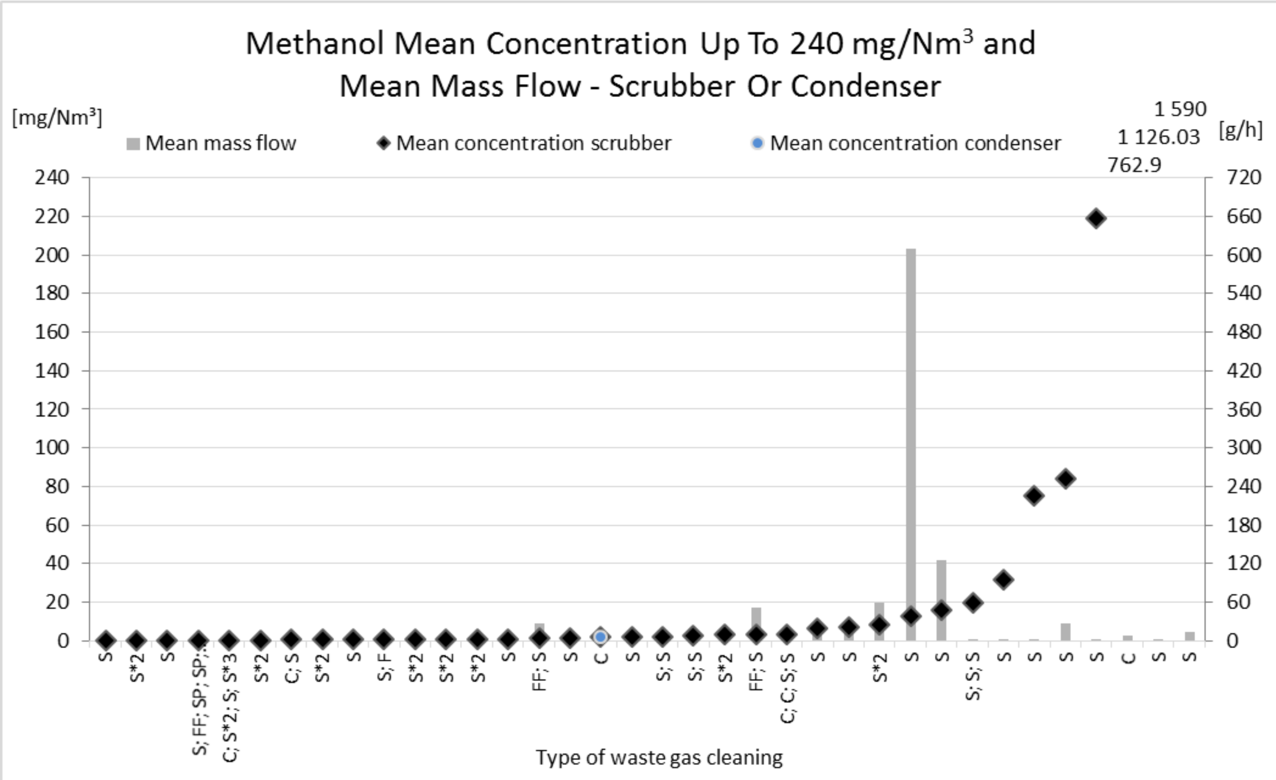
One data set with a high mean mass flow of 610 g/h and a mean concentration of 12.9 mg/Nm³ originates from the production of organometallic compounds (IED Annex 1 no. 4.1.g respectively no. 4.1.7 of 4. BImSchV).

Figure 88: Methanol mean concentration and mass flow with scrubber or condenser



(Ökopol 2016)

Figure 89: Methanol mean concentration and mass flow with scrubber or condenser, reduced scale up to 240 mg/Nm³



Note: Three highest concentration values are not plotted but indicated in the graph.

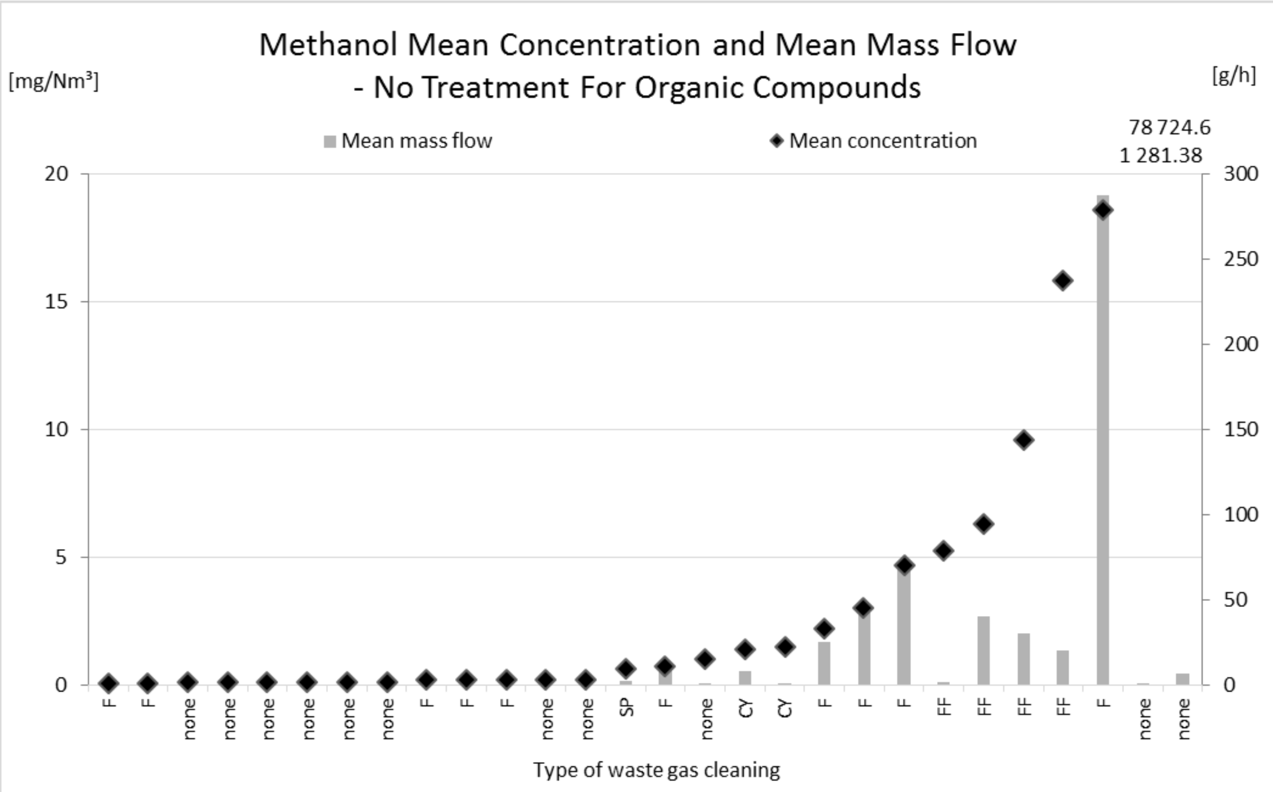
(Ökopol 2016)

Figure 90 shows methanol emission data from sources without treatment for organic substances. Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 31.

Data show that methanol emission concentrations from installations where no treatment for organic compounds is installed, are below 20 mg/Nm³ or have a mass flow below 10 g/h.

The two highest mean concentrations are not plotted but indicated in the graph (78 724.6 mg/Nm³ and 1 281.38 mg/Nm³); they are combined with mass flows of 7 g/h and 0.05 g/h and originate from a measurement during filling of a recovery unit for solvents and from a methanole storage tank in halogenated hydrocarbons production (IED Annex 1 no. 4.1.f respectively no 4.1.6 of 4. BImSchV).

Figure 90: Methanol mean concentration and mass flow with scrubber or condenser



Note: The two highest concentration values are out-of-range but indicated in the graph

(Ökopol 2016)

12.4 Conclusions for methanol data

Methanol (CH_4O) data assessment shows:

- Where no abatement system for methanol is installed the mean mass flow is in general below 10 g/h or the mean concentrations is below 20 mg/Nm³.
- Thermal oxidation or activated carbon filters are generally associated with mean emissions below 5 mg/Nm³.
- Scrubbers are generally associated with mean methanol emissions below 20 mg/Nm³.
- Highest mean concentration values were identified from the production of melamin formaldehyde resins and of epoxy resin granulate (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV) as well as from the production of antibiotica and of amino compounds (IED Annex 1 no. 4.1 respectively no. 4.1 of 4. BImSchV).

13 Acetic acid ($C_2H_4O_2$)

13.1 Acetic acid measurement

Acetic acid concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

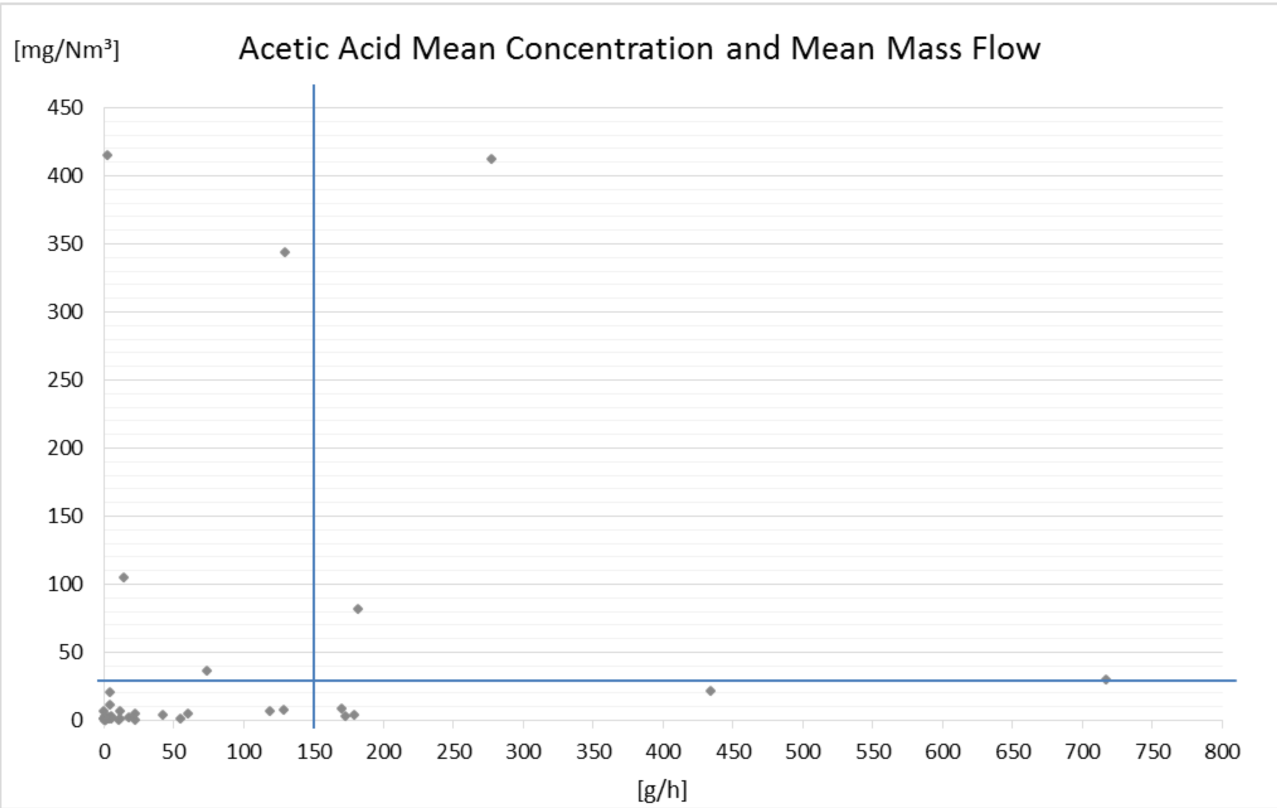
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds – Fundamentals.

13.2 Acetic acid concentration and related mass flow

Figure 91 all acetic acid mean concentration values (44 data) and the related mass flow. For all data, the mass flow of the source has been reported. For a detailed list of data see Annex 32.

Acetic acid concentrations are generally equal or below 20 mg/Nm³ (80 % of data). Where concentrations are higher than 20 mg/Nm³, mass flows do not exceed 300 g/h and are generally below 150 g/h (compare TOC mass flow thresholds in chapter 4.3).

Figure 91: Acetic acid mean concentration and mean mass flow



(Ökopol 2016)

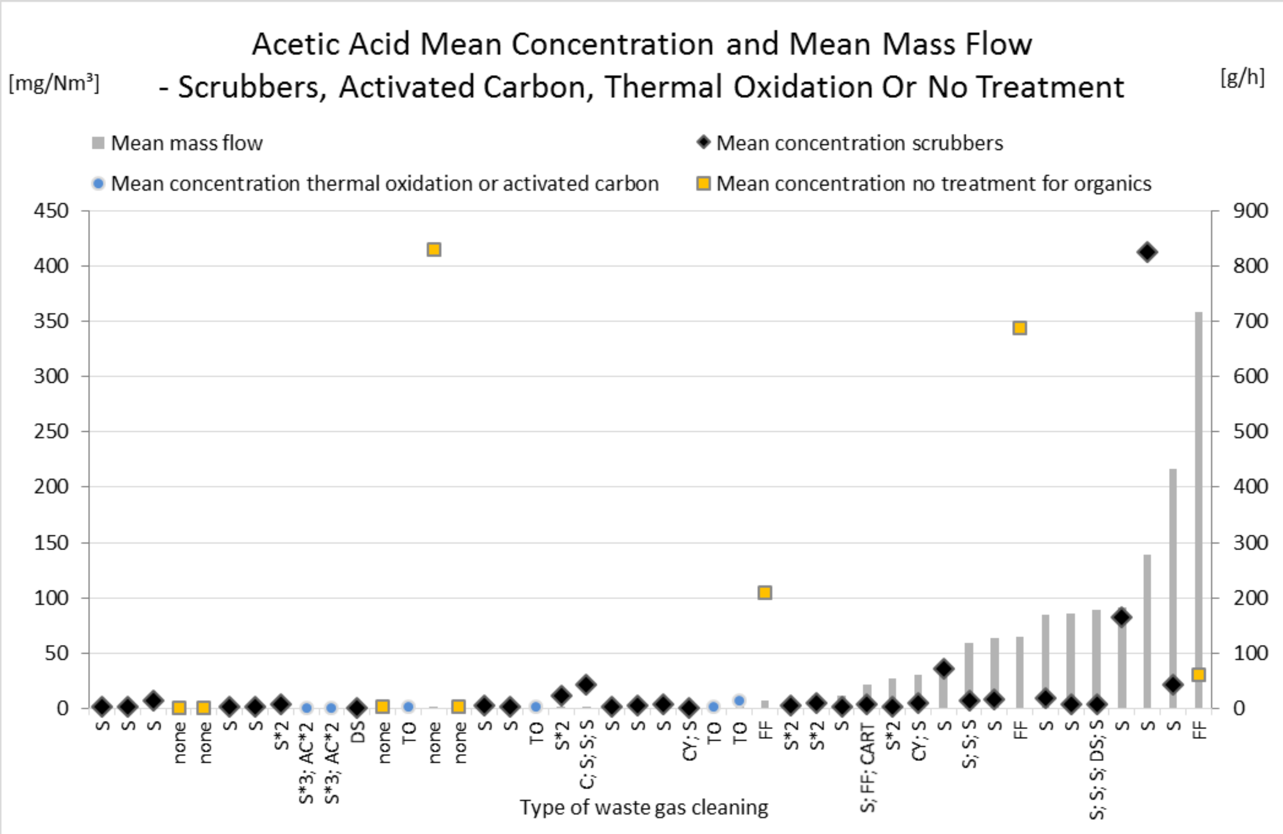
13.3 Acetic acid emissions and related waste gas treatment

Figure 92 shows acetic acid emission data and related waste gas treatment systems. Data is sorted by increasing mass flow values. For a detailed list of data see Annex 32.

Data show that thermal oxidation and activated carbon filters are associated with mean concentrations below 5 mg/Nm^3 (83 % of the data). Scrubbers are generally associated with mean acetic acid emission concentrations below 30 mg/Nm^3 (90 % of the data).

Four mean concentration values were measured above 30 mg/Nm^3, combined with mean mass flows below 300 g/h. They originate from different types of production (IED Annex 1 no. 4.1 respectively no. 4.1 of 4. BImSchV).

Figure 92: Acetic acid mean concentration and mass flow with related waste gas treatment



Note: Four highest concentration values are out-of-range but indicated in the graph.

(Ökopol 2016)

13.4 Conclusions for acetic acid data

Acetic acid ($C_2H_4O_2$) data assessment shows:

- Where no abatement system for acetic acid is installed the mean mass flow is in general below 150 g/h or the mean concentration is below 20 mg/Nm^3.
- Thermal oxidation or activated carbon filters are generally associated with mean acetic acid emissions below 5 mg/Nm^3.
- Scrubbers are generally associated with mean acetic acid emissions below 30 mg/Nm^3.

14 CMR: Formaldehyde (CH_2O)

Formaldehyde or methylaldehyd (CH_2O) is characterized as CMR substance (H341: possibly mutagenic in humans and H350: may cause cancer).

14.1 Formaldehyde measurement

Formaldehyde concentrations are all measured with method VDI 3862, mainly using the impinger method with 2,4-dinitrophenylhydrazine (DNPH); other reported methods use 4-amino-3-hydrazino-5-mercapto-1,2,4-triazole (AHMT) or acetylacetone.

- VDI 3862 Part 2:2000 (confirmed 2011) - Gaseous emission measurement - Measurement of aliphatic and aromatic aldeydes and ketones by DNPH method - Impinger method
- VDI 3862 Part 4:2001 (confirmed 2012) - Gaseous emission measurement; measurement of formaldehyde by the AHMT method
- VDI 3862 Part 6:2004 (confirmed 2015) - Gaseous emission measurement - Measurement of formaldehyde by the acetylacetone method

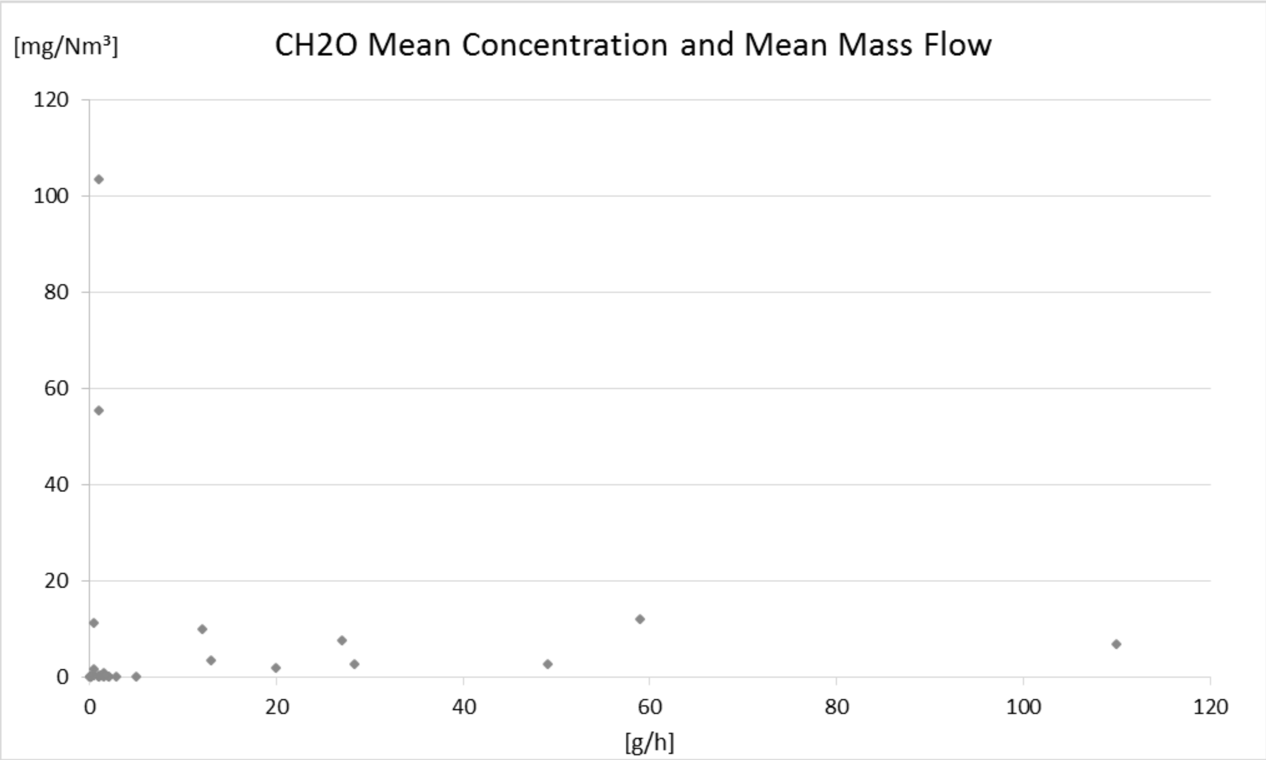
14.2 Formaldehyde concentration and related mass flow

Figure 93 shows all formaldehyde concentrations values (34 data) and the related mass flow. For all values, the mass flow of the source has been reported. For a detailed list of data see Annex 33 and Annex 34.

Formaldehyde concentrations are generally below 5 mg/Nm³ (79 % of data). Where mean concentration values are above 5 mg/Nm³, the mass flow is ≤ 1 g/h in three cases and between 12 - 110 g/h in four cases.

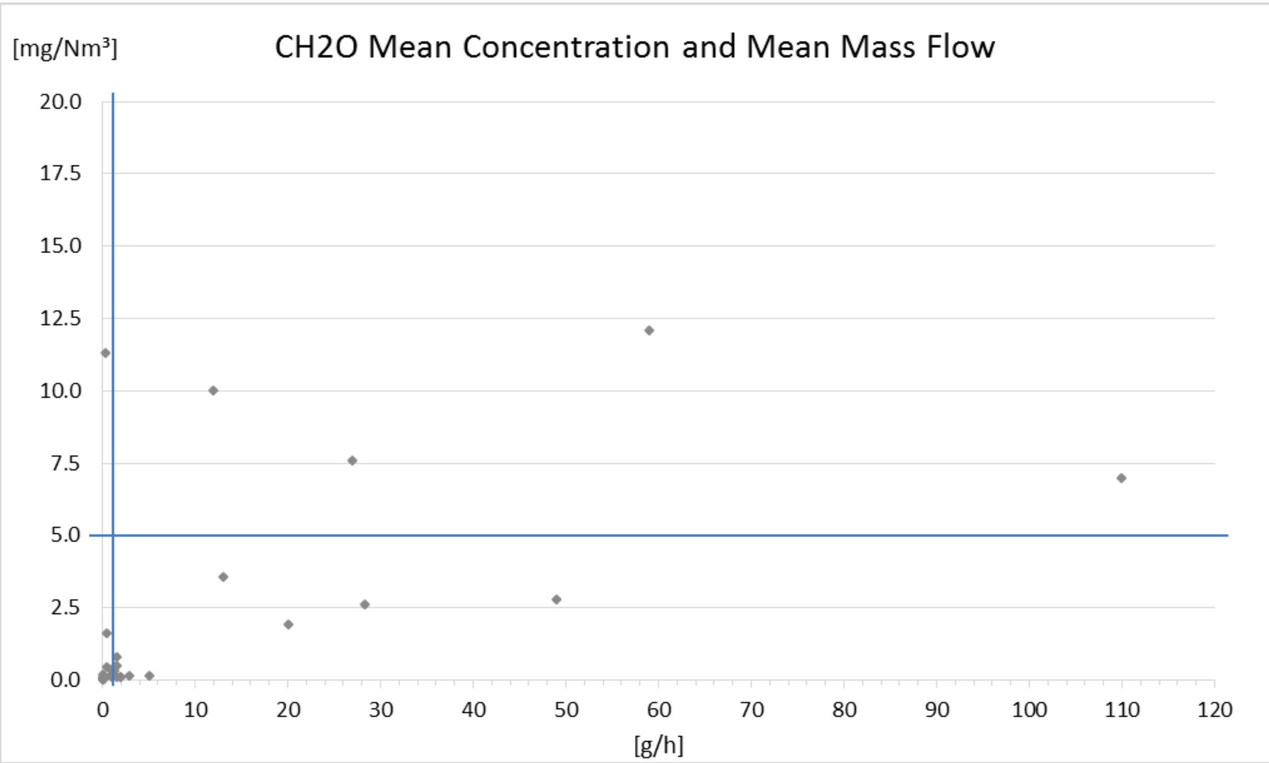
Two of the four high mass flows originate from the productions of resins and cement additives (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV), one from the production of biocides (IED Annex 1 no. 4.4 respectively no. 4.2 of 4. BImSchV), and one from the production of oxygen-containing hydrocarbons (IED Annex 1 no. 4.1.b respectively no. 4.1.2 of 4. BImSchV).

Figure 93: Formaldehyde mean concentration and mean mass flow



(Ökopol 2016)

Figure 94: Formaldehyde mean concentration and mean mass flow, reduced scale up to 20 mg/Nm^3



Note: Two values with mass flows of 1 g/h and concentrations of 55.3 mg/Nm^3 and 103.4 mg/Nm^3 are cut off.

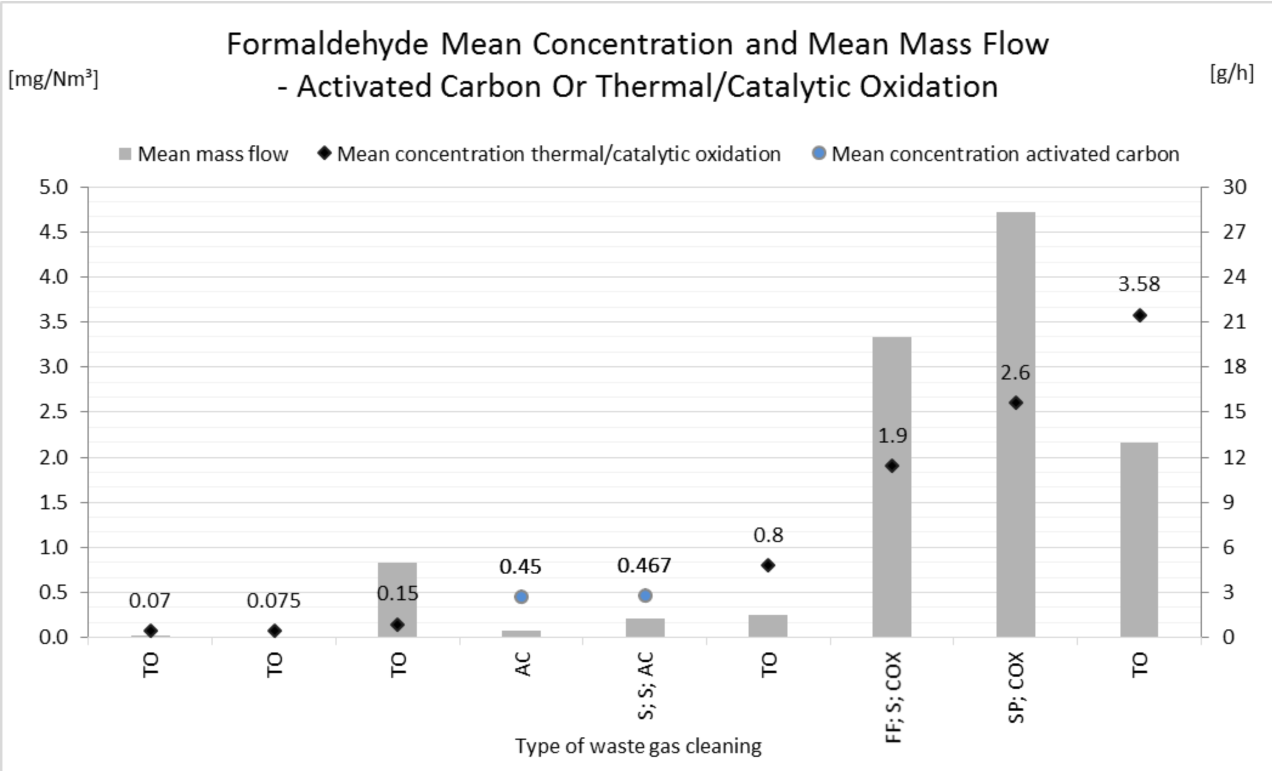
(Ökopol 2016)

14.3 Formaldehyde emissions from sources with activated carbon, thermal oxidation or catalytic oxidation

Figure 95 shows formaldehyde concentrations and mass flow (bars) from sources with thermal oxidation or catalytic oxidation (rhombus) or activated carbon filters (blue dots). Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 33.

Data show that all mean concentration values are below 5 mg/Nm³. Mean concentrations below 1 mg/Nm³ are generally associated with thermal oxidation or activated carbon, except one case. Two data sets associated with catalytic oxidation reported mean emission concentrations between 1 - 5 mg/Nm³.

Figure 95: Formaldehyde mean concentration and mean mass flow from sources with activated carbon filters, thermal oxidation or catalytic oxidation



(Ökopol 2016)

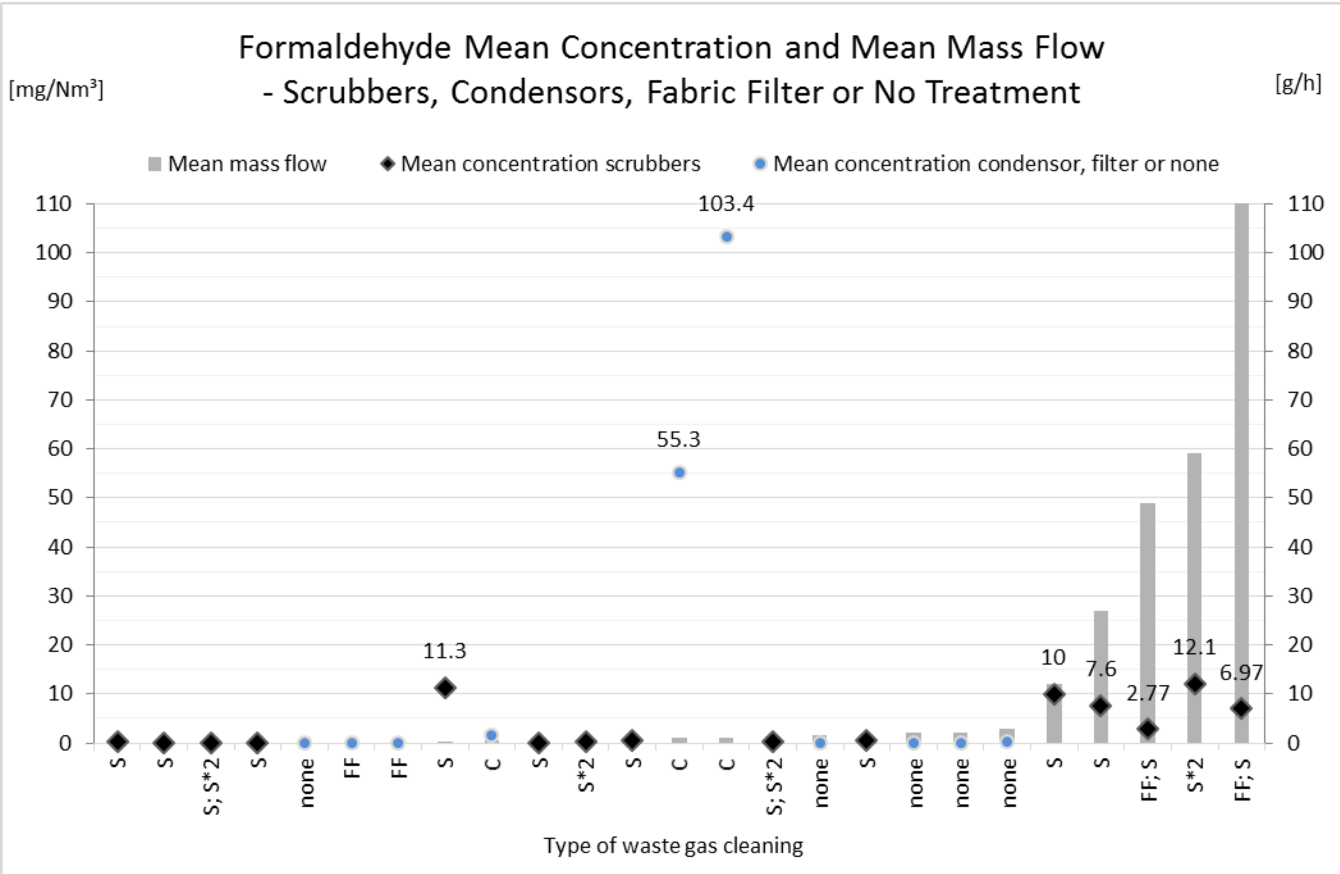
14.4 Formaldehyde emissions from sources with scrubbers, condensers, fabric filters or no treatment

Figure 96 and 97 show formaldehyde concentrations and mass flow (bars) from sources where either scrubbers (rhombus) are installed or condensers, fabric filters respectively no treatment (blue dots). Figure 96 shows all data, Figure 97 shows data with mean concentrations up to 20 mg/Nm³ and mean mass flows up to 10 g/h. Data is sorted by increasing mass flow. For a detailed list of data see Annex 34.

Data show that installations without treatment or with scrubbers, condensers or fabric filters generally have mean mass flows ≤ 1 g/h or, where mean mass flows are above 1 g/h, mean emission concentrations are below 5 mg/Nm³.

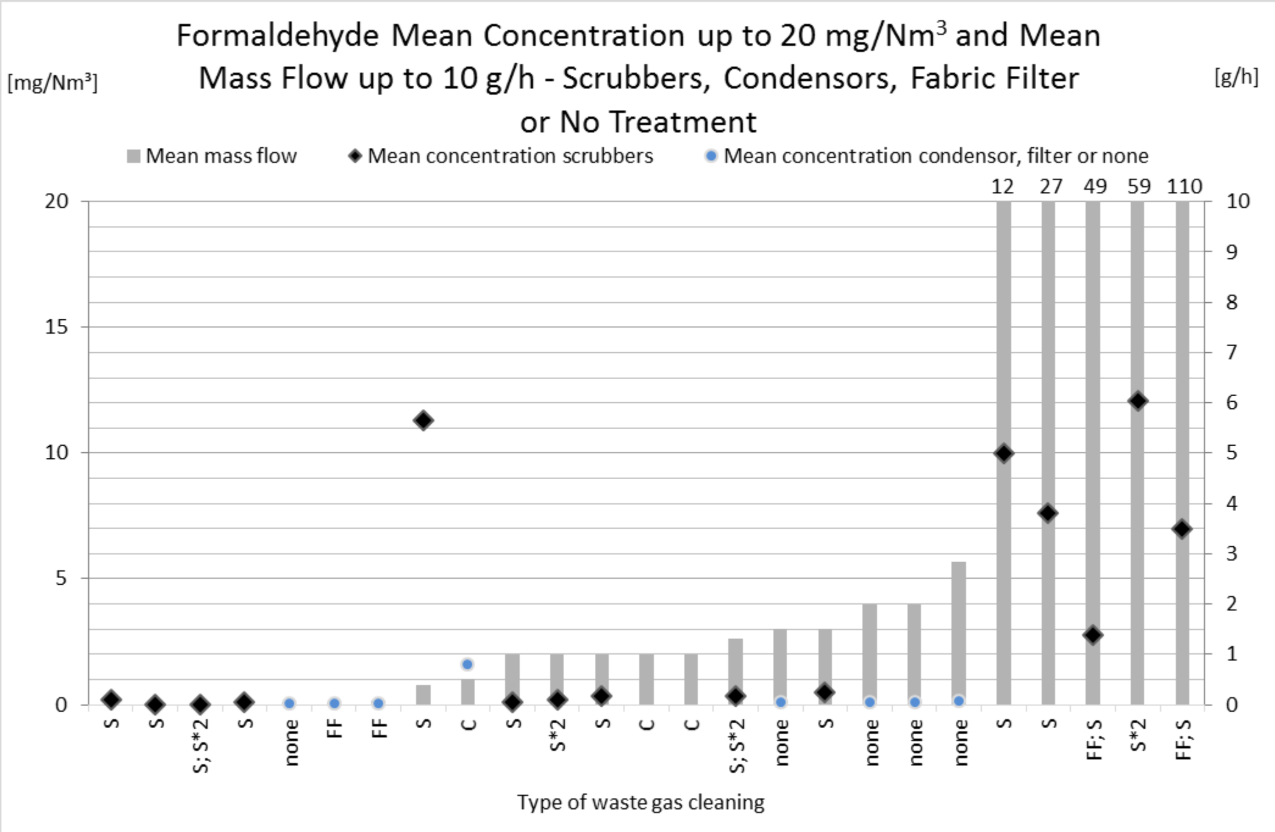
In four cases, mean emissions are higher: mean concentrations range up to 12.1 mg/Nm³ and associated mean mass flows are up to 110 g/h. Two of the cases originate from the productions of resins and cement additives (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV); one case originates from the production of oxygen-containing hydrocarbons (IED Annex 1 no. 4.1.b respectively no. 4.1.2 of 4. BImSchV) and the other one from the production of biocides (IED Annex 1 no. 4.4 respectively no. 4.2 of 4. BImSchV).

Figure 96: Formaldehyde mean concentration and mean mass flow from sources with scrubbers, condensers, fabric filters or no treatment



(Ökopol 2016)

Figure 97: Formaldehyde mean concentration and mean mass flow from sources with scrubbers, condensers, fabric filters or no treatment (reduced scale up to 20 mg/Nm³ and up to 10 g/h)



Note: Four mass flow values are cut off but indicated; two concentration values of 55.3 and 103.4 mg/Nm³ are cut off.

(Ökopol 2016)

14.5 Conclusions for formaldehyde data

Formaldehyde (CH_2O) data assessment shows:

- Where no abatement system for formaldehyde is installed, the mean mass flow is in general < 1 g/h or the mean concentration is below 5 mg/Nm³.
- Thermal oxidation or activated carbon filters are generally associated with mean emissions below 1 mg/Nm3; catalytic oxidation (two cases) shows mean emissions between 1 - 5 mg/Nm³.
- Highest mean concentrations values of 5 - 12.1 mg/Nm³ with related mean mass flows of 12 - 110 g/h were identified in the productions of resins or cement additives (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV), the production of oxygen-containing hydrocarbons (IED Annex 1 no. 4.1.b respectively no. 4.1.2 of 4. BImSchV) and the production of biocides (IED Annex 1 no. 4.4 respectively no. 4.2 of 4. BImSchV).

15 CMR: Ethylene oxide (C_2H_4O)

Ethylene oxide (C_2H_6O) is characterized as CMR substance (H340: may cause genetic defects; H350: may cause cancer).

15.1 Ethylene oxide measurement

Ethylene oxide concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

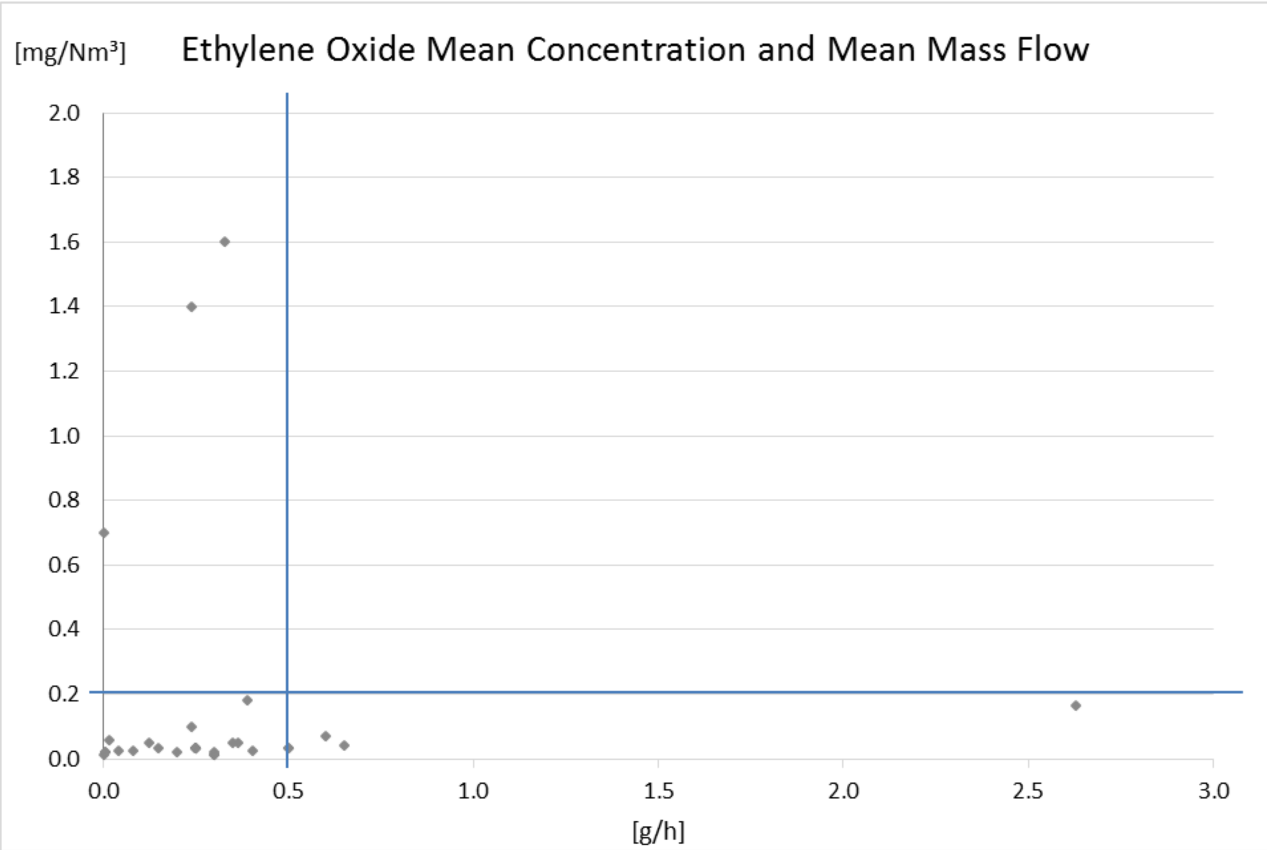
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals

15.2 Ethylene oxide concentration and related mass flow

Figure 98 shows all ethylene oxide mean concentration values (31 data) and the related mass flow. For all but one data set, the mass flow of the source was reported. For a detailed list of data see Annexes 36 and 37.

Ethylene oxide mean concentrations are generally below 0.2 mg/Nm³ (90 % of data). Where concentrations are higher than 0.2 mg/Nm³, mean mass flows do not exceed 0.5 g/h.

Figure 98: Ethylene oxide mean concentration and mean mass flow



(Ökopol 2016)

15.3 Ethylene oxide emissions and related waste gas treatment

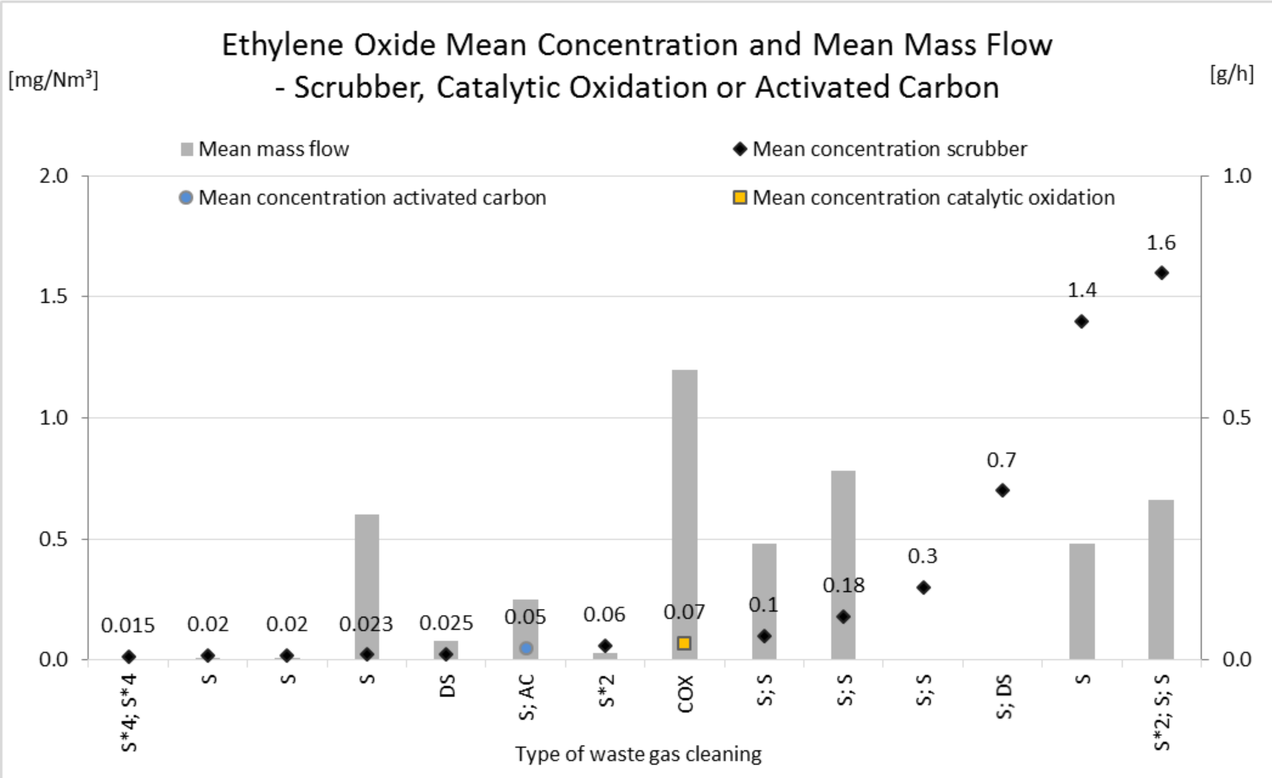
Figure 99 shows ethylene oxide emission data and related waste gas treatment systems (14 data). Data is sorted by increasing mass flow values. For a detailed list of data see Annex 35.

Waste gas abatement is realized with scrubbers, activated carbon or catalytic oxidation.

Data show that mean ethylene oxide emission concentrations associated with scrubbers, activated carbon or catalytic oxidation are generally below 0.2 mg/Nm³ (75 % of the data). Where mean emission concentrations are higher than 0.2 mg/Nm³, the corresponding mass flow does not exceed 0.5 g/h.

Activated carbon and catalytic oxidation are both associated with emission concentrations below 0.2 mg/Nm³.

Figure 99: Ethylene oxide mean concentration and mass flow with related waste gas treatment

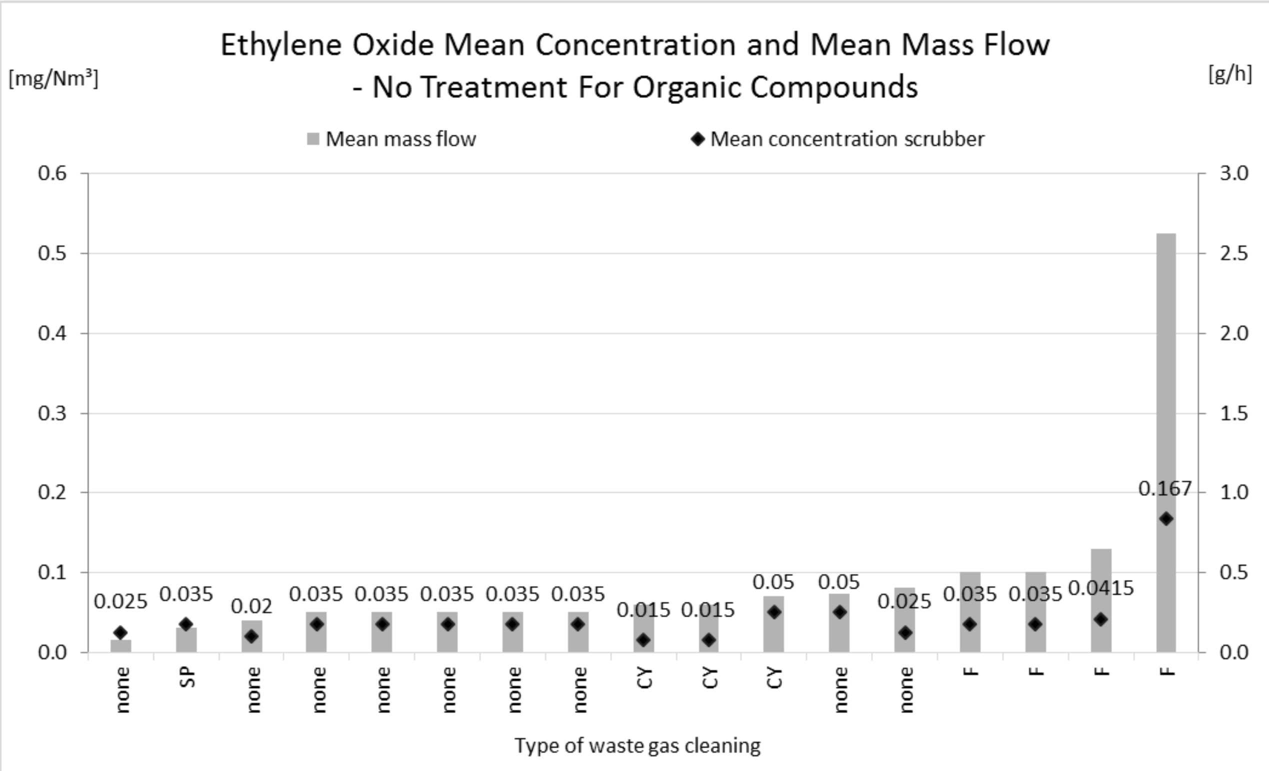


(Ökopol 2016)

Figure 100 shows ethylene oxide emission data from installations where no treatment system for organic compounds is installed (17 data). Data is sorted by increasing mean mass flow values. For a detailed list of data see Annex 36.

Data show that mean ethylene oxide emission concentrations from sources without treatment of organic compounds are all below 0.2 mg/Nm³. Mass flows are generally below 0.5 g/h except one case. The highest mass flow of 2.63 g/h corresponds with a concentration of 0.167 mg/Nm³ and originates from the production of methyl cellulose (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV).

Figure 100: Ethylene oxide mean concentration and mass flow with related waste gas treatment



(Ökopol 2016)

15.4 Conclusions for ethylene oxide data

Ethylene oxide (C_2H_4O) data assessment shows:

- Where in general no abatement system for ethylene oxide is installed, the mean mass flow is below 0.5 g/h or the mean concentration is below 0.2 mg/Nm³.
- Scrubbers, activated carbon and catalytic oxidation are generally associated with emission concentrations of ethylene oxide below 0.2 mg/Nm³.

16 CMR: Dioxins and furans (PCDD/F)

Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDD/F) are a group of organic compounds, with 2,3,7,8-tetrachlorodibenzo-p-dioxin being the most toxic, characterized as CMR substance (H350: may cause cancer).

16.1 PCDD/F measurement

PCDD/F concentrations are measured with method EN 1948, sampling a cooled or a heated probe of the waste gas, using a filter for particulate-bound PCDD/F, a condensate trap and adsorbers.

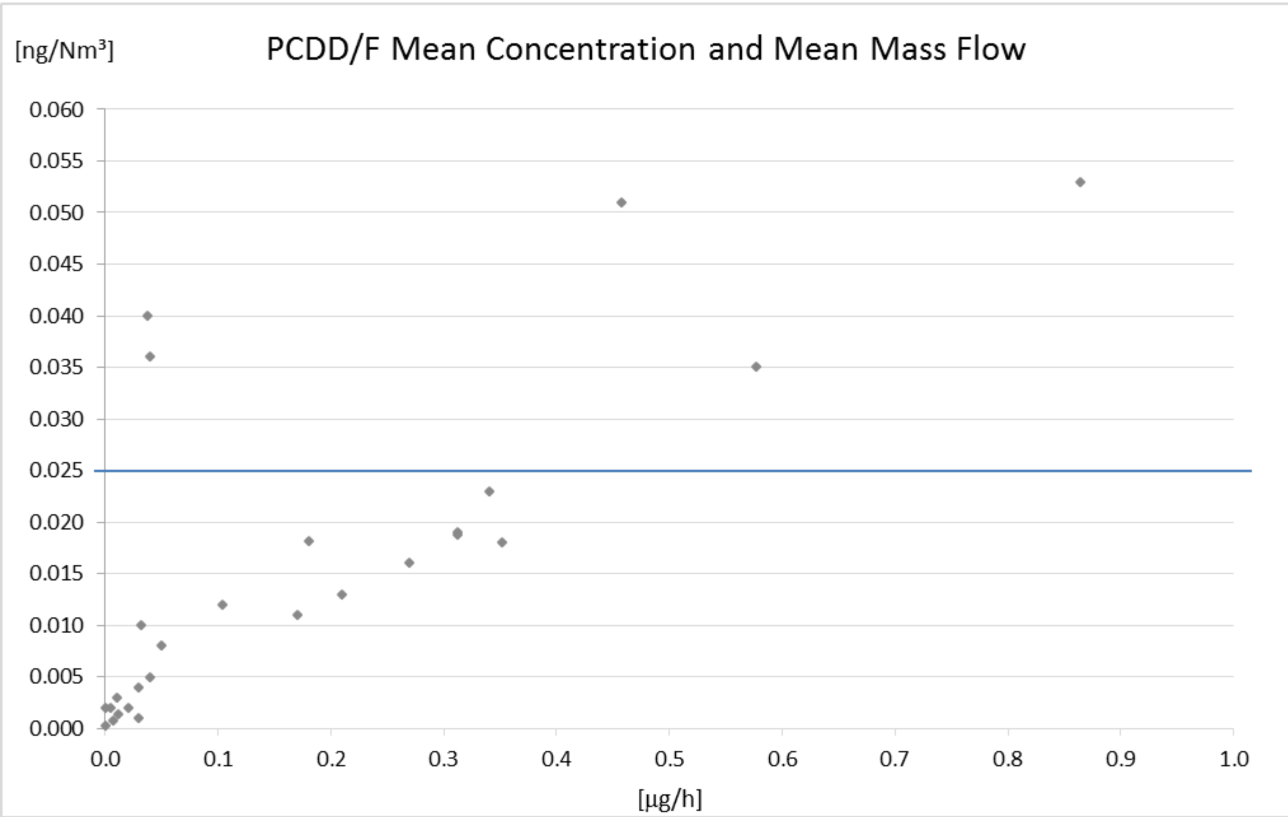
- EN 1948-1:2006 -Stationary source emissions - Determination of the mass concentration of PCDDs/PCDFs and dioxin-like PCBs - Part 1: Sampling of PCDDs/PCDFs.

16.2 PCDD/F concentration and related mass flow

Figure 101 shows all PCDD/F concentrations values (30 data) and the related mass flow. For all data, the mass flow of the source has been reported; in four cases where concentrations below the detection limit of 0.001 ng/Nm³ were measured, the mass flow was indicated with "< 1 g/h". For a detailed list of data see Annexes 38 and 39.

PCDD/F mean concentrations are generally below 0.025 ng/Nm³ (83 %); all values are below 0.06 ng/Nm³.

Figure 101: PCDD/F mean concentration and mean mass flow



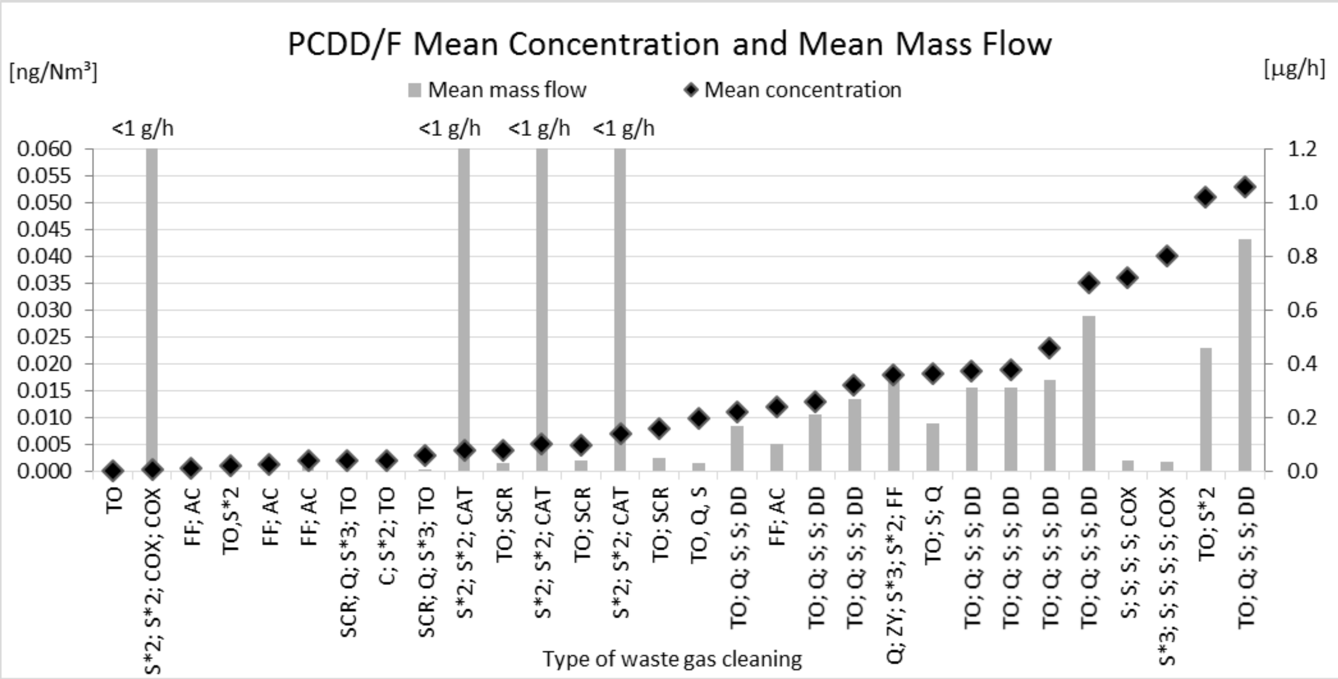
(Ökopol 2016)

16.3 PCDD/F emissions and associated waste gas treatment

Figure 102 shows PCDD/F concentrations (rhombus) and mass flow (bars) (30 measurements). Data is sorted by increasing mean concentration. For a detailed list of data see Annex 37.

Data show that mean emission concentrations associated with activated carbon or catalyst treatment as well as with a combination of scrubbers and thermal oxidation are below 0.025 ng/Nm³. With thermal oxidation or catalytic oxidation generally mean emission levels below 0.06 ng/Nm³ are achieved.

Figure 102: PCDD/F mean concentration and mass flow with associated waste gas treatment



(Ökopol 2016)

16.4 Conclusions for PCDD/F data

Dioxines and furans (PCDD/F) data assessment shows:

- Activated carbon, catalyst treatment or a combination of scrubbers and thermal oxidation are associated with PCDD/F mean emission levels below 0.025 ng/Nm³.
- Thermal or catalytic oxidation systems are generally associated with PCDD/F levels below 0.06 ng/Nm³.

17 CMR: Toluene (C_7H_8)

Toluene (C_7H_8) is among the most important solvents used in the chemical industry. It is characterized as potential CMR substance (H361d: possibly reproduction toxic in humans).

17.1 Toluene measurement

Toluene concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

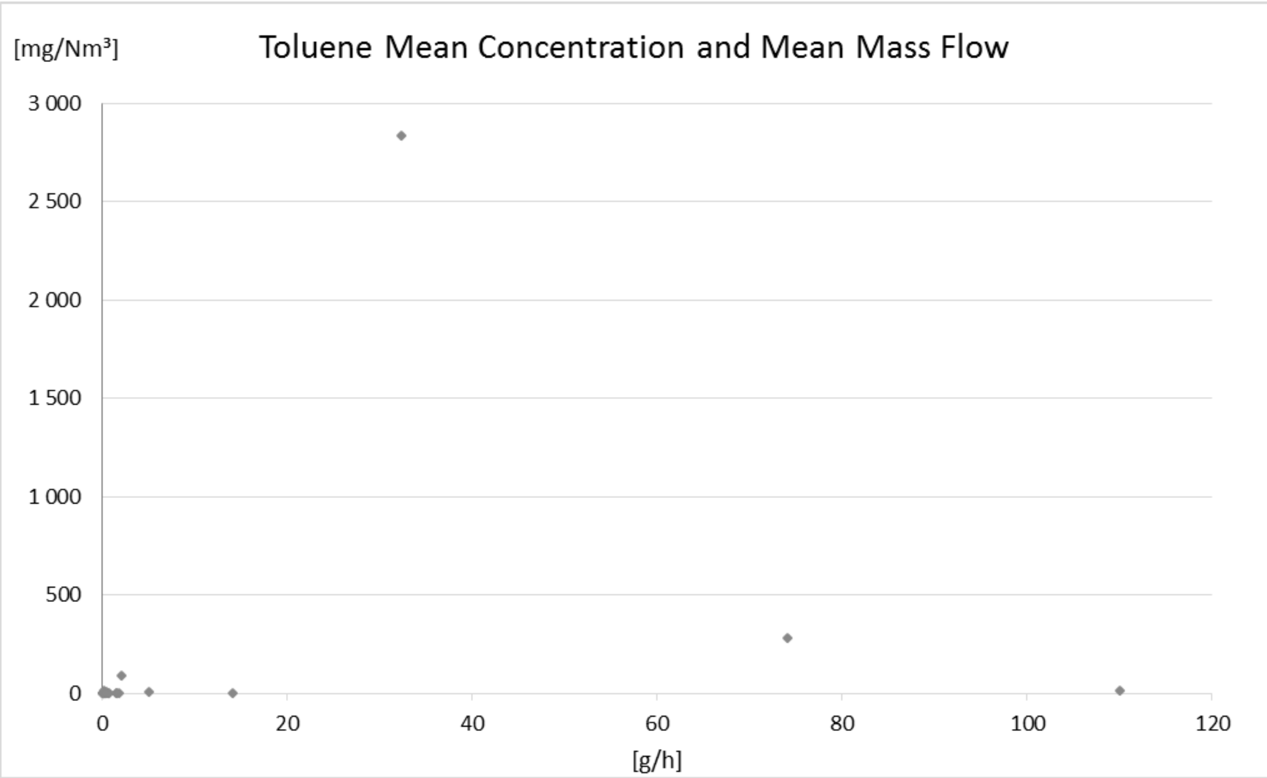
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals

17.2 Toluene concentration and related mass flow

Figure 103 shows all toluene concentrations values (26 data) and the related mass flow. Figure 104 shows the same data data with reduced scale up to 300 mg/Nm³ (one value cut off). For all except one value, the mass flow of the source has been reported. For a detailed list of data see Annex 39.

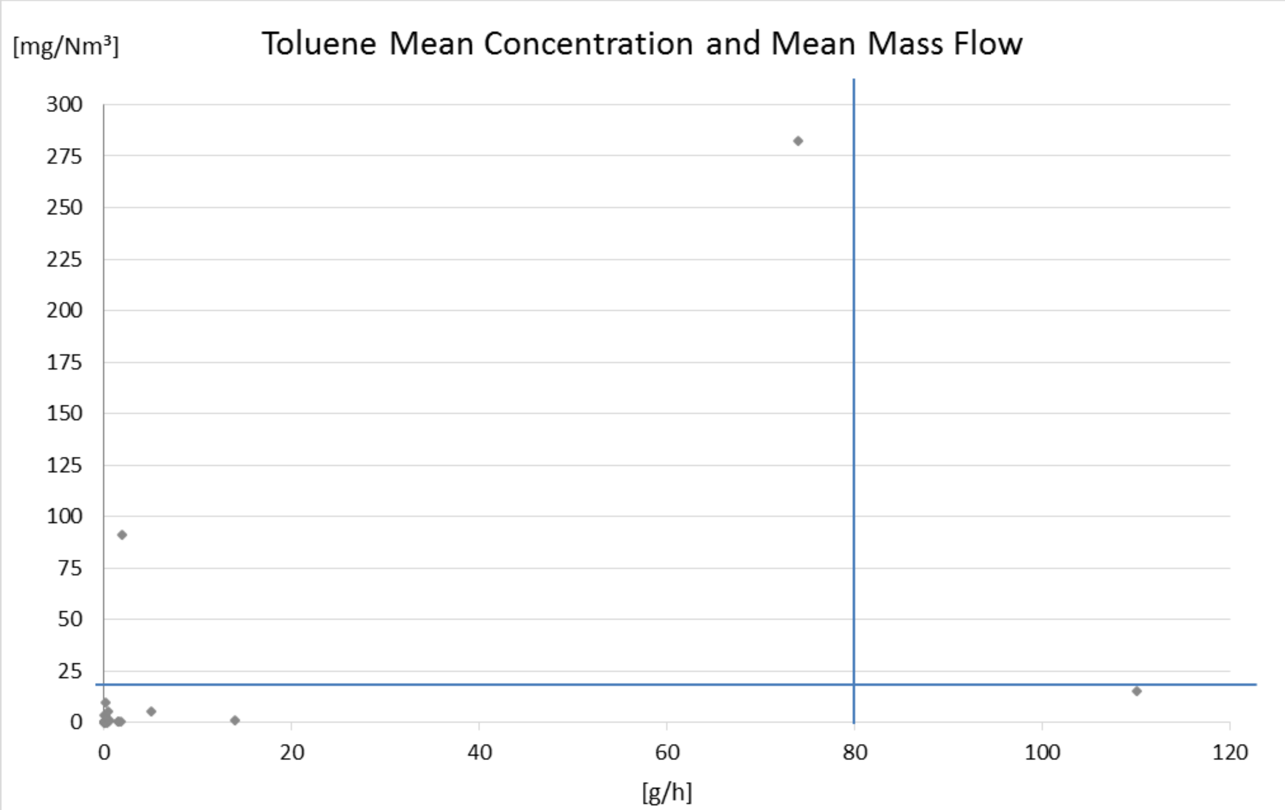
Data show that toluene mean concentrations are generally below 20 mg/Nm³ (85 % of data). Where higher mean concentration values were measured, the mean mass flow is below 80 g/h.

Figure 103: Toluene mean concentration and mean mass flow



(Ökopol 2016)

Figure 104: Toluene mean concentration and mean mass flow, reduced scale up to 300 mg/Nm³



Note: One value with a concentration of 2 838 mg/Nm³ and a mass flow of 32.35 g/h was cut off.

(Ökopol 2016)

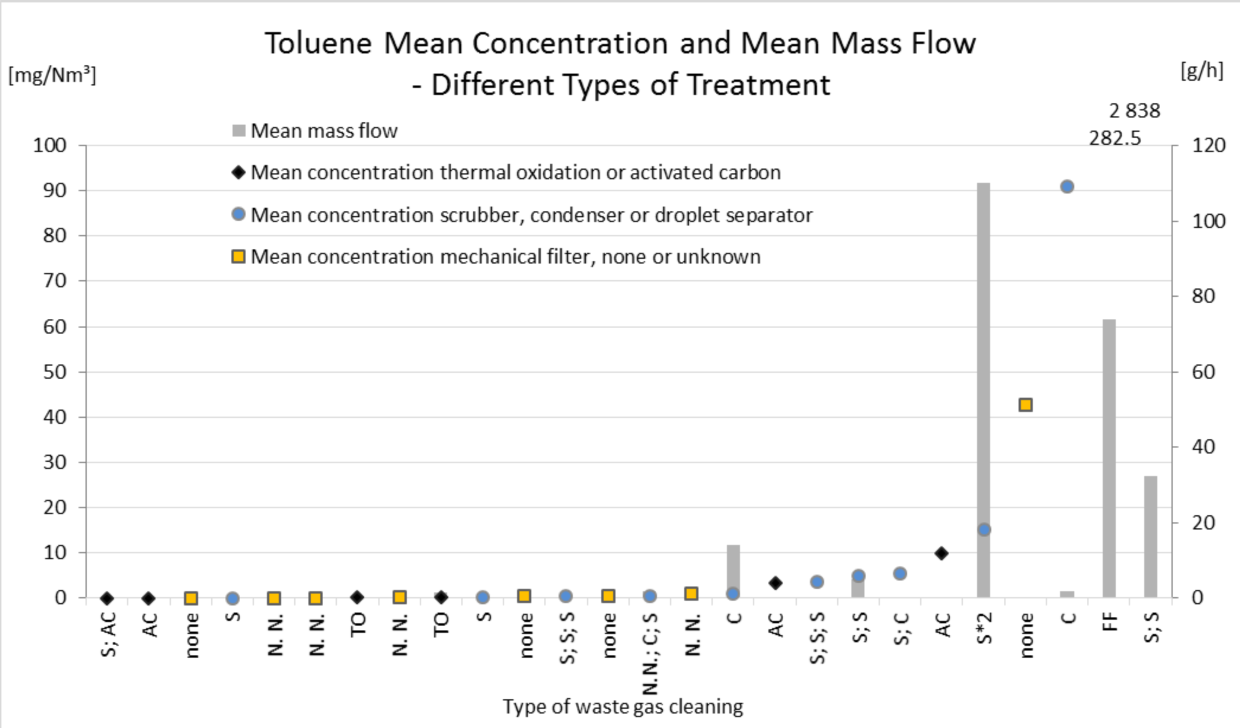
17.3 Toluene emissions and related waste gas treatment

Figure 105 shows toluene concentrations and mass flow (bars) with thermal oxidation or activated carbon filter (black rhombus), scrubbers or condensers or droplet separators (blue dots) or no treatment for organic emissions (orange square). Data is sorted by increasing mean concentration values. For a detailed list of data see Annex 39.

Data show that thermal oxidation and activated carbon filters are generally associated with toluene concentrations below 5 mg/Nm³ (83 % of data). Scrubbers are associated with mean toluene concentrations below 20 mg/Nm³ (82 % of data). Where no abatement system for toluene is installed the mass flow is below 2 g/h and the mean concentrations are below 1 mg/Nm³.

The highest mean concentration value of 2 838 mg/Nm³ (with a mass flow of 32.25 g/h) was measured where containers are filled in the production of silicone resins (production of organometallic compounds: IED Annex 1 no. 4.1.g respectively no. 4.1.8 of 4. BImSchV). The other high value of 282.5 mg/Nm³ (mass flow 74 g/h) was measured where big bags are filled in the production of plant protection products (IED Annex 1 no. 4.4 respectively no. 4.1.18 of 4. BImSchV).

Figure 105: Toluene mean concentration and mean mass flow with related treatment system



Note: Two highest concentration values are out-of-range but indicated in the graph.

(Ökopol 2016)

17.4 Conclusions for toluene data

Toluene (C_7H_8) data assessment shows:

- Where no abatement system for toluene is installed the mass flow is below 2 g/h and the mean concentrations are below 1 mg/Nm³.
- Thermal oxidation and activated carbon filters are associated with toluene mean concentrations below 5 mg/Nm³.
- Scrubbers are associated with toluene mean concentrations below 20 mg/Nm³.
- Where mean concentration values were higher than 20 mg/Nm³, the related mean mass flow was below 80 g/h.

18 CMR: Propylene oxide (C_3H_6O)

Propylene oxide is characterized as CMR substance (H340: may cause genetic defects; H350: may cause cancer).

18.1 Propylene oxide measurement

Propylene oxide concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

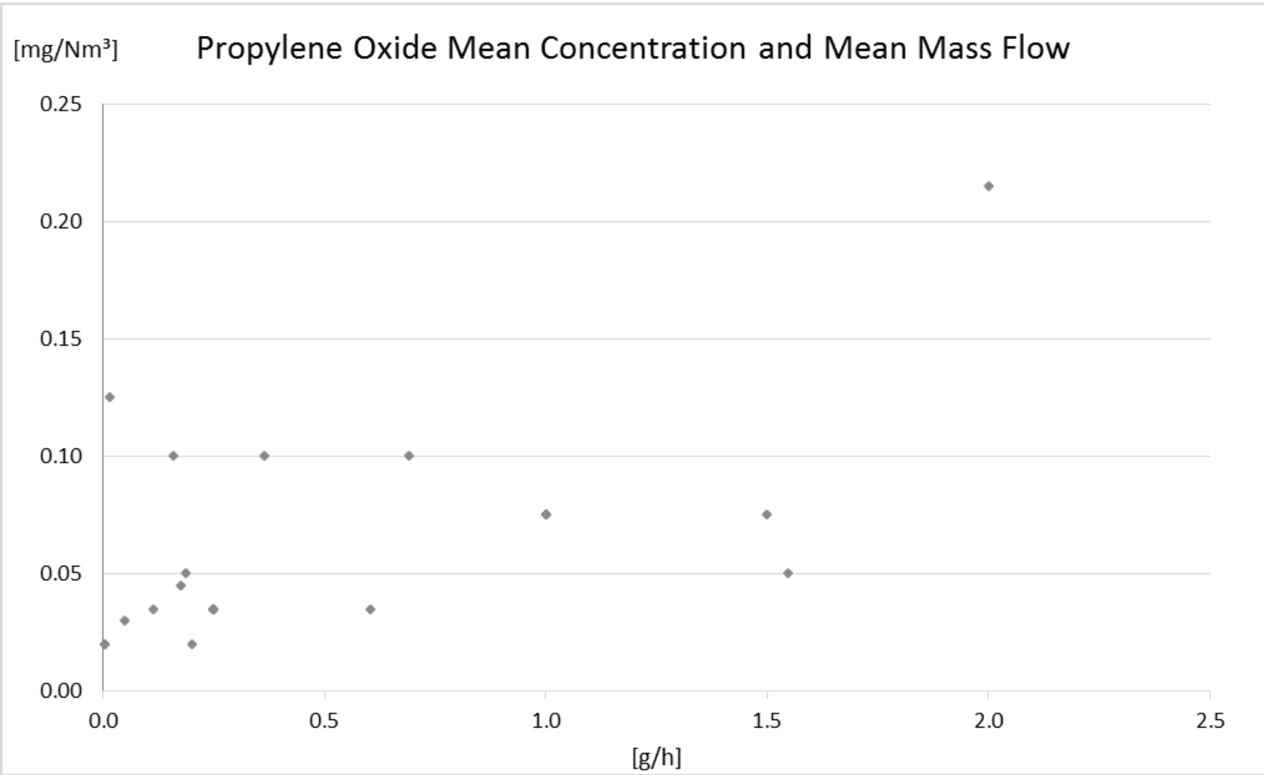
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals.

18.2 Propylene oxide concentration and related mass flow

Figure 106 shows all propylene oxide concentrations values (24 data) and the related mass flow. For all values, the mass flow of the source has been reported. All reported mean concentration values include measurement results below the limit of detection (LOD). For a detailed list of data see Annex 40.

Propylene oxide mean concentrations are all below 0.25 mg/Nm³; all mean mass flows are below 2.5 g/h.

Figure 106: Propylene oxide mean concentration and mean mass flow



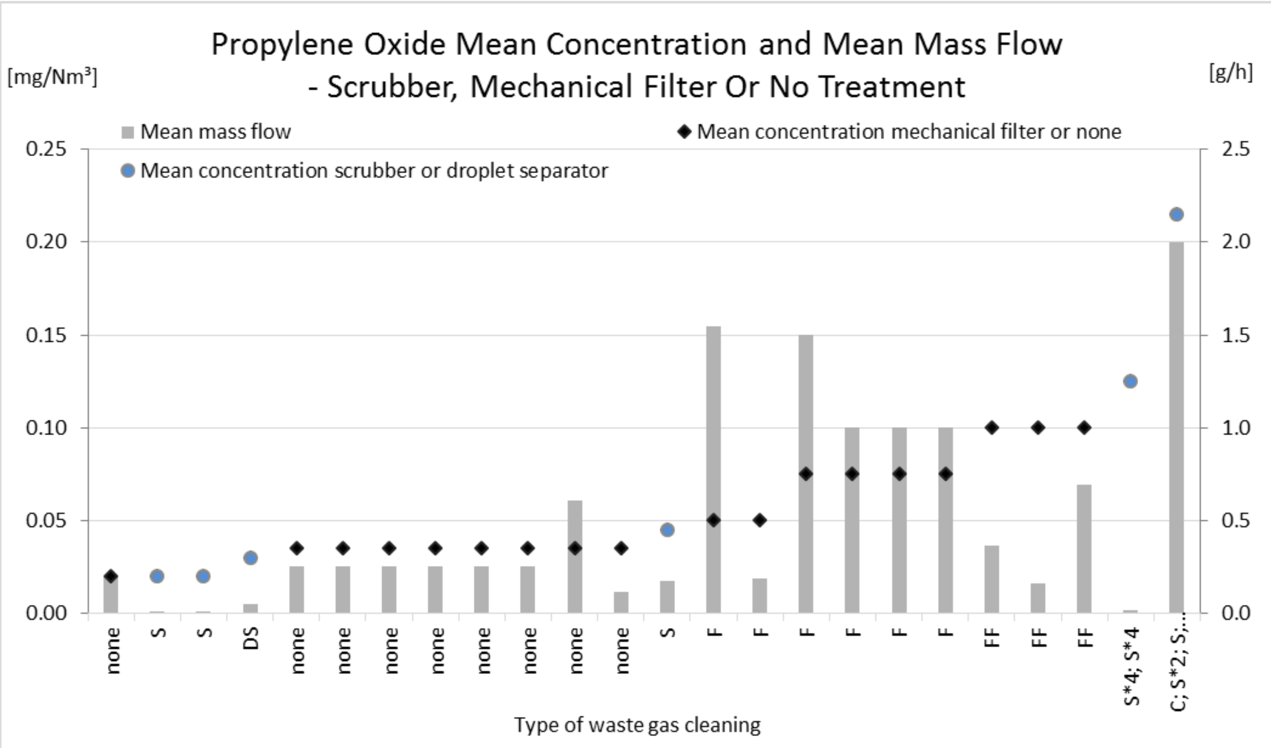
(Ökopol 2016)

18.3 Propylene oxide emissions from sources with scrubbers, mechanical filters or no treatment

Figure 107 shows propylene oxide concentrations and mean mass flow (bars) from sources where either scrubbers or droplet separators are installed (blue dots) or no treatment for organic compounds (black rhombus). Data is sorted by increasing concentration values. For a detailed list of data see Annex 40.

Data show that emission concentrations are all below 0.25 mg/Nm³.

Figure 107: Propylene oxide mean concentration and mean mass flow from sources with scrubber, droplet separator, mechanical filter or no treatment



(Ökopol 2016)

18.4 Conclusions for propylene oxide data

Propylene oxide (C_3H_6O) data assessment shows:

- Where no abatement system for propylene oxide is installed, the mean mass flow is below 2.5 g/h and the mean concentration below 0.25 mg/Nm³.
- Mean concentration values of propylene oxide associated with scrubbers and droplet separators are below 0.25 mg/Nm³.

19 CMR: Benzene (C_6H_6)

Benzene (C_6H_6) is characterized as CMR substance (mutagenic, may cause cancer).

19.1 Benzene measurement

Benzene concentrations are measured with method EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination).

- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals.

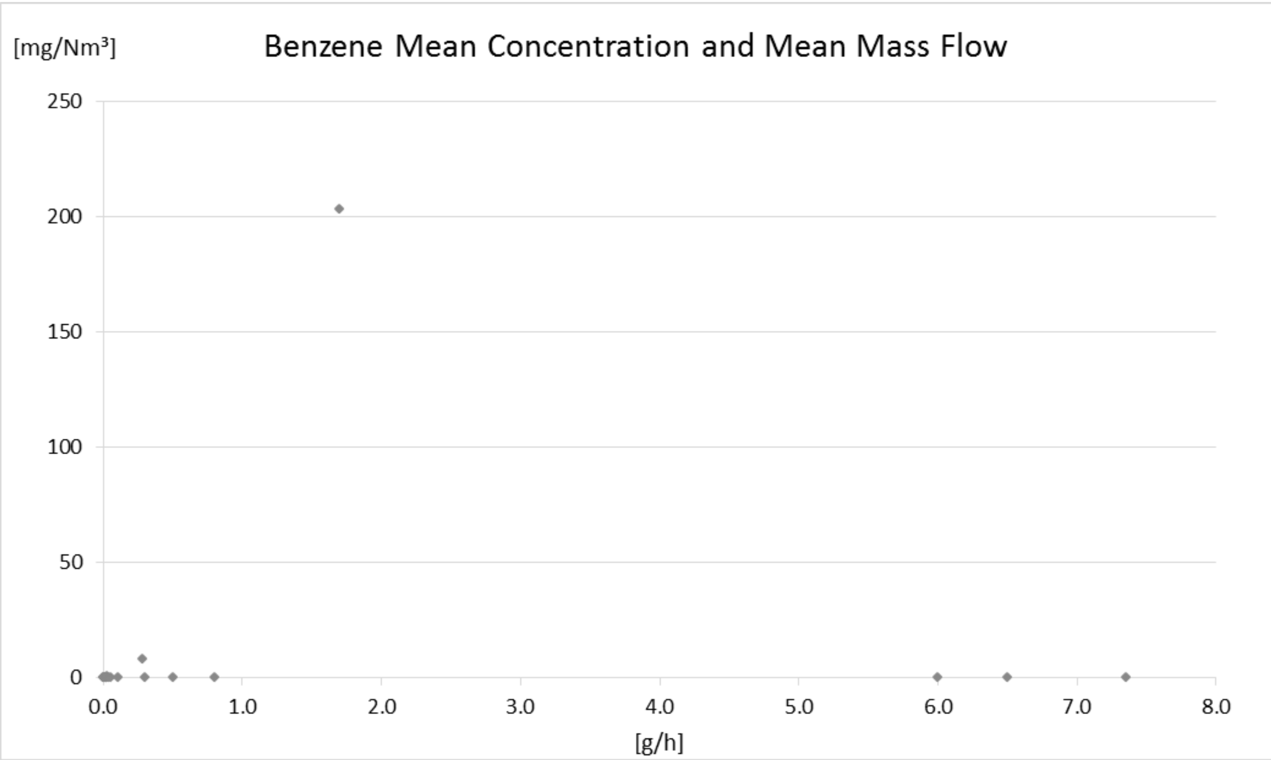
19.2 Benzene concentration and related mass flow

Figure 108 shows all benzene mean concentrations values (18 data) and the related mean mass flow. Figure 109 shows the same data with reduced scale up to 2 mg/Nm³ (two values cut off). For all except one value, the mass flow of the source has been reported. For a detailed list of data see Annex 41.

Data show that benzene concentrations are generally below 0.5 mg/Nm³ (83 % of data).

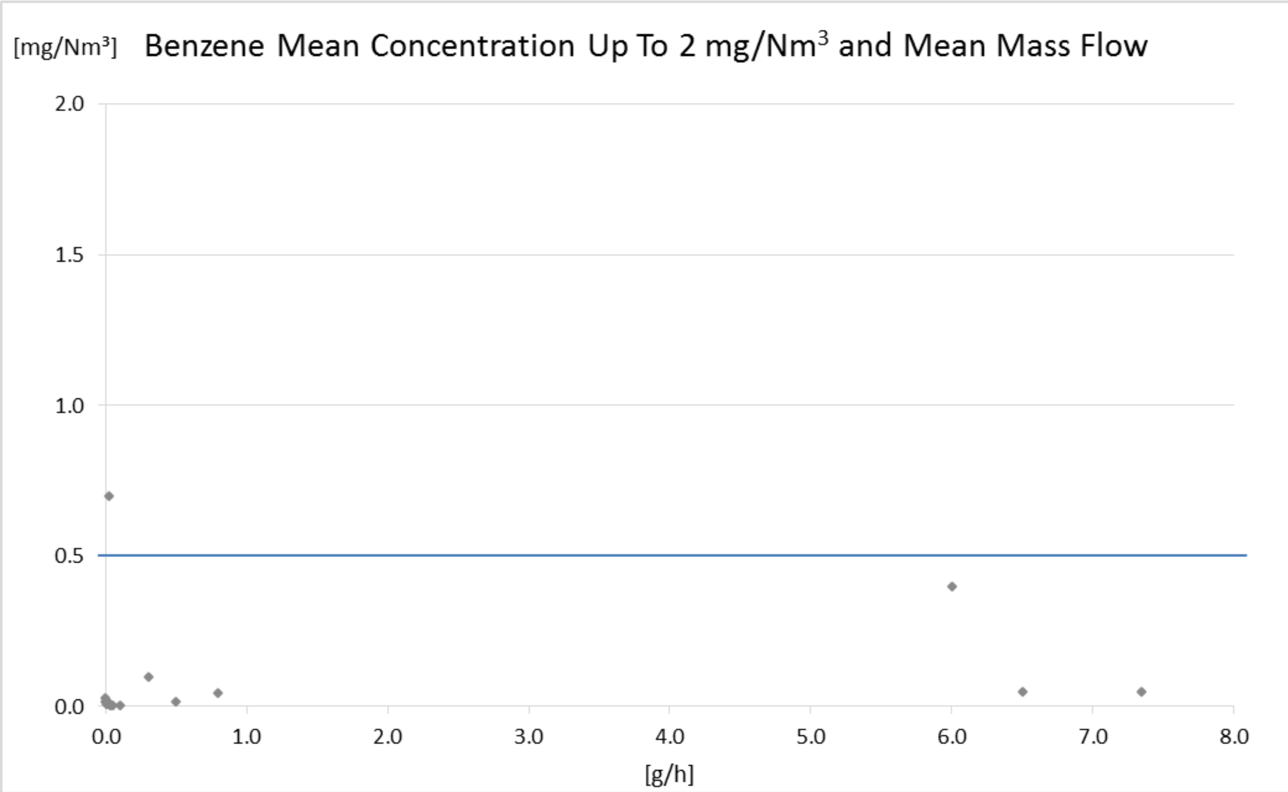
Where higher concentrations were measured, mean mass flows were below 2 g/h. The highest mean mass flow has a corresponding concentration of 203.1 mg/Nm³ and originates from filling and release in the production of epoxy resin granulate (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV).

Figure 108: Benzene mean concentration and mean mass flow



(Ökopol 2016)

Figure 109: Benzene mean concentration and mean mass flow, reduced scale up to 2 mg/Nm³



(Ökopol 2016)

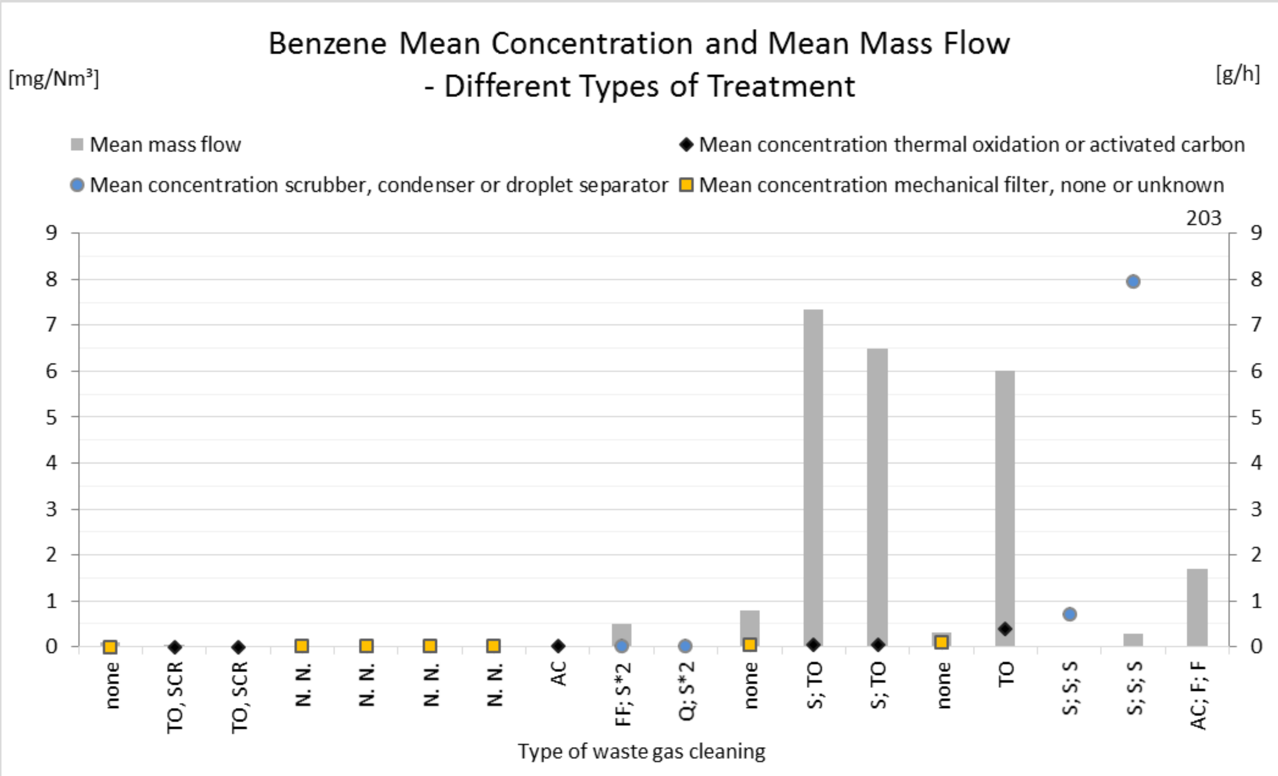
19.3 Benzene emissions and related waste gas treatment

Figure 110 shows benzene concentrations and mean mass flow (bars) with thermal oxidation or activated carbon filter (black rhombus), scrubbers or condensers or droplet separators (blue dots) or no treatment for organic emissions (orange square). Data is sorted by increasing concentration values. For a detailed list of data see Annex 41.

Data show that thermal oxidation and activated carbon filters are generally associated with mean benzene concentrations below 0.5 mg/Nm³ (83 % of data). Scrubbers show mean concentrations below 10 mg/Nm³.

The highest mean concentration value of 203 mg/Nm³ with a corresponding mean mass flow of 1.7 g/h was measured from filling and release of reactor vessels in the production of epoxide resin granulate (IED Annex 1 no. 4.1.h respectively no. 4.1.8 of 4. BImSchV).

Figure 110: Benzene mean concentration and mean mass flow with related treatment system



Note: The highest concentration value is out-of-range but indicated in the graph.

(Ökopol 2016)

19.4 Conclusions for benzene data

Benzene (C_6H_6) data assessment shows:

- Where no abatement system for benzene is installed the mean mass flow is below 1 g/h and the mean concentration is below 0.25 mg/Nm³.
- Thermal oxidation and activated carbon filters are associated with mean benzene concentrations below 0.5 mg/Nm³ and mean mass flows below 10 g/h.
- Scrubbers are associated with mean benzene concentrations below 10 mg/Nm³ and mean mass flows below 2 g/h.

20 CMR: Phenol (C_6H_6O)

Phenol (C_6H_6O) is characterized as CMR substance (H341: suspected of causing genetic defects).

20.1 Phenol measurement

Phenol concentrations are measured with several methods, mainly with EN 13649, sampling with activated carbon and subsequent solvent desorption, in combination with VDI 2457 (chromatographic determination). Additionally, DIN 38409 was used, a method for phenol analysis in water.

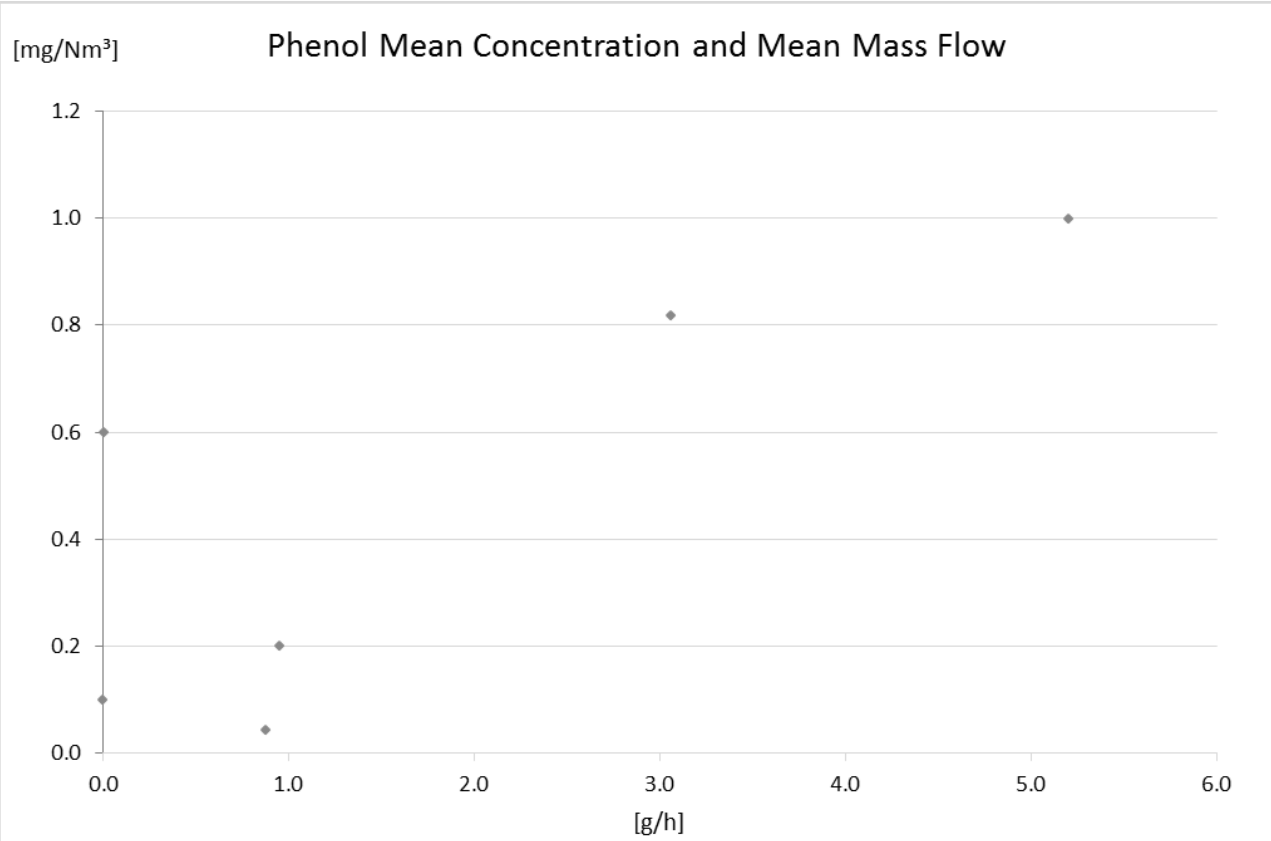
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds – Fundamentals.
- DIN 38409-16:1984 - German standard methods for the examination of water, waste water and sludge; general measures of effects and substances (group H); determination of the phenol index (H 16).

20.2 Phenol concentration and related mass flow

Figure 111 shows all phenol concentrations values (7 data sets) and the related mean mass flow. For all except one value, the mass flow of the source has been reported. For a detailed list of data see Table 17 (after next page).

Data show that all mean phenol concentrations are equal or below 1 mg/Nm³; mean mass flows are < 6 g/h.

Figure 111: Phenol mean concentration and mean mass flow

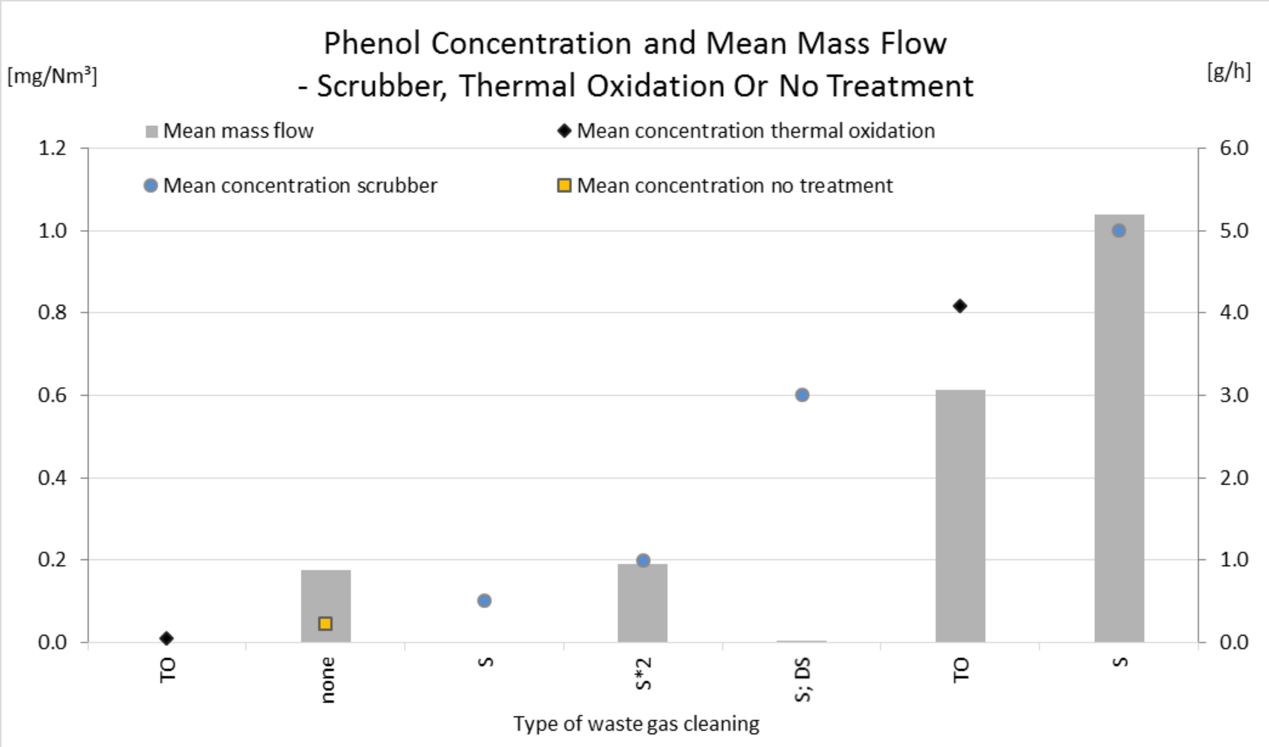


(Ökopol 2016)

20.3 Phenol emissions and related waste gas treatment

Figure 112 shows mean phenol concentrations and mean mass flow (bars) with thermal oxidation (black rhombus), scrubbers (blue dots) or no treatment (orange square). Data is sorted by increasing concentrations.

Figure 112: Phenol mean concentration and mean mass flow with related treatment system



(Ökopol 2016)

Table 17 shows the mean concentration values of phenol and the related mean mass flow. The values are sorted by increasing mean concentration. The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 17: Phenol emissions from sources without dust treatment system

#	Type of installation	Waste gas system		Phenol Measurement method	Mean Volume Flow (*) [m³/h]	Phenol Mean Mass Flow [g/h]	Phenol Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.1, 4.1.2, 4.1.3, 4.1.6,4.1.11;4.1.13,4.1.15	C	TO	VDI 2457 Bl. 1 und 4	480	-	0.01	<0.02	mg/m³
2	4.1.8	-	none	EN 13649	19 501	0.875	0.044	0.044	mg/m³
3	4.1.2	S	S	VDI 2457; EN 13649	130	0	0.1	<0.2	mg/m³
4	4.1.2	S	S*2	VDI 2457 Bl. 4	5 200	0.95	0.2	<0.4	mg/m³
5	4.1.11	S	S; DS	DIN 38409	2.5	0.002	0.6	0.6	mg/m³
6	4.1.8	C	TO	NIOSH 2546	3 740	3.06	0.818	0.818	mg/m³
7	4.1.8	S	S	EN 13649	5 383	5.2	1	1	mg/m³

20.4 Conclusions for phenol data

Phenol (C_6H_6O) data assessment shows:

- In one case where no abatement system for phenol is installed, the mean mass flow is below 1 g/h and the mean concentration is below 0.5 mg/Nm³.
- Thermal oxidation and scrubbers are associated with mean phenol concentrations of < 1 mg/Nm³; related mean mass flows are below 6 g/h.

21 CMR: Toluene diisocyanate (TDI, $C_9H_6N_2O_2$)

Toluene diisocyanate (TDI, $C_9H_6N_2O_2$) is characterized as CMR substance (H350: may cause cancer).

21.1 Toluene diisocyanate measurement

Concentrations of toluene diisocyanate are measured with method EN 13649, sampling on activated carbon and desorption with solvents, in combination with VDI 2457, chromatographic determination.

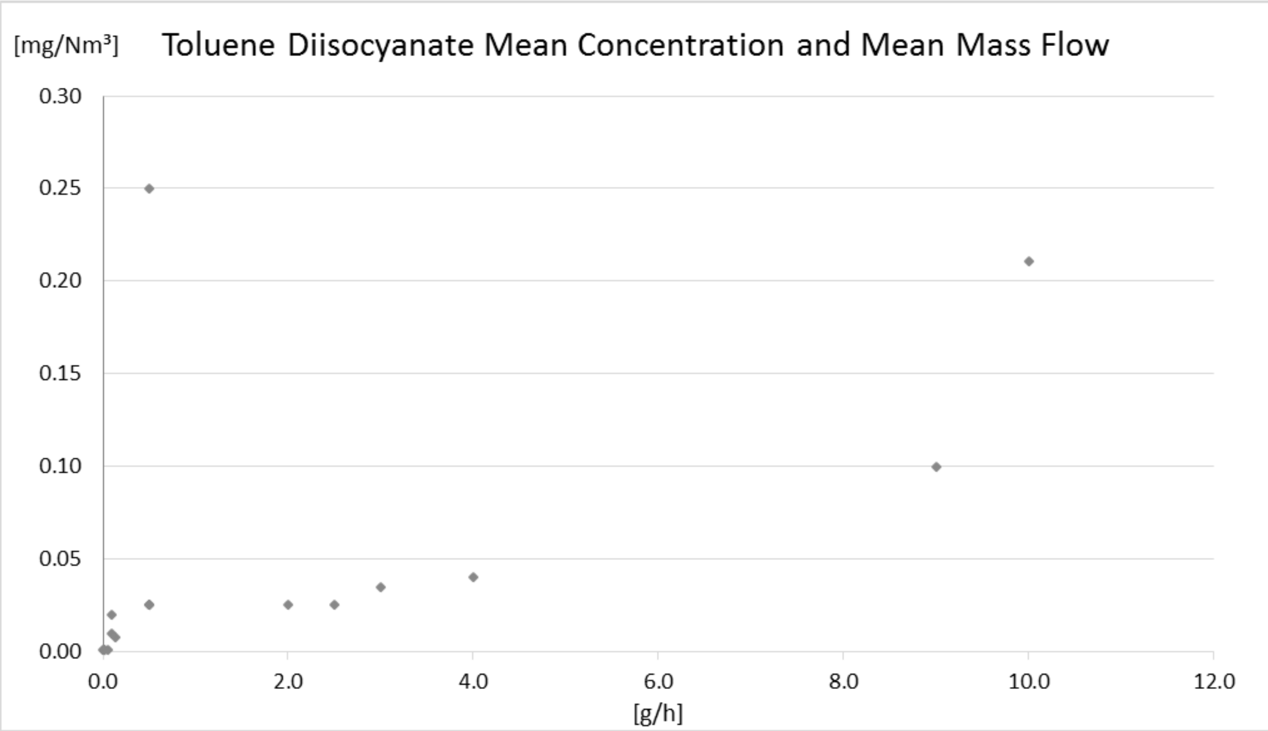
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals

21.2 Toluene diisocyanate concentration, mass flow and waste gas treatment

All toluene diisocyanate concentrations (18 data) originate from sources where no waste gas treatment system is installed. For a detailed list of data see Annex 42.

Data show that all mean concentrations of toluene diisocyanate are below 0.25 mg/Nm³; mean mass flows are ≤ 10 g/h.

Figure 113: Toluene diisocyanate mean concentration and mean mass flow



(Ökopol 2016)

21.3 Toluene diisocyanate emissions and related waste gas treatment

None of the emission data of toluene diisocyanate was reported with waste gas treatment.

21.4 Conclusions for toluene diisocyanate data

Toluene diisocyanate ($C_9H_6N_2O_2$) data assessment shows:

- Mean concentrations of toluene diisocyanate are < 0.25 mg/Nm³; mean mass flows are < 10 g/h.

22 CMR: Vinyl chloride (C_2H_3Cl)

Vinyl chloride, short "VC" (C_2H_3Cl), is characterized as CMR substance (H350: may cause cancer).

22.1 Vinyl chloride measurement

Vinyl chloride concentrations are measured with several methods. Most frequently, method VDI 3482 is mentioned, as well as method EN EN 13649, both sampling on activated carbon and applying desorption with solvents. Method VDI 2457 is used for chromatographic determination. In one case method VDI 3494 is used, elaborated for venyl chloride monitoring in ambient air (substituted by VDI 2100-2:2001).

- VDI 3482 Bl. 4:1984 (withdrawn) - Measurement of gaseous immissions - Gas chromatographic determination of organic compounds using capillary columns - Sampling by enrichment on activated carbon; desorption with solvent
- VDI 3482 Bl. 5:1984 (withdrawn) - Measurement of gaseous immissions - Gas chromatographic determination of aromatic hydrocarbons - Sampling by enrichment on activated carbon; desorption with solvent
- VDI 3494 Bl. 2:1986 (withdrawn) - Gaseous Air Pollution Measurement; Determination Of Vinyl Chloride Concentrations
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.

22.2 Vinyl chloride concentration, mass flow and waste gas treatment system

Table 18 shows all vinyl chloride concentrations values (11 data) and the related mass flow. For all but one value, the mass flow of the source has been reported. All but one mean concentration include at least one result below the limit of detection (LOD).

All mean vinyl chloride concentrations are all below 0.3 mg/Nm³; mean mass flows are below 3 g/h.

In Table 18, the second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth and seventh column indicate the mean mass flow, and the eighth and ninth column show the mean concentration value.

Table 18: Vinyl chloride emissions and related treatment system

#	Type of installation	Waste gas system		Vinyl chloride Measurement method	Mean Volume Flow (*) [m³/h]	Vinyl chloride Mean Mass Flow		Vinyl chloride Mean Concentration	
						Value	Unit	Value	Unit
1	4.1.8	S	FF	N. N.	7 830	-	-	<0.01	mg/m³
2	4.1.6	S	TO; S*2	VDI 2457 Bl. 1	8 933	<0.279	g/h	<0.03	mg/m³
3	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	16 300	<1.333	g/h	<0.0666	mg/m³
4	4.1.7	S	COX	VDI 3494/2	380	0.038	g/h	0.099	mg/m³
5	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	16 597	<2	g/h	<0.1	mg/m³

#	Type of installa-tion	Waste gas system		Vinyl chloride Measurement method	Mean Volume Flow (*) [m³/h]	Vinyl chloride Mean Mass Flow		Vinyl chloride Mean Concentration	
						Value	Unit	Value	Unit
6	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	17 539	<2	g/h	<0.1	mg/m³
7	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	16 400	<2	g/h	<0.1	mg/m³
8	4.1.7	S	COX	EN 13649	233	<0.03	g/h	<0.13	mg/m³
9	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	15 519	<2.66	g/h	<0.2	mg/m³
10	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	15 740	<3.33	g/h	<0.2	mg/m³
11	4.1.6/8	C	TO; Q; S; S; DD	EN 14792	16 400	<2.843	g/h	<0.233	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

22.3 Conclusions for vinyl chloride data

Vinyl chloride (C_2H_3Cl) data assessment shows:

- Vinyl chloride mean concentrations are all below 0.3 mg/Nm³; mean mass flows are below 3 g/h.

23 CMR: 1,2-Dichloroethane, benzyl chloride, epichlorohydrin

1,2-Dichloroethane ($C_2H_4Cl_2$, "DCE"), benzyl chloride (C_7H_7Cl) and epichlorohydrin (C_3H_5ClO) are halogenated organic compounds, characterized as CMR substances (H350: may cause cancer).

23.1 Dichloroethane, benzyl chloride, epichlorohydrin measurement

Concentrations of dichloroethane, benzyl chloride, epichlorohydrin are measured with several methods. Most frequently, method EN 13649 is used, sampling on activated carbon and applying desorption with solvents, in combination with VDI 2457, chromatographic determination. In few cases, VDI 3482 is mentioned.

- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals
- VDI 3482 Bl. 4:1984 (withdrawn) - Measurement of gaseous immissions - Gas chromatographic determination of organic compounds using capillary columns - Sampling by enrichment on activated carbon; desorption with solvent
- VDI 3482 Bl. 5:1984 (withdrawn) - Measurement of gaseous immissions - Gas chromatographic determination of aromatic hydrocarbons - Sampling by enrichment on activated carbon; desorption with solvent

23.2 Dichloroethane, benzyl chloride, epichlorohydrin concentration, mass flow and waste gas treatment system

Tables 19 and 20 show concentrations of dichloroethane (10 data) and benzyl chloride (2 data) as well as epichlorohydrin (2 data) with the related mass flow and related treatment system. For all values, the mean mass flow of the source has been reported. All mean concentrations include at least one result below the limit of detection (LOD).

In the tables, the second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5 page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow. The seventh and eighth column indicate the mean mass flow, and the ninth and tenth column show the mean concentration value.

Table 19 shows that benzyl chloride and epichlorohydrin emissions treated with scrubbers are associated with concentrations below 2 mg/Nm³. Where concentration are between 1 - 2 mg/Nm³, the related mass flow is below 2.5 g/h.

Table 20 shows that dichloroethane and benzyl chloride emissions treated with thermal oxidation are associated with concentrations below 1 mg/Nm³.

Table 19: Benzyl chloride and epichlorohydrin emissions with scrubbers

#	Substance	Type of installation	Waste gas system		Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow		Mean Concentration	
							Value	Unit	Value	Unit
1	C_7H_7Cl	4.1	S	S	EN 13649:2002	1 448	<0.2	g/h	<0.15	mg/m³
1	C_3H_5ClO	4.1	S	S	EN 13649:2002	1 448	<2.3	g/h	<1.62	mg/m³

#	Sub-stance	Type of installa-tion	Waste gas system		Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow		Mean Concentration	
							Value	Unit	Value	Unit
2	C_3H_5ClO	4.1	S	S; S	EN 13649:2002	1 590	0.2	g/h	0.14	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Table 20: Dichloroethane and benzyl chloride emissions with thermal oxidation

#	Sub-stance	Type of installa-tion	Waste gas system		Measure-ment method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow		Mean Concentration	
							Value	Unit	Value	Unit
1	$C_2H_4Cl_2$	4.1.6	S	TO; S*2	VDI 2457 Bl. 1	8 933	<0.279	g/h	<0.03	mg/m³
2	$C_2H_4Cl_2$	4.1.6	S	TO; S*2	VDI 2457 Bl. 1	8 933	<0.279	g/h	<0.03	mg/m³
3	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	16 300	<1.333	g/h	<0.067	mg/m³
4	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	17 100	<2	g/h	<0.1	mg/m³
5	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	17 100	<2	g/h	<0.1	mg/m³
6	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	16 400	<2	g/h	<0.1	mg/m³
7	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	15 519	<2.66	g/h	<0.2	mg/m³
8	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3482/4-5	15 740	<3.33	g/h	<0.2	mg/m³
9	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	16 400	<3.666	g/h	<0.233	mg/m³
10	$C_2H_4Cl_2$	4.1.6/8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	16 400	<3.666	g/h	<0.233	mg/m³
11	C_7H_7Cl	4.1.2	C	TO	CEN/TS 13649	1 788	<0.003	g/h	<0.002	mg/m³
12	C_7H_7Cl	4.1.2	C	TO	CEN/TS 13649	512	<0.0009	g/h	<0.002	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

23.3 Conclusions for dichloroethane, benzyl chloride, epichlorohydrin data

Data assessment of 1,2-dichloroethane ($C_2H_4Cl_2$, "DCE"), benzyl chloride (C_7H_7Cl) and epichlorohydrin (C_3H_5ClO) shows:

- Mean emissions concentrations associated with thermal oxidation are generally below 1 mg/Nm^3; where 1 mg/Nm^3 is exceeded, the mean mass flow is below 2.5 g/h.

24 Non-CMR halogenated organic compounds, e.g. chloromethane (CH_3Cl), chloropropane (C_3H_7Cl), dichlorobenzene ($C_6H_4Cl_2$), dichloromethane (CH_2Cl_2)

24.1 Non-CMR halogenated organic compounds measurement

Concentrations of non-CMR halogenated compounds like chloromethane (CH3Cl), chloropropane (C_3H_7Cl), dichlorobenzene ($C_6H_4Cl_2$), dichloromethane (CH_2Cl_2) are measured with several methods. Most frequently, method EN 13649 is used, sampling on activated carbon and applying desorption with solvents, in combination with VDI 2457, chromatographic determination. In few cases, VDI 3482 is mentioned.

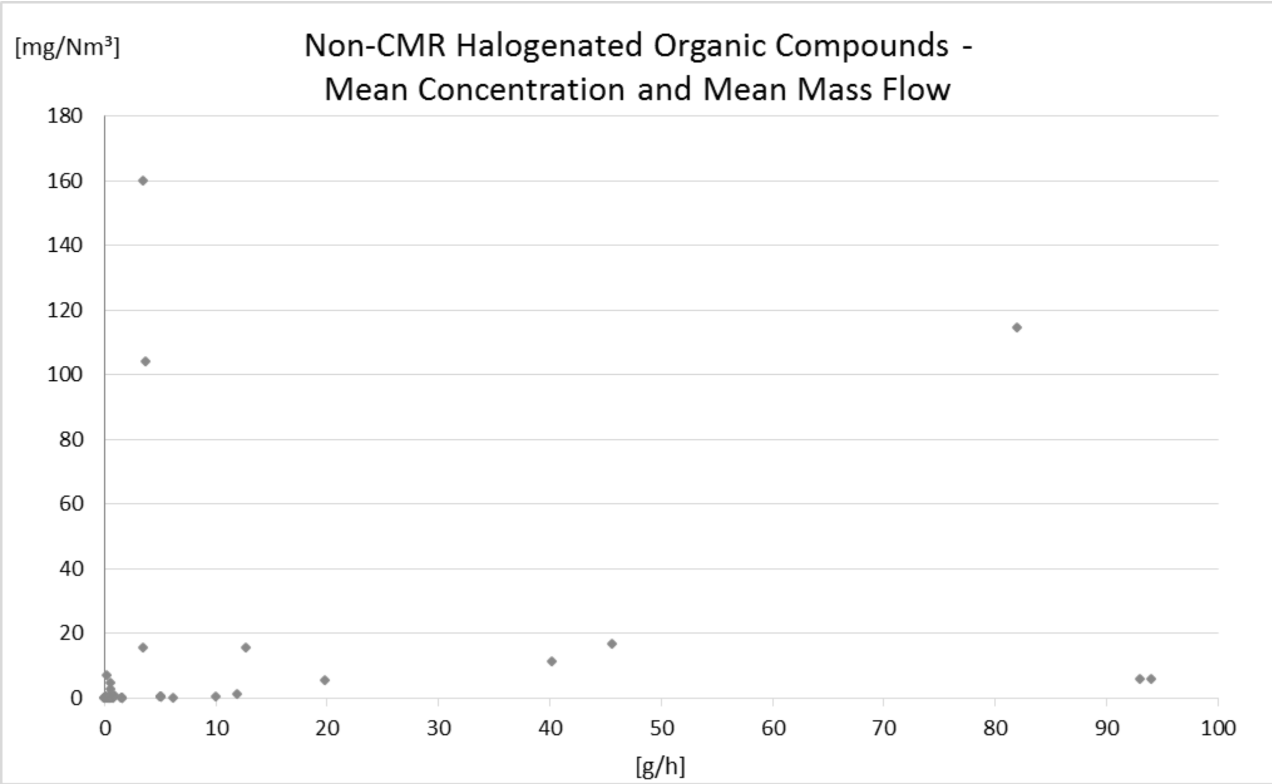
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds – Fundamentals.

24.2 Non-CMR halogenated organic compound concentration and mass flow

Figure 114 shows all non-CMR halogenated organic compound concentrations (47 data) and the related mass flow. For all data, the mass flow of the source has been reported. For a detailed list of data see Annex 43 to Annex 45.

Data show that mean concentrations of non-CMR halogenated organic compounds are generally < 20 mg/Nm³ (94 % of data). Where higher concentration values were measured, mean mass flows were below 100 g/h.

Figure 114: Non-CMR halogenated organic compound mean concentration and mean mass flow



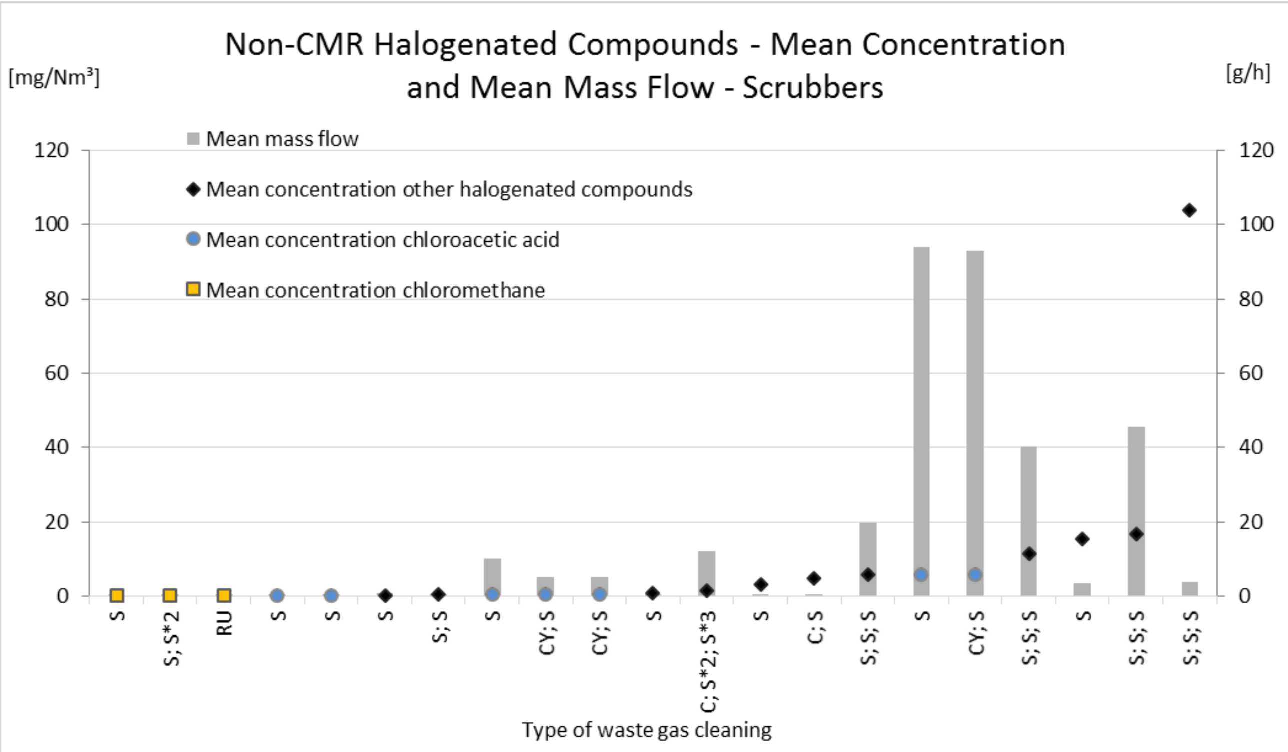
(Ökopol 2016)

24.3 Non-CMR halogenated organic compound concentration, mass flow and related waste gas treatment

Figure 115 shows mean concentration and mean mass flow (bars) of non-halogenated compounds from installations with scrubbers. Concentration values of chloromethane are indicated with orange squares, concentrations of chloroacetic acid values with blue dots, and all other halogenated compound concentrations with a black rhombus. Data is sorted by increasing concentration values. For a detailed list of data see Annex 43.

Data show that scrubbers are generally associated with mean concentrations below 20 mg/Nm³ (95 % of data). Where 20 mg/Nm³ is exceeded, a mean mass flow of 3.7 g/h is combined with the 104 mg/Nm³.

Figure 115: Non-CMR halogenated organic compound mean concentration and mean mass flow with scrubbers

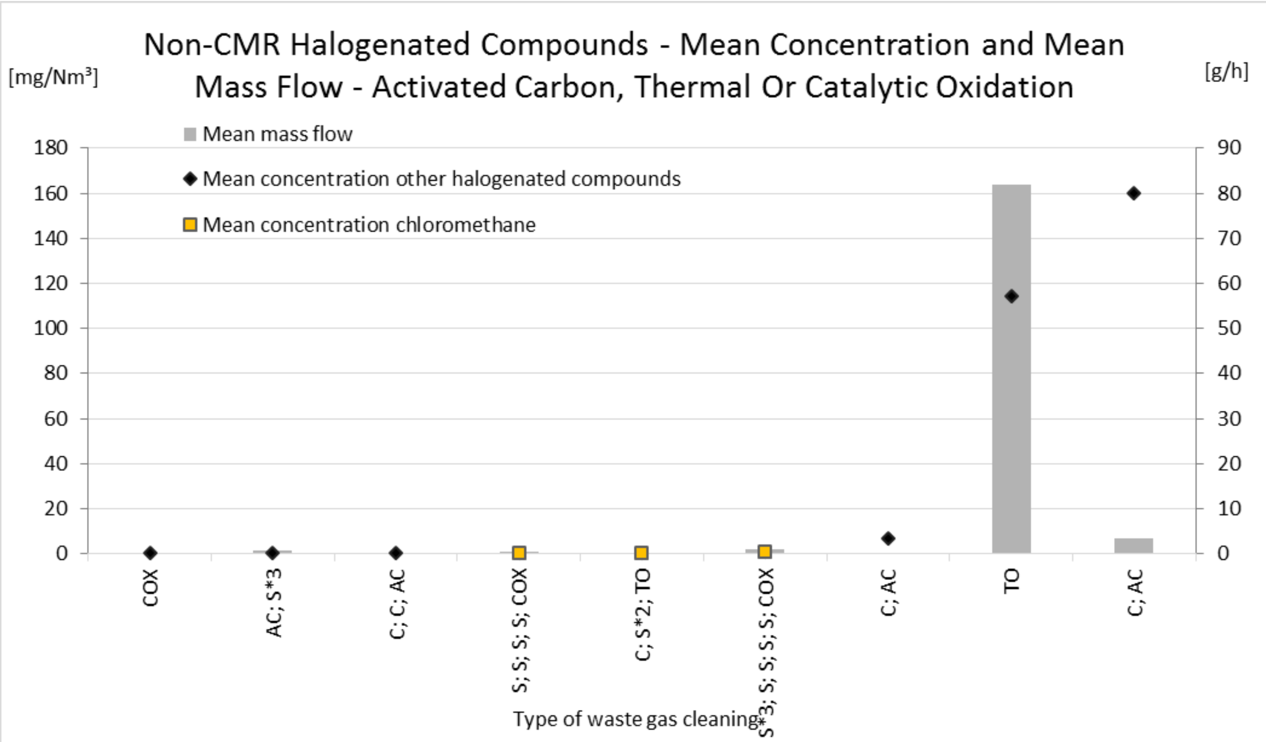


(Ökopol 2016)

Figure 116 shows mean concentration and mean mass flow (bars) of non-halogenated compounds from installations with thermal oxidation, catalytic oxidation or activated carbon filters. Chloromethane concentration values are indicated with orange squares, all other halogenated compounds are indicated with a black rhombus. Data is sorted by increasing concentration values. For a detailed list of data see Annex 45.

Data show that thermal oxidation, catalytic oxidation or activated carbon filters are generally associated with concentrations below 5 mg/Nm³ (78 % of data). Where mean concentrations are above 5 mg/Nm³, a mean mass flow of 100 g/h is not exceeded.

Figure 116: Non-CMR halogenated organic compound mean concentration and mean mass flow with activated carbon, thermal oxidation of catalytic oxidation

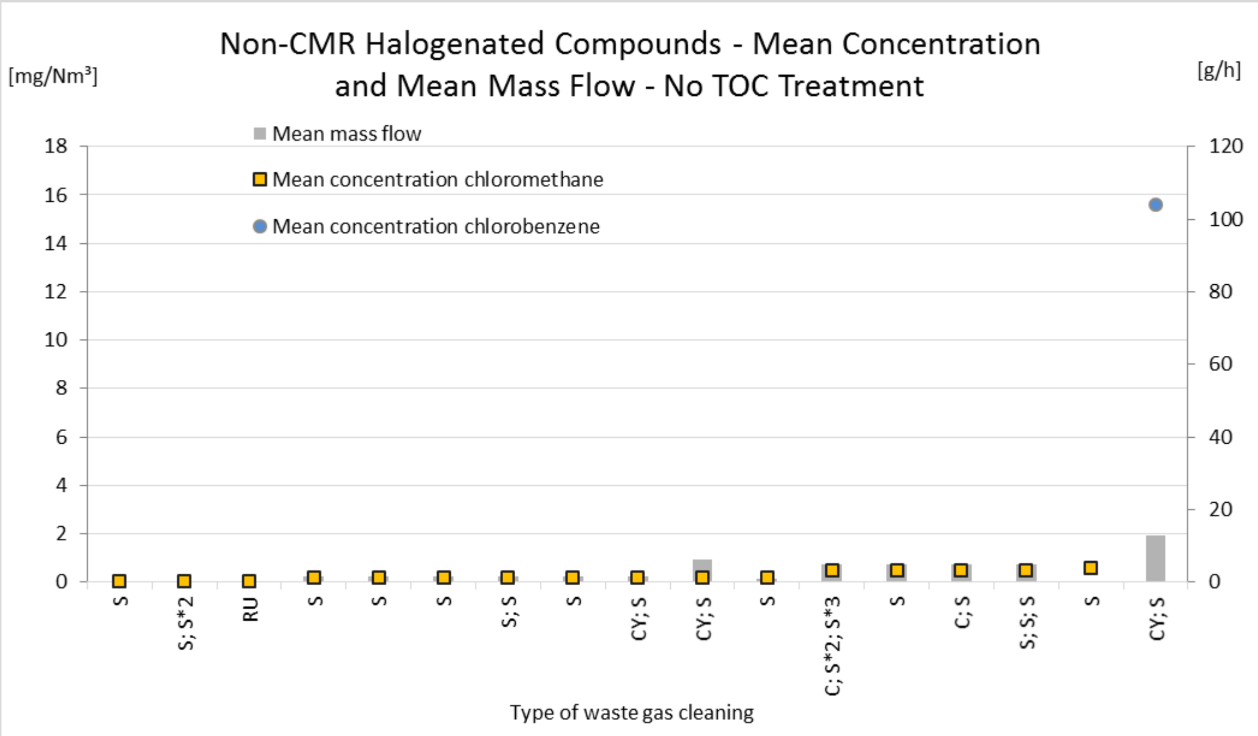


(Ökopol 2016)

Figure 117 shows mean concentration and mean mass flow (bars) of non-halogenated compounds from installations with mechanical treatment or no waste gas treatment. Chloromethane concentration values are indicated with orange squares, one measurement of chlorobenzene is shown as blue dot. Data is sorted by increasing concentration values. For a detailed list of data see Annex 45.

Data show that all mean chloromethane concentrations are < 2 mg/Nm³, the mean mass flow is < 10 g/h. Measurements of chlorobenzene show a mean concentration < 20 mg/Nm³; the mean mass flow is < 20 g/h.

Figure 117: Non-CMR halogenated organic compound mean concentration and mean mass flow with mechanical treatment or no waste gas treatment



(Ökopol 2016)

24.4 Conclusions for non-CMR halogenated organic compounds

Data assessment of non-CMR halogenated organic compounds shows:

- Scrubbers are generally associated with mean concentrations below 20 mg/Nm3; in the case where 20 mg/Nm³ is exceeded, the mean mass flow is < 5 g/h.
- Thermal oxidation, catalytic oxidation or activated carbon filters are generally associated with mean concentrations below 5 mg/Nm³; where concentrations are above 5 mg/Nm³, a mean mass flow of 100 g/h is not exceeded.

25 More harmful organic compounds

This section comprises organic compounds having specific hazardous properties and therefore not covered by together with those generally measured as TOC. In Germany, these more harmful organic compounds are categorized as “Organic Compounds Class I”. They are measured and documented individually or as a sum parameter. For all substances listed in “Organic Compounds Class I” see Annex 1.

25.1 More harmful organic compounds measurement

Concentrations of more harmful organic compounds are measured with method EN 13649, sampling on activated carbon and desorption with solvents, in combination with VDI 2457, chromatographic determination.

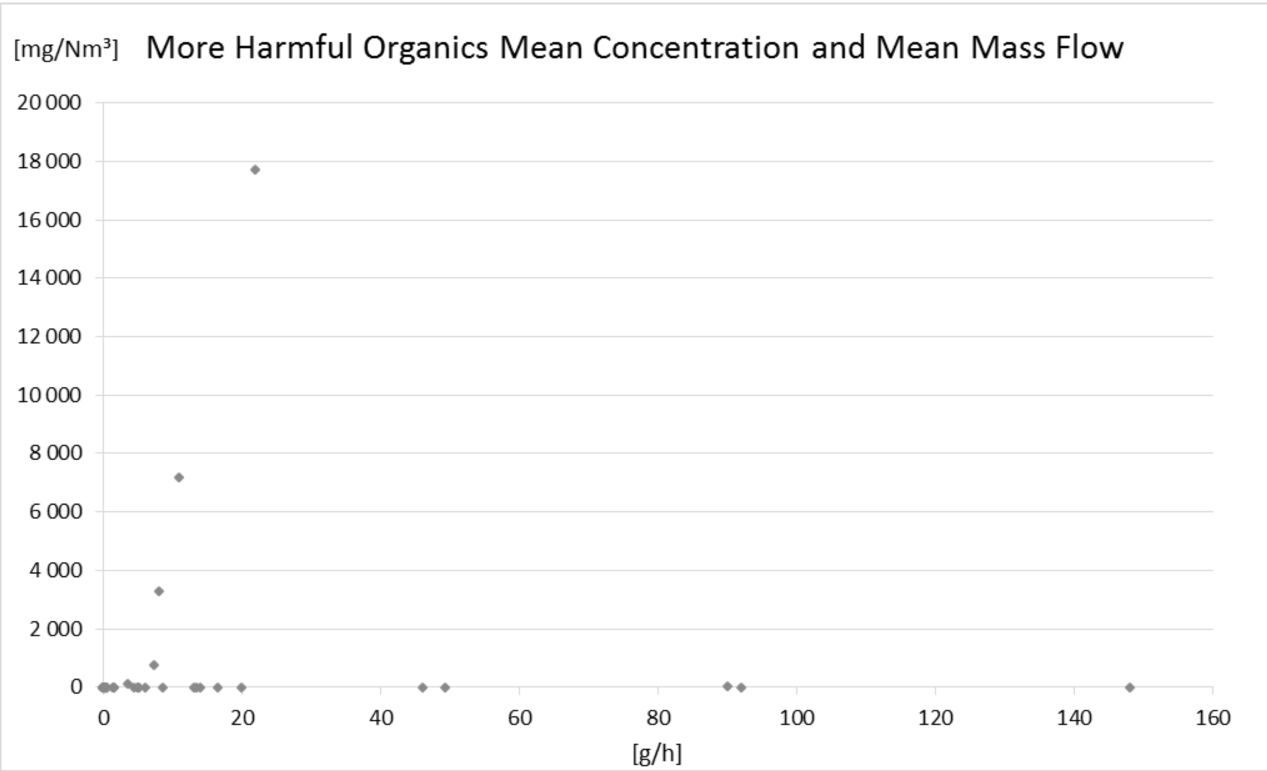
- EN 13649:2002-10-30 - Stationary source emissions - Determination of the mass concentration of individual gaseous organic compounds- Activated carbon and solvent desorption method.
- VDI 2457 Bl. 1:1997 (confirmed 2013) - Gaseous emission measurement - Chromatographic determination of organic compounds - Fundamentals

25.2 More harmful organic compound concentration and mass flow

Figure 118 shows all concentration values of more harmful organic compounds categorized class I (49 data) and the related mass flow. Figure 119 shows the same data with a reduced scale (six values are cut off). For all data, the mass flow of the source has been reported. For a detailed list of data see Annexes 47 and 48.

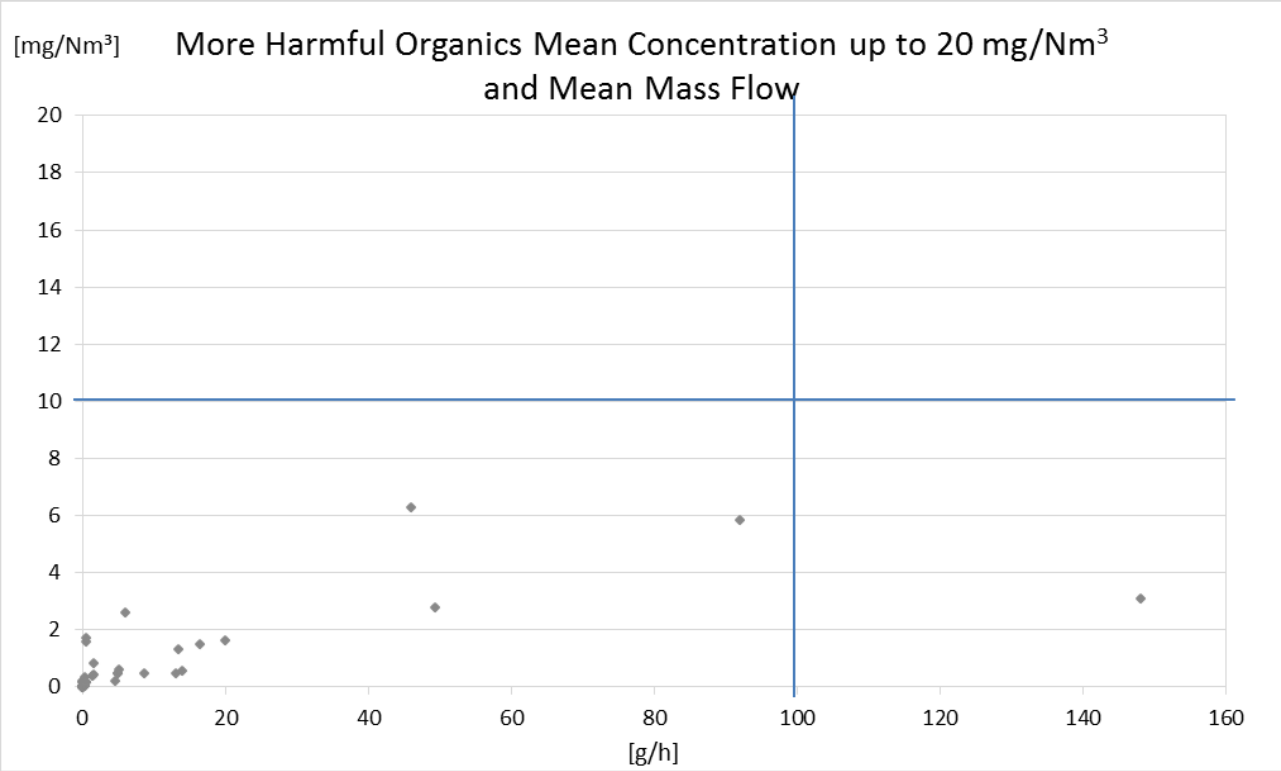
Data show that mean concentrations of more harmful organic compounds are generally below 10 mg/Nm³ (85 % of data). Where higher concentration values were measured, the mean mass flow is below 100 g/h.

Figure 118: More harmful organic compound mean concentration and mean mass flow



(Ökopol 2016)

Figure 119: More harmful organic compound mean concentration and mean mass flow with reduced scale up to 20 mg/Nm³



Note: Six values with concentrations of 50.53 - 17 700 mg/Nm³ and mass flows of 3.48 - 90 g/h are cut off.

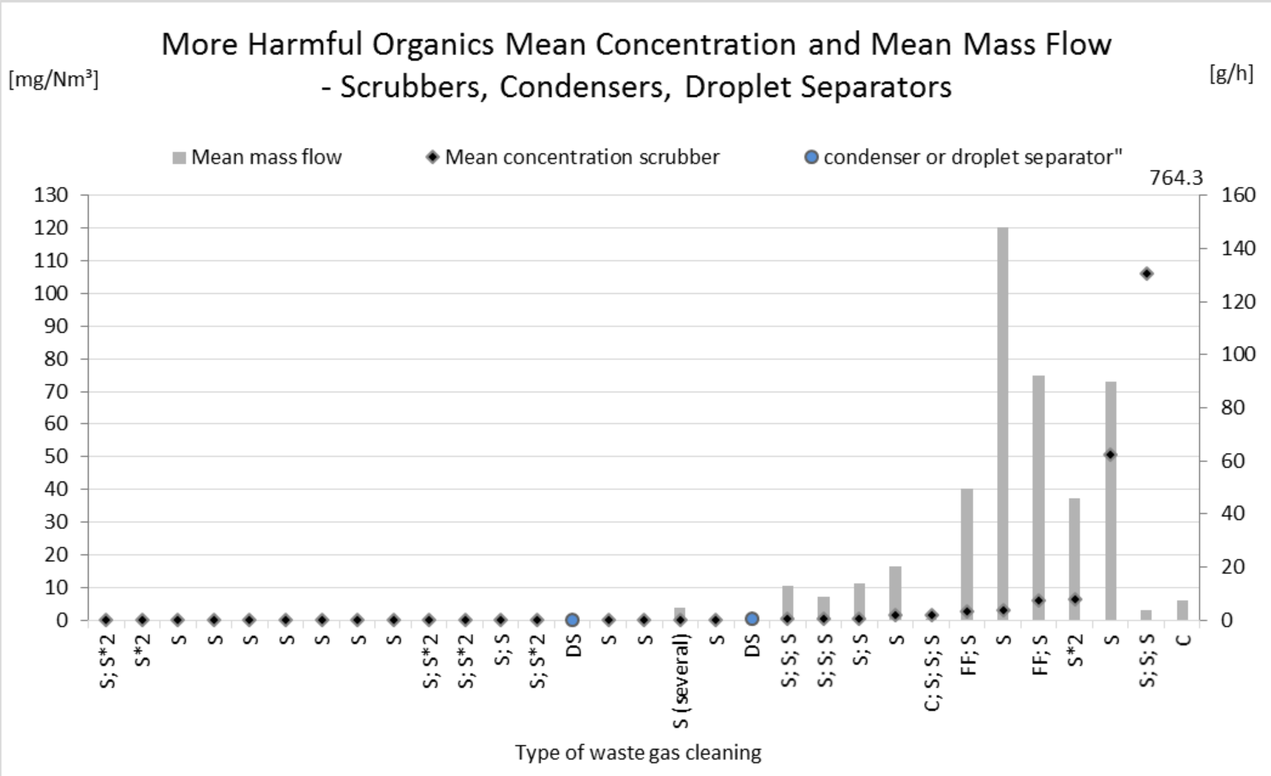
(Ökopol 2016)

25.3 More harmful organic compound concentration, mass flow and related waste gas treatment

Figure 120 shows concentration and mass flow (bars) of more harmful organic compounds from installations with scrubbers, condensers or droplet separators (31 data sets). Data is sorted by increasing concentration values. For a detailed list of data see Annexes 47.

Data show that scrubbers are generally associated with mean concentrations below 10 mg/Nm³ (90 % of data sets). Where mean concentrations are above 10 mg/Nm³, a mean mass flow of 100 g/h is not exceeded.

Figure 120: More harmful organic compound mean concentration and mean mass flow with scrubbers, condensers or droplet separators



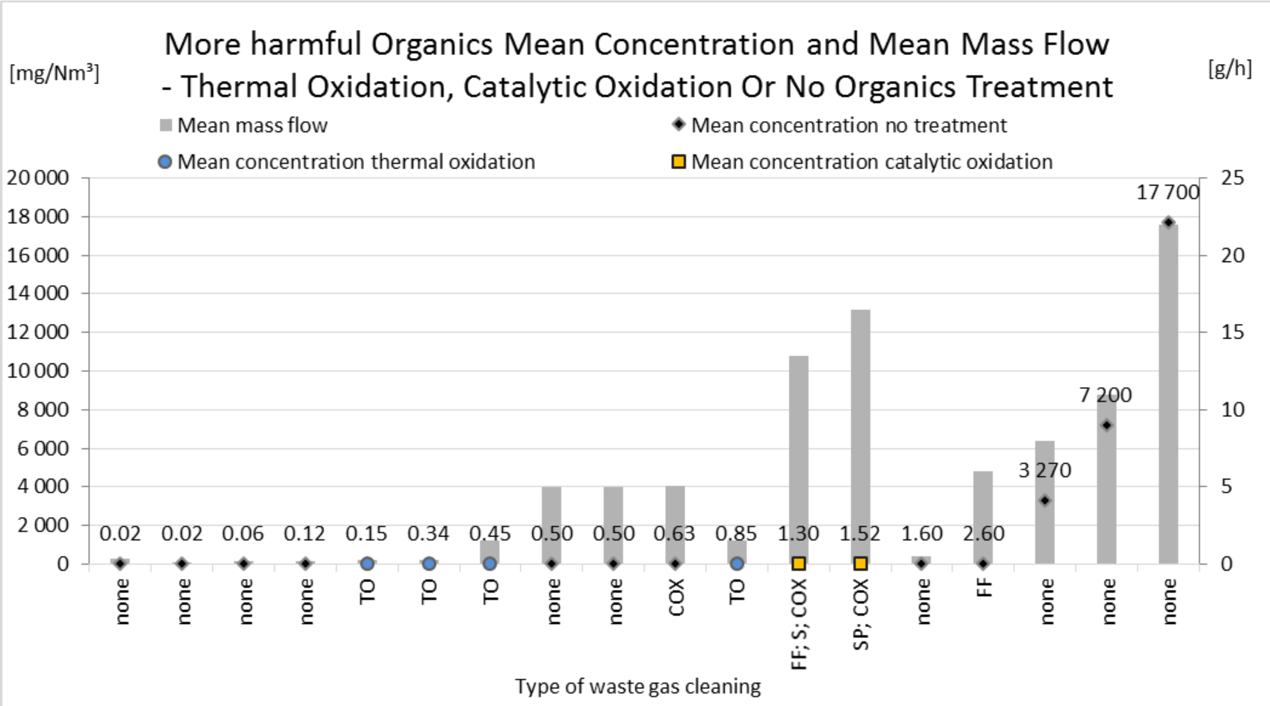
(Ökopol 2016)

Figure 121 shows concentration and mass flow (bars) of more harmful organic compounds from installations with thermal oxidation (blue dot), catalytic oxidation (orange square) or no treatment of organic compounds (black rhombus). Data is sorted by increasing concentration values. For a detailed list of data see Annexes 48.

Data show that thermal and catalytic oxidation (7 data sets) are associated with mean concentrations below 5 mg/Nm³.

Where no treatment for organic compounds is installed, mean concentrations are below 10 mg/Nm³ or the mean mass flow is below 30 g/h.

Figure 121: More harmful organic compound mean concentration and mean mass flow with scrubbers



(Ökopol 2016)

25.4 Conclusions for more harmful organic compounds

Data assessment of more harmful organic compounds shows:

- Scrubbers are generally associated with mean concentrations below 10 mg/Nm³; where mean concentrations are above 10 mg/Nm³, a mean mass flow of 100 g/h is not exceeded.
- Thermal or catalytic oxidations are generally associated with mean concentrations below 5 mg/Nm³.
- Where no treatment for organic compounds is installed, mean concentrations are below 10 mg/Nm³, or the mean mass flow is below 30 g/h.

26 Metals

Metals are measured and documented individually or as sum parameter. They can be found as gaseous elemental form (e.g. elemental mercury) or in oxidized form, bound to particles (PM). According to volatility and toxicity, 13 metals are categorized as "PM Class I" (mercury, thallium), "PM Class II" (lead, cobalt, nickel, selenium, telluric) and "PM Class III" (antimony, chromium, copper, manganese, vanadium, tin).

26.1 Metals measurement

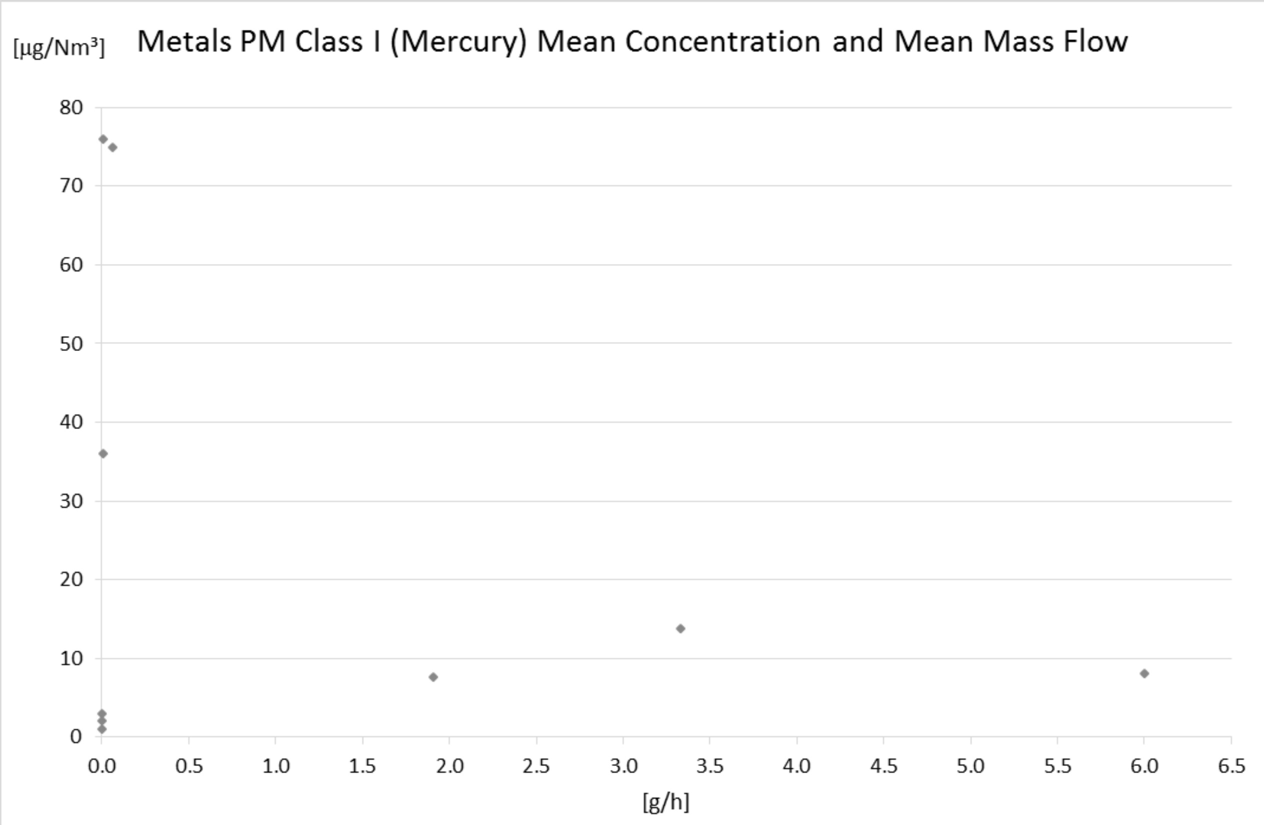
Dust collection is done according to methods EN 13284 and VDI 2066 (see chapter 3.1 on page 79) or following method VDI 3868 (using an absorption system consisting of washing bottles as is done for the measurement of gaseous emissions like SO_2 and HCl). Subsequently, metal concentrations in dust are determined generally with method EN 14385 (atomic absorption spectrometry AAS) as well as corresponding method VDI 2268. Furthermore, DIN 38406 series are used, consisting of methods for the examination of water, waste water and sludge, describing determination of metals by atomic absorption spectrometry (AAS). Mercury is measured with EN 13211, determining particulate, oxidized and volatile mercury in air, and with EN 1483, measuring mercury with atomic absorption spectrometry.

- VDI 3868 Bl. 1:1994 (confirmed 2015) - Determination of total emission of metals, metalloids, and their compounds - Manual measurement in flowing, emitted gases - Sampling system for particulate and filter-passing matter.
- EN 14358:2004 - Stationary source emissions - Determination of the total emission of As, Cd, Cr, Co, Cu, Mn, Ni, Pb, Sb, TI and V.
- VDI 2268 Bl. 1:1987 (confirmed 2015) - Chemical analysis of particulate matter; determination of Ba, Be, Cd, Co, Cr, Cu, Ni, Pb, Sr, V, Zn in particulate emissions by atomic spectrometric methods.
- DIN 38406-Series - German standard methods for the examination of water, waste water and sludge.
- EN 13211:2001 - Air quality - Stationary source emissions - Manual method of determination of the concentration of total mercury
- EN 1483:2007 - Water quality - Determination of mercury - Method using atomic absorption spectrometry.

26.2 Metals concentration and mass flow PM Class I (mercury data)

Figure 122 below shows all mean concentrations of metals PM Class I (11 data of mercury) and the related mass flow. For all but one data, the mass flow has been reported. For a detailed list of data see Annex 48.

Figure 122: Metals PM Class I (mercury) mean concentration and mean mass flow



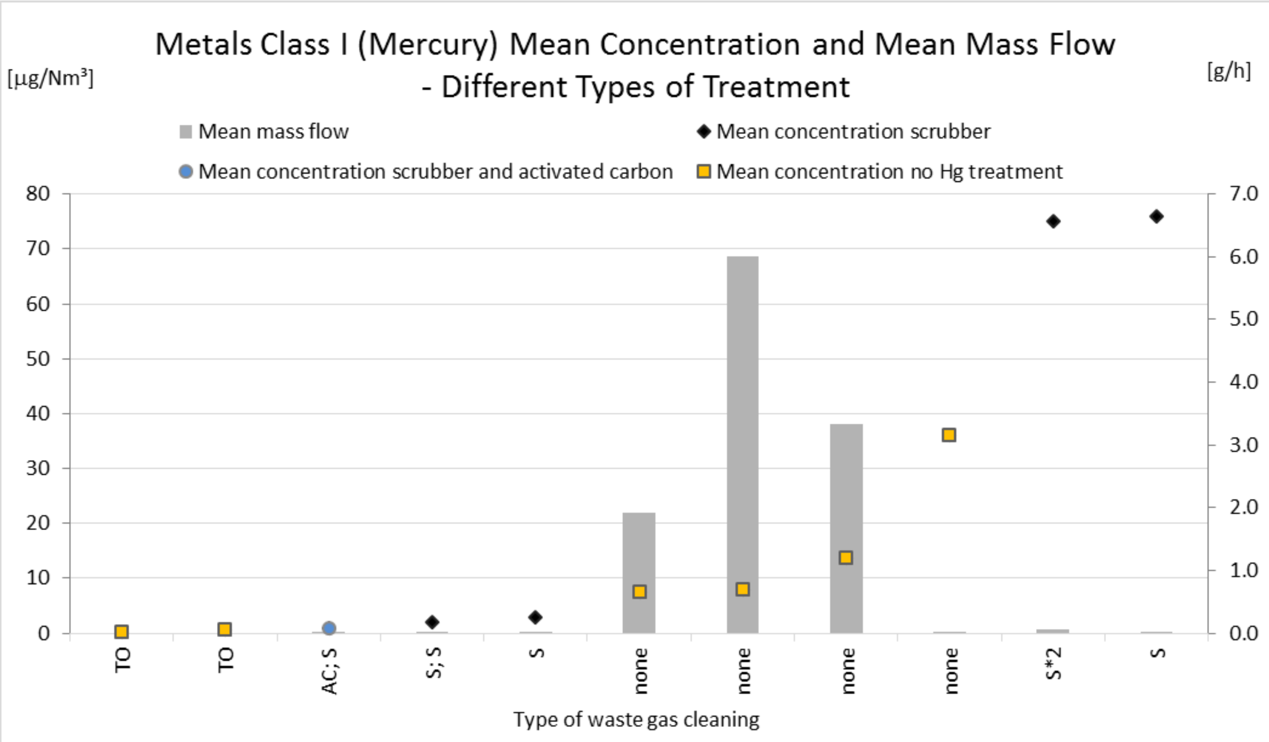
(Ökopol 2016)

Data in Figure 122 show that five concentration values of mercury are < 3 µg/Nm³ (45 % of data). In three cases, where mean concentrations are higer, mercury mean mass flows are below 0.1 g/h. In other three cases, where mercury mean concentrations are between 8 - 36 µg/Nm³, mean mass flows are between 1.9 g/h and 6 g/h with volumes between 230 000 and 730 000 Nm³/h. These three data sets originate from the ventilation of production halls for alcoholates (IED no. 4.1.4) and chloralkali (IED no. 4.1.12).

26.3 Metals concentration PM Class I, mass flow and related waste gas treatment

Figure 123 shows concentration and mass flow (bars) of metals PM Class I (11 data of mercury) from installations with scrubbers (black rhombus), scrubbers and activated carbon filter (blue dot) and from sources without waste gas treatment (orange squares). Data is sorted by increasing concentration values. For a detailed list of data see Annex 48.

Figure 123: Metals PM Class I (mercury) mean concentration, mean mass flow and treatment system



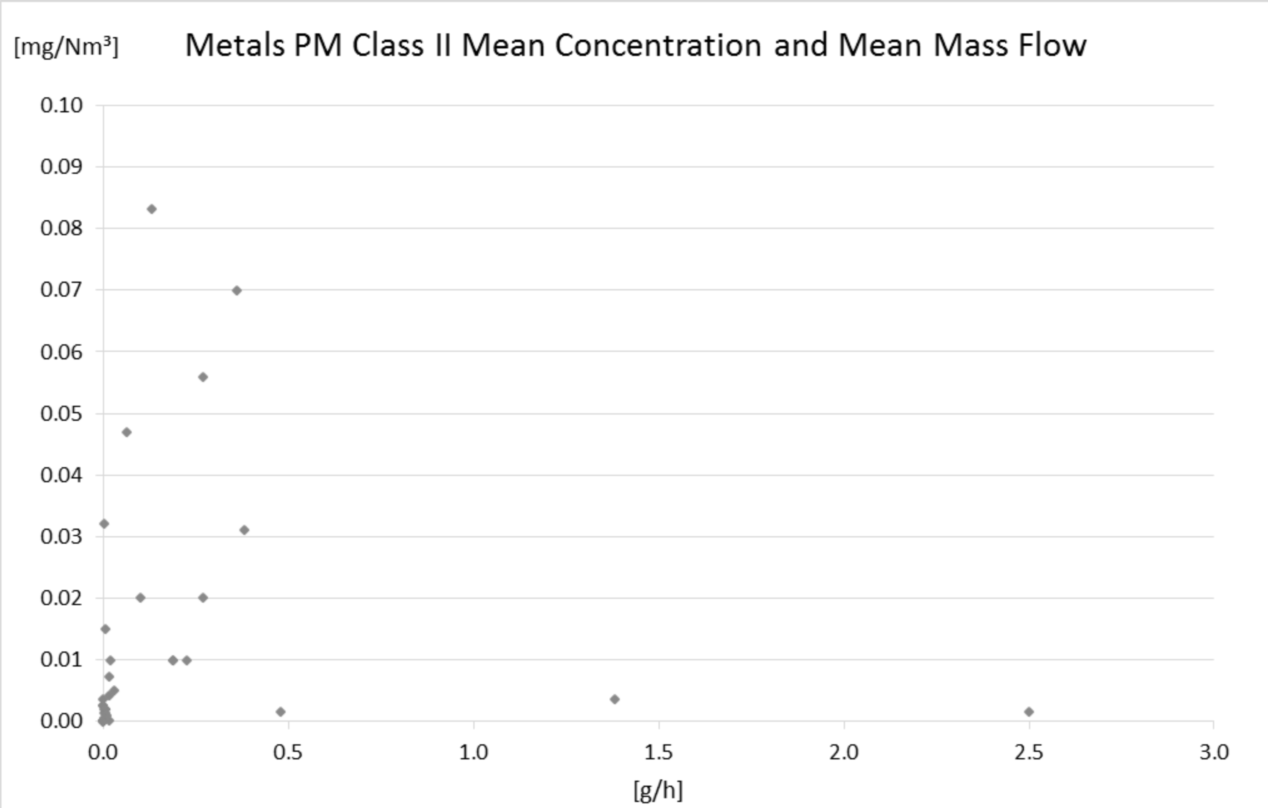
(Ökopol 2016)

26.4 Metals concentration and mass flow PM Class II (Pb, Co, Ni, Se, Te data)

Figure 124 shows all mean concentrations of metals of PM Class II (lead, cobalt, nickel, selenium, telluric, 42 data) and the related mean mass flow. For all but one data, the mass flow has been reported. For a detailed list of data see Annex 49.

Data show that mean concentrations of metals of PM Class II are generally below 0.01 mg/Nm³ (67 % of data). Where mean concentrations are higher, a mean mass flow of 0.5 g/h is not exceeded.

Figure 124: Metals PM Class II (Pb, Co, Ni, Se, Te) mean concentration and mean mass flow

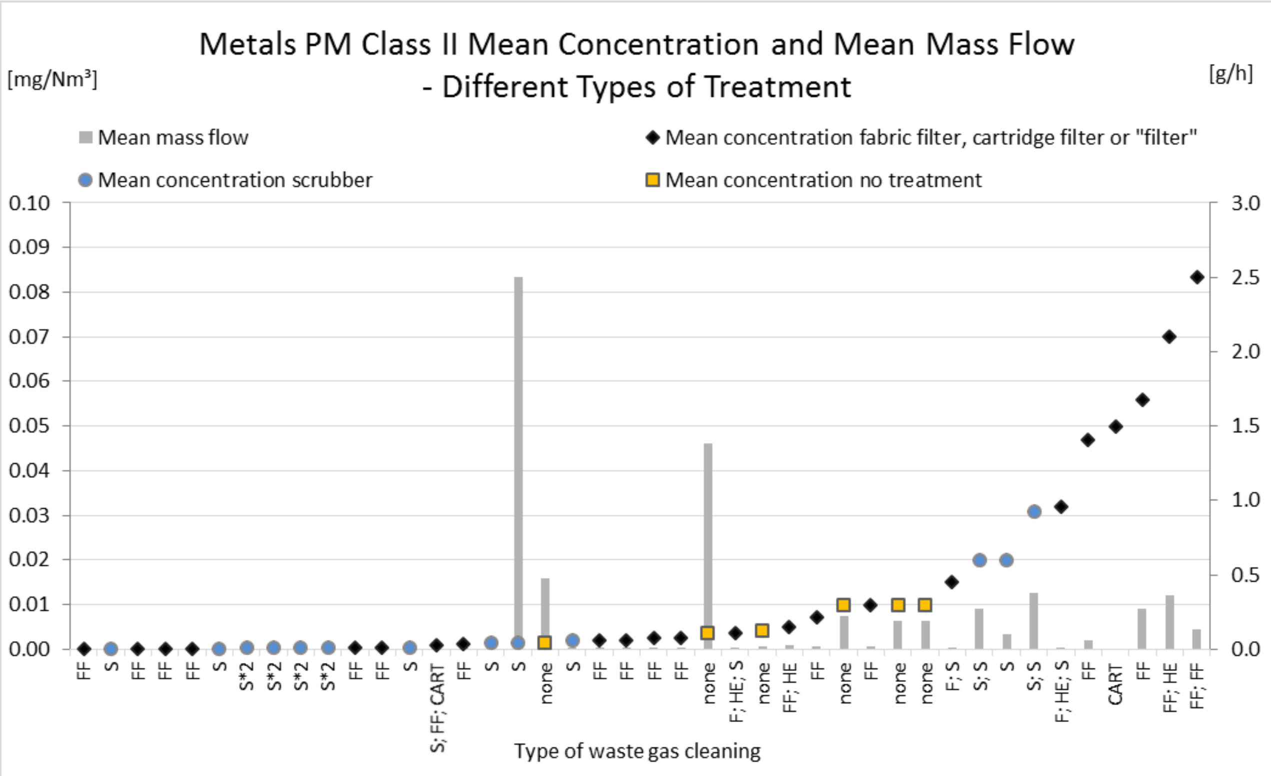


(Ökopol 2016)

26.5 Metals concentration PM Class II, mass flow and related waste gas treatment

Figure 125 shows concentration and mass flow (bars) of metals PM Class II (lead, cobalt, nickel, selenium, telluric, 42 data) from installations with fabric filter, cartridge filter or “filter” (assumed to be fabric filters) (black rhombus), scrubbers (blue dots) or no treatment (orange squares). Data is sorted by increasing mean concentration. For a detailed list of data see Annex 50.

Figure 125: Metals PM Class II mean concentration, mean mass flow and treatment system



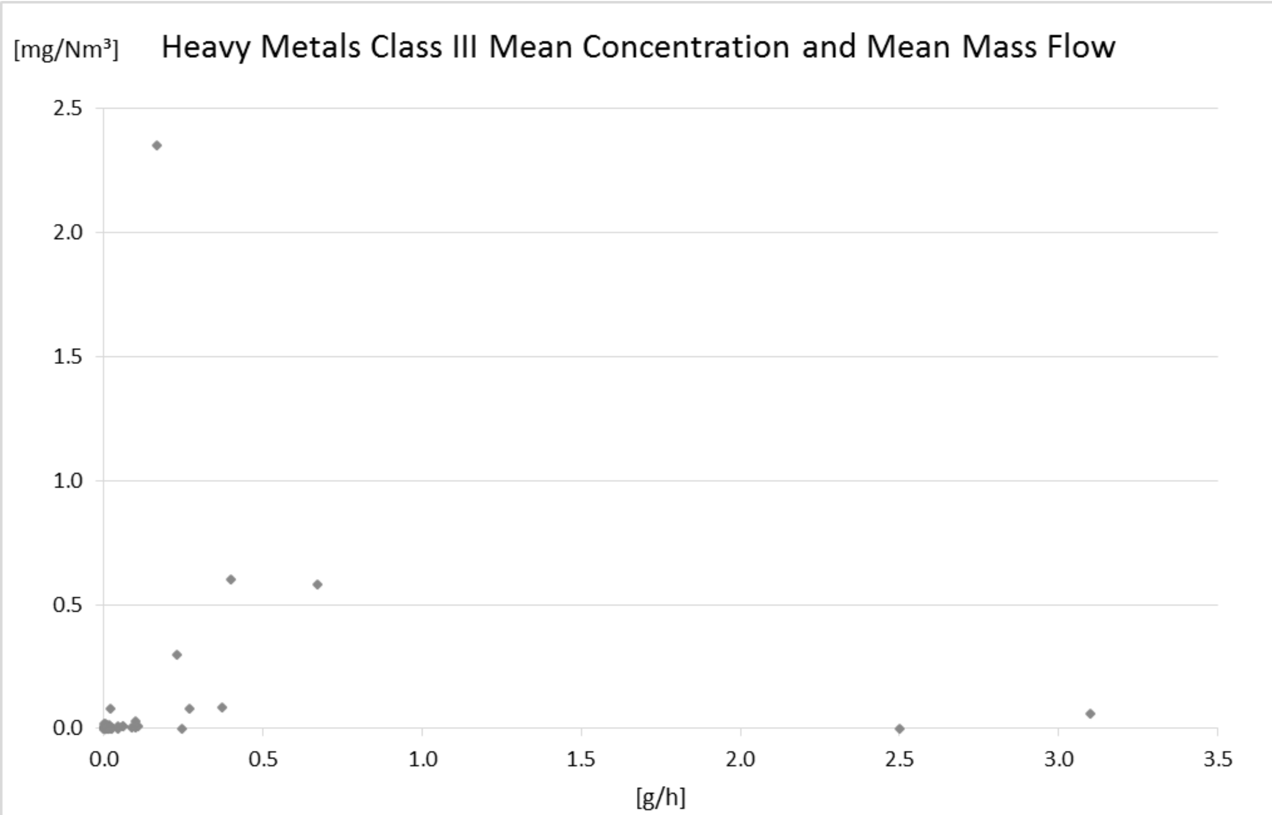
(Ökopol 2016)

26.6 Metals concentration and mass flow PM Class III (Sb, Cr, Cu, Mn, Sn, V data)

Figure 126 shows all mean concentrations of metals of PM Class III (antimony, chromium, copper, manganese, tin, vanadium, 49 data) and the related mass flow. For all data, the mass flow has been reported. For a detailed list of data see Annex 50.

Data show that mean concentrations of metals of PM Class III are generally below 0.5 mg/Nm³ (84 % of data). Where mean concentrations are higher, a mean mass flow of 1.0 g/h is not exceeded.

Figure 126: Metals PM Class III (Cr, Co, Mn, Sb, Sn, V) mean concentration and mean mass flow

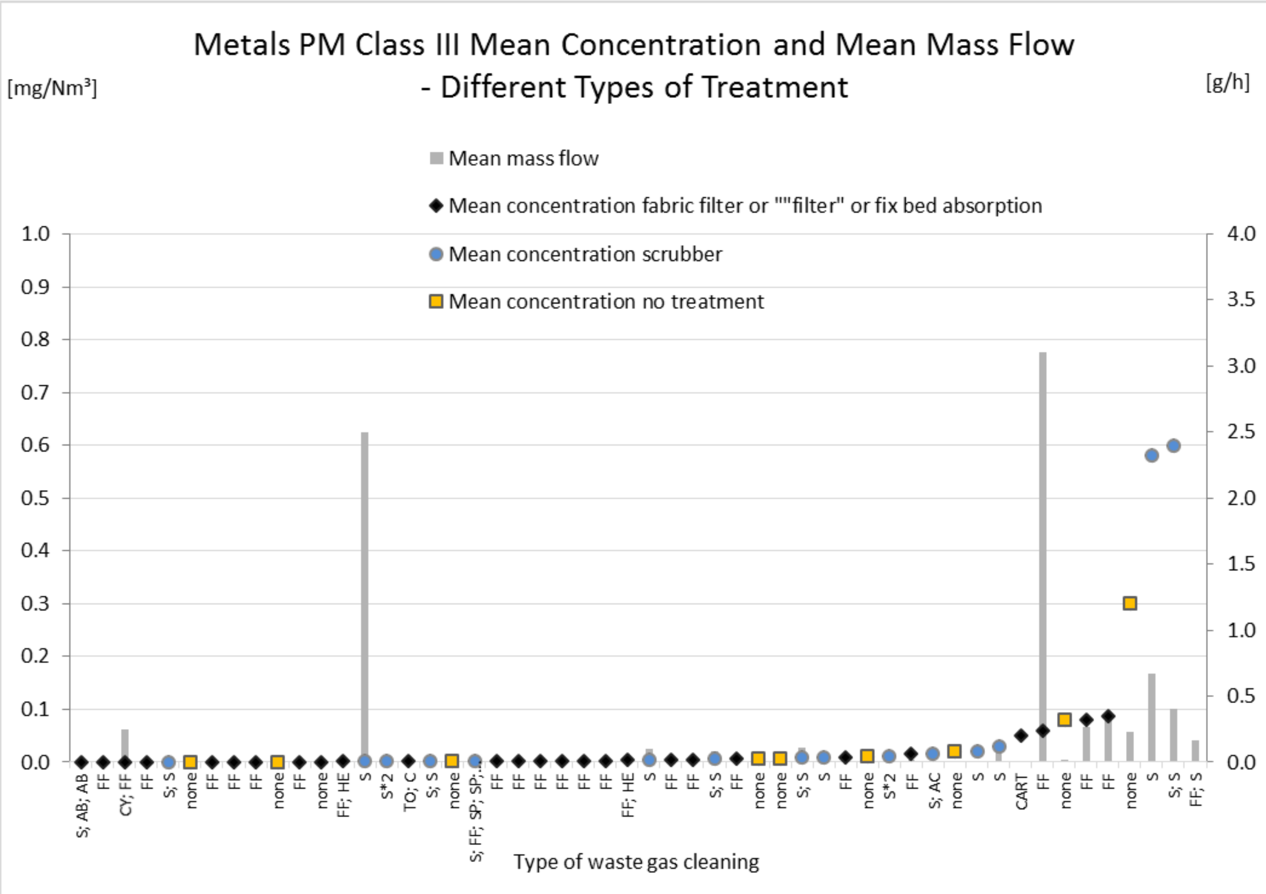


(Ökopol 2016)

26.7 Metals concentration PM Class III, mass flow and related waste gas treatment

Figure 127 shows concentration and mass flow (bars) of metals PM Class III (antimony, chromium, copper, manganese, vanadium, tin, 52 data) from installations with fabric filter, cartridge filter or "filter" (assumed to be fabric filters) (black rhombus), scrubbers (blue dots) or no treatment (orange squares). Data is sorted by increasing concentration values. For a detailed list of data see Annex 50.

Figure 127: Metals PM Class III mean concentration, mean mass flow and treatment system



(Ökopol 2016)

26.8 Conclusions for metals

Data assessment of metals shows:

- Mean concentrations of mercury (PM Class I) are generally below 15 µg/Nm³; where mean concentration values are higher, mercury emissions have mean mass flows below 0.25 g/h.
- Mean concentrations of metals of PM Class II are generally below 0.01 mg/Nm³; where mean concentrations are higher, a mean mass flow of 0.5 g/h is not exceeded.
- Mean concentrations of metals of PM Class III are generally below 0.5 mg/Nm³; where mean concentrations are higher, a mean mass flow of 1.0 g/h is not exceeded.

27 Other data (other metals, other organic CMR, HCN, amino organic compounds, CO)

Other data measured and reported from chemical installations, not discussed before because of low relevance or low number of measurement data, can be found in the Annex:

- Data of other metals, not discussed before (see Annex 51),
- Data of other organic CMR substances, not discussed before (see Annex 52),
- Data of hydrogen cyanide and amino organic compounds (see Annex 53),
- Data of carbon monoxide (see Annex 54).

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Annex 1 – Measured parameters and risk catagories

Table 21 shows the parameters covered by the data assessment as well as the number of measurements of each parameter.

Table 22 and 23 show organic compounds with similar risk classification. (TA Luft 2002)

The first group of parameters (Table 22, "OC Class I") is associated with higher risks than the second group of parameters (Table 23, "OC Class II").

Table 21: Measured substances

Substance	Number of measurements
Acetaldehyde	4
Acetaldehyde, crotonaldeyhde, methanol	2
Acetic anhydride	1
Acetone	2
Acetone, 2-propanol	1
Acetic acid	44
Acrylonitril	11
Aminoethylethanolamine (AEEA)	1
Allyl glycide ether (AGE)	2
Amines	4
Ammonia	78
Aniline	1
Antimony	1
Arsenic and arsenic compounds	1
Arsenic and copper	1
Benz(a)pyrene	1
Benzene	18
Benzene sulfonyl chloride	1
Benzene, dichloroethylene	1
Benzene, trichloroethylene	1
Benzyl chloride	2
Bisphenol A	3
Butyl acrylate	3
Butyl chloride, tert.	1
Cadmium	2
Carbon disulphide	3
Carbo platinum	5
Carbon monoxide	121
Chlorine	41
Chlorobenzene	1

Substance	Number of measurements
Chloroethane	1
Chloroform	1
Chloromethane	22
Chromium	14
Chromium (VI)	6
Copper	15
m-,p-Dichloro benzene	2
m-Dichloro benzene	1
Dichloroethane	10
cis 1,2-Dichloroethene	2
Dichloromethane	4
Dichloromethane, tri ethylamine, N,N-dimethylacetamide, acetic acid	1
Diethanolamine (DEA)	1
Diethylenetriamine (DETA)	1
3,4 Dihydroxy-5-nitrobenzaldehyde (DHNB)	1
Dimethylacetamide	1
Bis-(N,N-Dimethyl amino ethyl)-ether	4
Dimethylaminopropylamine (DMAPA)	1
Dimethyl ether	5
1,2-Dimethylimidazol	4
N,N-Dimethyl benzylamine	4
Dimethyl formamide	6
Dimethyl sulphate	3
Dimethyl sulphide	2
Dioxane	1
Dioxins and furans (PCDD/F)	30
Dust	682
Epichlorohydrine	2
Endocrine disrupting chemicals (EDC)	8
Ethanol	2
Ethanolamine	1
Ethyl acrylate	4
Ethylene	3
Ethylene diamine	1
Ethylene oxide	31
Formamide	1
Formic acid	6

Substance	Number of measurements
Formaldehyde	34
Glycerine	1
Glyoxal	2
Hexane	2
Hydrazine	6
Hydrogen bromide	9
Hydrogen chloride	177
Hydrogen cyanide	8
Hydrogen fluoride	41
Hydrogen sulphide	2
1,3-bis (2-isocyanatopropan-2-yl) benzene (TMXDI)	1
Isopropanol	6
Isopropyl chloride	1
Kresol	8
Lead and lead compounds	5
Lead, cobalt, nickel, selenic, telluric	1
Maleic acid dimethyl ester	1
Maleic anhydride	2
Manganese	5
Methylene diphenyl diisocyanate (MDI)	1
Mercury	11
Methacrylic acid	1
Methanol	80
Methanol, formaldehyde	1
Methanol, toluene	2
Methanol, toluene, 1,3-dichloro benzene, 1,4-dichloro benzene, trifluoroethanol	1
Methanol, toluene, acetic acid	1
Methyl acrylate	4
Methyl chloride	1
Methyl isobutyl ketone	1
Mono ethanolamine (MEA)	1
Mono-isopropylamine (MIPA)	1
Morphine	5
Nickel	24
Nitrogen oxide	211
p-Chloroaniline	4
p-Dichlorobenzene	1

Substance	Number of measurements
Phenol	7
Phenol, kresol, formaldehyde	1
Phenol, o,m,p-Kresol, dimethyl phenol, formaldehyde	2
o-Phenylene diamine	1
Phosphoric acid	2
p-Kresidine	2
p-Nitro chlorobenzene	2
1,2 - Propandiol	1
Propylene oxide	24
Ruthenium, manganese, chromium, antimony, copper	1
Siloxane	2
Solvesso 100	1
Solvesso 200 ND	2
Sulphur dioxide	92
Tetrachloroethene	1
Tetraethoxysilane	1
Tin	5
TOC	437
Toluene	26
Toluene -2,4-diisocyanate	18
Trichloroethene	2
Trichloromethane	2
Triethylamine	3
1,3,5 - Trioxane	1
Vinyl chloride	11
Xylene	5
Xylene (o,m,p), ethylbenzene	1
Xylene, 1,2-dichlorobenzene	1
Zinc	3

Table 22: Organic compounds with increased risk potential (OC Class I)

Substance
Acetaldehyde 75–07–0
Acetamide 60–35–5
Acetamide, N-phenyl– 103–84–4
Acetic acid anhydride 108–24–7
Acetic acid ethenyl ester 108–05–4
Acetic acid, chloro- 79–11–8

Substance
Acetic acid, chloro-, methyl ester 96–34–4
(Acetic acid, methoxy- 625–45–6) **
Acetic acid, trichloro– 76–03–9
Acrylic acid 79–10–7
Alkyl-lead compounds
Allyl chloride 107–05–1
4-Amino-2-nitrophenol 119–34–6
Aniline 62–53–3
Aniline, N-methyl- 100–61–8
Benzenamine, 2,4-dimethyl– 95–68–1
Benzenamine, 2-methyl-5-nitro- 99–55–8
Benzenamine, 4-methoxy- 104–94–9
Benzenamine, 5-chloro-2-methyl- 95–79–4
Benzenamine, N,N-dimethyl- 121–69–7
Benzene, (dichloromethyl)- 98–87–3
Benzene, 1,1'-methylenebis[4-isocyanato- 101–68–8
Benzene, 1,2,4,5-tetrachloro– 95–94–3
Benzene, 1-chloro-2-nitro 88–73–3
Benzene, 1-chloro-4-nitro- 100–00–5
Benzene, 1-methyl-3-nitro– 99–08–1
Benzene, 1-methyl-4-nitro– 99–99–0
Benzene, 2,4-dichloro-1-methyl- 95–73–8
Benzene, nitro- 98–95–3
1,2-Benzenediol (Pyrocatechin) 120–80–9
Benzenesulfonyl chloride 98–09–9
1,2,4-Benzenetricarboxylic acid 528–44–9
p-Benzoquinone 106–51–4
Benzoyl chloride 98–88–4
Benzoyl peroxide 94–36–0
Biphenyl (Diphenyl) 92–52–4
(Bis(2-ethylhexyl)phthalate 117–81–7) **
N,N-Bis-(3-aminopropyl)-methylamine 105–83–9
1,3-Butadiene, 1,1,2,3,4,4-hexachloro– 87–68–3
1-Butanamine, 109–73–9
1-Butanethiol 109–79–5
2-Butenal (Crotonaldehyde) 123–73–9
Butylamine, iso– 78–81–9
2-Butyne-1,4-diol 110–65–6

Substance
Camphor 76–22–2
Caprolactam 105–60–2
Carbamic chloride, diethyl- 88–10–8
Carbon tetrachloride 56–23–5
Carbonyl sulfide 463–58–1
(2-Chloro-1,3-butadiene (Chloroprene) 126–99–8) **
Chloroacetic acid isopropyl ester 105–48–6
Chloroform (Trichloromethane) 67–66–3
Chloromethane 74–87–3
Chloropicrin (Trichloronitromethane) 76–06–2
Cresole 1319–77–3
2-Cyano-2-propenoic acid, methyl ester (Mecrylate) 137–05–3
2-Cyclohexen-1-one, 3,5,5-trimethyl– 78–59–1
(3,3'-Diamino-benzidine 91–95–2) **
Diaminoethane (Ethylenediamine) 107–15–3
Dichlorophenols
Diglycidyl ether 2238–07–5
(Di-n-butyltindichloride 683–18–1) **
Dinitronaphthalene (all isomers) 27478–34–8
1,4-Dioxane 123–91–1
Diphenyl ether 101–84–8
Diphenylamine 122–39–4
Diphenylmethane–2,4´–Diisocyanate 5873–54–1
Ethanamine, N-ethyl- 109–89–7
Ethane, 1,1,2,2-tetrachloro– 79–34–5
Ethane, 1,1,2-trichloro– 79–00–5
Ethane, 1,1-dichloro-1-nitro- 594–72–9
Ethane, hexachloro- 67–72–1
Ethane, pentachloro- 76–01–7
Ethanedial (Glyoxal) 107–22–2
1,2-Ethanediamine, N-(2-aminoethyl)- 111–40–0
1,2-Ethanediol, dinitrate 628–96–6
Ethanethiol (Ethyl mercaptan) 75–08–1
Ethanol, 2-chloro- 107–07–3
Ethanolamine 141–43–5
Ethene, 1,1-dichloro- 75–35–4
Ethene, 1,1-difluoro- (Genetron 1132a) 75–38–7
(2-Ethoxyethyl acetate 111–15–9) **

Substance
Ethyl chloride 75–00–3
Ethyl chloroacetate 105–39–5
Ethylamine 75–04–7
Ethylene 74–85–1
Formaldehyde 50–00–0
(Formamide 75–12–7) **
Formic acid 64–18–6
2-Furancarboxaldehyde (Furfural) 98–01–1
2,5-Furandione 108–31–6
2-Furanmethanamine 617–89–0
Glutaraldehyde (1,5-Pentandial) 111–30–8
Hexahydrophthalic Anhydride 85–42–7
1,6-Hexamethylene diisocyanate 822–06–0
1,6-Hexanediamine 124–09–4
Hexanoic acid, 2-ethyl- 149–57–5
2-Hexanone 591–78–6
(Hydrazine, phenyl- 100–63–0) **
Hydroquinone (1,4-Benzenediol) 123–31–9
(2-Imidazolidinethione 96–45–7) **
Isophorone diisocyanate 4098–71–9
Ketene 463–51–4
Lead acetate (monobasic) 1335–32–6
Methanamine, N-methyl- 124–40–3
Methane, isocyanato- 624–83–9
Methane, tribromo– 75–25–2
Methanethiol (Methyl mercaptan) 74–93–1
Methyl bromide 74–83–9
Methyl iodide 74–88–4
4-Methyl-3-oxa-1-pentanol 109–59–1
2-Methyl-m-phenylenediamine 823–40–5
N-Methyl-N,2,4,6-tetranitroaniline (tetryl) 479–45–8
Methylamine 74–89–5
Methylene chloride 75–09–2
4,4'-Methylenebis(2-methylcyclohexylamine) 6864–37–5
Montanic acid waxes, Zn–salts 73138–49–5
Morpholine 110–91–8
1-Naphthalenamine 134–32–7
Naphthalene, 1,5-diisocyanato- 3173–72–6

Substance
1,5-Naphthalenediamine 2243–62–1
2-Naphthyl phenyl amine 135–88–6
2-Nitro–p–phenylenediamine,2 5307–14–2
m-Nitroaniline 99–09–2
o-Nitroaniline 88–74–4
p-Nitroaniline 100–01–6
Nitrocresols
Nitrophenols
Nitropyrenes 5522–43–0
Nitrotoluene (all isomers) 1321–12–6
(Octamethylcyclotetrasiloxane) *
Oxalic acid 144–62–7
Pentachloronaphthalene 1321–64–8
N,N,N',N'',N''- Pentamethyldiethylenetriamine 3030–47–5
Phenol 108–95–2
Phenol, 2,4,5-trichloro– 95–95–4
Phenol, p-tert-butyl 98–54–4
Phenyl–1–(p–tolyl)–3–dimethylaminopropane,1– 5632–44–0
Phthalic anhydride 85–44–9
Phthalonitrile 91–15–6
Piperazine 110–85–0
2-Propanamine, 2-methyl- 75–64–9
Propane, 1,2-dichloro- 78–87–5
(Propane, 1-bromo- 106–94–5) **
1,2-Propanediol, dinitrate 6423–43–4
1,2,3-Propanetriol, trinitrate 55–63–0
Propanoic acid, 2,2-dichloro- 75–99–0
2-Propenal (Acrolein, Acrylaldehyde) 107–02–8
1-Propene, 3-chloro-2-methyl- 563–47–3
2-Propenoic acid, butyl ester 141–32–2
2-Propenoic acid, ethyl ester (Ethyl acrylate) 140–88–5
2-Propenoic acid, methyl ester 96–33–3
2-Propyn-1-ol 107–19–7
Pyridine 110–86–1
Sodium chloroacetate 3926–62–3
Sodium Trichloroacetate 650–51–1
4-Tert-butyltoluene 98–51–1
1,1,2,2-Tetrabromoethane 79–27–6

Substance
Tetrachloroethylene 127–18–4
Thioalcohols
Thioethers
Thiourea 62–56–6
Toluene-2,4-diisocyanate-584–84–9
Toluene-2,6-diisocyanate-91–08–7
p-Toluidine 106–49–0
Trichlorobenzenes (all isomers) 12002–48–1
(Trichloroethylene 79–01–6) **
Trichloronaphtalene 1321–65–9
Trichlorophenols
Tricresyl phosphate (ooo,oom,oop,omm,omp,opp) 78–30–8
Triethylamine 121–44–8
Trimellitic anhydride 552–30–7
Tri-n-butylphosphate 126–73–8
2,4,7-Trinitrofluorenone 129–79–3
Trinitrotoluene (TNT) 118–96–7
N-Vinylpyrrolidone 88–12–0
Xylenols (except for 2,4–Xylenol) 1300–71–6

* Incorporation into Class I proposed by the Ministry of Environment (TA Luft 2016)
** In future deleted in TA Luft becaus classified as CMR according to consolidated version of CLP Regulation (2008)

(TA Luft 2002)

Table 23: Organic compounds with elevated risk potential (OC Class II)

Substance
1-Bromo-3-chloropropane *
1,1-Dichloroethane
1,2-Dichloroethylene, cis and trans
Ethanolic acid
Methyl formiate
Nitroethane
Nitromethane
Octamethylcyclotetrasiloxane *
1,1,1-Trichloroethane
1,3,5-Trioxane *

* Incoporation into Class I proposed by the Ministry of Environment (TA Luft 2016)

(TA Luft 2002)

Annex 2 – Chemical Industry Processes

Chemical installations in Germany are permitted according to the type of process and the related number in the Ordinance “4. BImSchV” (2013). Table 24 indicates the type of process according to the numbering system valid from May 2013.

Note that chemical installations according to no. 4.7 of 4. BImSchV (production of carbon and graphite) respectively IED Annex I no. 6.8 are covered by the BAT Reference Document for the non-ferrous metal industry. The reason is explained in the BREF: “because of the similarity of part of the process to the production of anodes at some aluminium smelters as an integral part of the production process”. (NFM BREF 2014)

Therefore, measurements from the production of carbon and graphite were not assessed in the study.

Table 24: Chemical industry activities under the scope of Germany’s 4. BImSchV (2013)

#	Description (German)	Description (English)
4.	Chemische Erzeugnisse, Arzneimittel, Mineralölraffination und Weiterverarbeitung	Chemical products, pharmaceuticals, mineral oil refining and further processing
4.1	Anlagen zur Herstellung von Stoffen oder Stoffgruppen durch chemische Umwandlung in industriellem Umfang, ausgenommen Anlagen zur Erzeugung oder Spaltung von Kernbrennstoffen oder zur Aufarbeitung bestrahlter Kernbrennstoffe, zur Herstellung von:	Installations for the production of substances or groups of substances by chemical transformation on industrial scale, excluding installations for the production or fission of nuclear fuels or for the reprocessing of spent nuclear fuels, especially for the production of:
4.1.1	Kohlenwasserstoffen (lineare oder ringförmige, gesättigte oder ungesättigte, aliphatische oder aromatische),	hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic),
4.1.2	sauerstoffhaltigen Kohlenwasserstoffen wie Alkohole, Aldehyde, Ketone, Carbonsäuren, Ester, Acetate, Ether, Peroxide, Epoxide,	oxygen-containing hydrocarbons, such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxides,
4.1.3	schwefelhaltigen Kohlenwasserstoffen,	sulphurous hydrocarbons,
4.1.4	stickstoffhaltigen Kohlenwasserstoffen wie Amine, Amide, Nitroso-, Nitro- oder Nitratverbindungen, Nitrile, Cyanate, Isocyanate,	nitrogenous hydrocarbons, such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates,
4.1.5	phosphorhaltigen Kohlenwasserstoffen	phosphorouscontaining hydrocarbons,
4.1.6	halogenhaltigen Kohlenwasserstoffen	halogen-containing hydrocarbons,
4.1.7	metallorganischen Verbindungen,	organometallic compounds,
4.1.8	Kunststoffen (Kunstharzen, Polymeren, Chemiefasern, Fasern auf Zellstoffbasis),	basic plastic materials (synthetic resins, polymers, man-made fibres, fibres on basis of cellulose)
4.1.9	synthetischen Kautschuken,	synthetic rubbers,
4.1.10	Farbstoffen und Pigmenten sowie von Ausgangsstoffen für Farben und Anstrichmittel,	dyestuffs and pigments as well as intermediates for dyes and paint materials,
4.1.11	Tensiden,	surfactants,

#	Description (German)	Description (English)
4.1.12	Gasen wie Ammoniak, Chlor und Chlorwasserstoff, Fluor und Fluorwasserstoff, Kohlenstoffoxiden, Schwefelverbindungen, Stickstoffoxiden, Wasserstoff, Schwefeldioxid, Phosgen,	gases, such as ammonia, chlorine and hydrogen chloride, fluorine and hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, phosgene,
4.1.13	Säuren wie Chromsäure, Flusssäure, Phosphorsäure, Salpetersäure, Salzsäure, Schwefelsäure, Oleum, schwefelige Säuren,	acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids,
4.1.14	Basen wie Ammoniumhydroxid, Kaliumhydroxid, Natriumhydroxid,	bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide,
4.1.15	Salzen wie Ammoniumchlorid, Kaliumchlorat, Kaliumkarbonat, Natriumkarbonat Perborat, Silbernitrat,	salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate,
4.1.16	Nichtmetallen, Metalloxiden oder sonstigen anorganischen Verbindungen wie Kalziumkarbid, Silizium, Siliziumkarbid, anorganische Peroxide, Schwefel,	non-metals, metal oxides or other inorganic compounds, such as calcium carbide, silicon, silicon carbide, inorganic peroxides, sulphur,
4.1.17	phosphor-, stickstoff- oder kaliumhaltigen Düngemitteln (Einnährstoff- oder Mehrnährstoffdünger),	phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers),
4.1.18	Ausgangsstoffen für Pflanzenschutzmittel und von Bioziden,	basic plant health products and of biocides,
4.1.19	Arzneimitteln einschließlich Zwischenerzeugnisse,	pharmaceutical products (active substances for pharmaceuticals),
4.1.20	Herstellung von Explosivstoffen;	explosives;
4.1.21	von Stoffen oder Stoffgruppen, die keiner oder mehreren der Nummern 4.1.1 bis 4.1.20 entsprechen	
4.1.22	Herstellung von - organischen Grundchemikalien, - anorganischen Grundchemikalien, - phosphor-, stickstoff- oder kaliumhaltigen Düngemitteln (Einnährstoff oder Mehrnährstoff), - Ausgangsstoffen für Pflanzenschutzmittel und Bioziden, - Grundarzneimitteln unter Verwendung eines chemischen oder biologischen Verfahrens oder - Explosivstoffen im Verbund, bei denen sich mehrere Einheiten nebeneinander befinden und in funktioneller Hinsicht miteinander verbunden sind (integrierte chemische Anlagen);	
4.6	Anlagen zur Herstellung von Ruß	Installations for the production of carbon black

#	Description (German)	Description (English)
4.7 (*)	Anlagen zur Herstellung von Kohlenstoff (Hartbrandkohle) oder Elektrographit durch Brennen oder Graphitieren, zum Beispiel für Elektroden, Stromabnehmer oder Apparateteile	Installations for the production of carbon (hard-burnt coal) or electrographite by incineration or graphitizing, e.g. for electrodes, brushes or apparatus parts

(*) Not covered in this study because as covered in the BAT Reference Document for Non-Ferrous Metals Production (4. BImSchV 2013)

Annex 3 – Dust data – Fabric Filter or "Filter"

Table 25 shows the mean concentration values of dust and the related mean mass flow associated fabric filters or with systems named as "filter" (assumed to be fabric filters). The values are sorted by increasing mean concentration.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 25: Dust emissions from sources with fabric filter, "filter", cartridge filter or membrane filter

#	Type of installation	Waste gas system including fabric filter, "filter", cartridge filter or membrane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.7	S	FF	VDI 2066	187	0.13	0.0007	0.0007	mg/m³
2	4.1.15	S	FF	VDI 2066/1; EN 14284	680	0.01	0.015	<0.03	mg/m³
3	4.1.15	S	FF	EN 13284; VDI 2066 Bl. 1	2 090	0.04	0.02	<0.04	mg/m³
4	4.1	S	F*2	VDI 2066/1	1 150	0.035	0.03	<0.06	mg/m³
5	4.1.16	S	FF	EN 13284; VDI 2066 Bl. 1	8 240	0.21	0.03	0.03	mg/m³
6	4.1	S	FF	VDI 2066/1	2 800	0.1	0.035	<0.07	mg/m³
7	4.1	S	F	VDI 2066/1	510	0.02	0.04	<0.08	mg/m³
8	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 620	0.1	0.05	<0.1	mg/m³
9	4.1	S	FF	VDI 2066/1	1 770	0.05	0.05	<0.1	mg/m³
10	4.1.2	S	FF	VDI 2066 Bl. 1	323	0.5	0.05	<0.1	mg/m³
11	4.1.10	S	FF	VDI 2066	907	0.05	0.05	<0.1	mg/m³
12	4.1.16	S	FF	EN 13284; VDI 2066 Bl. 1	800	0.04	0.05	0.05	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
13	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	201	0.01	0.05	<0.1	mg/m³
14	4.1.15	S	FF	VDI 2066/1; EN 14284	1 070	0.07	0.06	0.06	mg/m³
15	4.1.16	S	FF	EN 13284; VDI 2066 Bl. 1	830	0.05	0.06	0.06	mg/m³
16	4.1.16	S	FF	VDI 2066/1	700	0.04	0.06	0.06	mg/m³
17	4.1.16	S	FF	VDI 2066/1	3 530	0.27	0.08	0.08	mg/m³
18	4.1.16	S	FF	VDI 2066/1	650	0.05	0.08	0.08	mg/m³
19	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	4 200	0.5	0.1	<0.2	mg/m³
20	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	7 450	1	0.1	<0.2	mg/m³
21	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	26 010	3	0.1	<0.2	mg/m³
22	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 580	0.2	0.1	<0.2	mg/m³
23	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	20 460	2	0.1	<0.2	mg/m³
24	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	2 990	0.5	0.1	<0.2	mg/m³
25	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	6 400	1	0.1	<0.2	mg/m³
26	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	2 830	1	0.1	<0.2	mg/m³
27	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	16 790	2	0.1	<0.2	mg/m³
28	4.1 / 4.2	S	F	EN 13284-1:2002, VDI 2066 Bl. 1:2006	1 080	0.1	0.1	<0.2	mg/m³
29	4.1 / 4.2	S	F	EN 13284-1:2002, VDI 2066 Bl. 1:2006	310	0.05	0.1	<0.2	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original	Unit
30	4.1 / 4.2	S	F	EN 13284-1:2002, VDI 2066 Bl. 1:2006	360	0.05	0.1	<0.2	mg/m³
31	4.1.15	S	CY; FF	VDI 2066 Bl.1	1 530	0.2	0.1	<0.2	mg/m³
32	4.1	S	MF	EN 13284-1, VDI 2066 Bl.1	7 112	1	0.1	<0.2	mg/m³
33	4.1.8	S	FF	VDI 2066 Bl. 1	8 790	1	0.1	<0.2	mg/m³
34	4.1.8	S	FF	VDI 2066 Bl. 1	6 320	0.5	0.1	<0.2	mg/m³
35	4.1.8	S	FF	VDI 2066 Bl. 1	697	0.1	0.1	<0.2	mg/m³
36	4.1.8	S	FF	VDI 2066 Bl. 1	752	0.1	0.1	<0.2	mg/m³
37	4.1.8	S	FF	VDI 2066 Bl. 1	6 010	0.5	0.1	<0.2	mg/m³
38	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	833	-	0.1	<0.2	mg/m³
39	4.1.10	S	FF	VDI 2066	364	0.05	0.1	<0.2	mg/m³
40	4.1.15	2	FF	VDI 2066 Bl.1	1 910	0.25	0.1	<0.2	mg/m³
41	4.1.15	S	FF	VDI 2066	<686	75	0.1	<0.2	mg/m³
42	4.1.16	S	FF	VDI 2066 Bl.1	2 350	0.5	0.1	<0.2	mg/m³
43	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	1 170	0.15	0.1	<0.2	mg/m³
44	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	1 614	0.15	0.1	<0.2	mg/m³
45	4.1.18	S	F	EN 13284-1, VDI 2066 Bl.1	480	0.05	0.1	<0.2	mg/m³
46	4.1.21	S	F	EN 13284-1, VDI 2066 Bl.1	1 360	0.15	0.1	<0.2	mg/m³
47	4.1	S	FF	VDI 2066 Bl.1	245	0.025	0.1	<0.2	mg/m³
48	4.1	S	FF	VDI 2066 Bl.1	3 408	0.35	0.1	<0.2	mg/m³
49	4.1	S	FF	EN 13284, VDI 2066/1	4 620	0.3	0.1	0.1	mg/m³
50	4.2	S	FF	VDI 2066 Bl.1	2 880	0.25	0.1	<0.2	mg/m³
51	4.1.18	S	FF	EN 13284-1, VDI 2066 Bl.1	316	0.05	0.1	<0.2	mg/m³
52	4.1	S	FF	VDI 2066/1; EN 13284	1 293	0.03	0.11	0.11	mg/m³
53	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	1 300	0.15	0.115	<0.23	mg/m³
54	4.1.15	S	CY; FF	VDI 2066	2 466	0.295	0.12	<0.24	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
55	4.1.10	S	FF	VDI 2066	325	0.05	0.12	<0.24	mg/m³
56	4.1.15	S	FF	VDI 2066	53	0.005	0.125	<0.25	mg/m³
57	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	1 240	0.15	0.13	<0.26	mg/m³
58	4.1.15	S	FF	VDI 2066 Bl.1	1 440	0.2	0.133	<0.266	mg/m³
59	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	520	0.065	0.135	<0.27	mg/m³
60	4.1.8	S	FF	VDI 2066 Bl. 1	6 970	1	0.135	<0.27	mg/m³
61	4.1.10	S	F	VDI 2066	724	0.1	0.135	<0.27	mg/m³
62	4.1.15	S	FF	VDI 2066	600	0.1	0.14	<0.28	mg/m³
63	4.1	C	S; FF; CART	EN 13284-1:2002, VDI 2066 BL.1:2006	9 960	1.4	0.14	<0.28	mg/m³
64	4.1.8	S	FF	VDI 2066 Bl. 1	3 077	0.5	0.145	<0.29	mg/m³
65	4.1.10	S	FF	VDI 2066	1 981	0.3	0.145	<0.29	mg/m³
66	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 630	0.2	0.15	<0.3	mg/m³
67	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	780	0.1	0.15	<0.3	mg/m³
68	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	390	0.05	0.15	<0.3	mg/m³
69	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	180	0.025	0.15	<0.3	mg/m³
70	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	280	0.05	0.15	<0.3	mg/m³
71	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 310	0.15	0.15	<0.3	mg/m³
72	4.1.10	S	F	VDI 2066	4 555	0.5	0.15	<0.3	mg/m³
73	4.1	S	FF	VDI 2066 Bl.1, EN 13284-1	1 540	0.25	0.15	<0.3	mg/m³
74	4.1	S	FF	VDI 2066 Bl. 1,EN 13284-1	1 410	0.2	0.15	<0.3	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
75	4.1.8	S	FF	VDI 2066 Bl. 1; EN 13284-1	1 790	0.24	0.15	<0.3	mg/m³
76	4.1.8	S	FF	VDI 2066 Bl. 1	41 500	5	0.15	<0.3	mg/m³
77	4.1.8	S	FF	VDI 2066 Bl. 1	56 400	7.5	0.15	<0.3	mg/m³
78	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	919	0.15	0.15	<0.3	mg/m³
79	4.1.10	S	FF	VDI 2066	14 922	2.5	0.15	<0.3	mg/m³
80	4.1.10	S	FF	VDI 2066	7 433	1.5	0.15	<0.3	mg/m³
81	4.1.10	S	FF	VDI 2066	1 052	0.15	0.15	<0.3	mg/m³
82	4.1.10	S	FF	VDI 2066	1 523	0.25	0.15	<0.3	mg/m³
83	4.1.10	S	FF	VDI 2066	1 480	0.25	0.15	<0.3	mg/m³
84	4.1.10	S	FF	VDI 2066 Bl. 1	1 700	0.5	0.15	<0.3	mg/m³
85	4.1.10	S	FF	VDI 2066 Bl. 1	800	0.125	0.15	<0.3	mg/m³
86	4.1.10	S	FF	VDI 2066 Bl. 1	2 100	0.5	0.15	<0.3	mg/m³
87	4.1.10	S	FF	VDI 2066 Bl. 1	5 900	1	0.15	<0.3	mg/m³
88	4.1.10	S	FF	VDI 2066 Bl. 1	1 900	0.5	0.15	<0.3	mg/m³
89	4.1.10	S	FF	VDI 2066 Bl. 1	6 600	1	0.15	<0.3	mg/m³
90	4.1.10	S	FF	VDI 2066 Bl. 1	2 100	0.5	0.15	<0.3	mg/m³
91	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	EN 13284-1, VDI 2066 Bl.1	11	0.0015	0.15	<0.3	mg/m³
92	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	EN 13284-1, VDI 2066 Bl.1	5 020	1	0.15	<0.3	mg/m³
93	4.1.10	S	FF	VDI 2066, EN 13284-1	1 160	0.15	0.15	<0.3	mg/m³
94	4.1.10	S	FF	VDI 2066 Bl. 1	6 900	1	0.15	<0.3	mg/m³
95	4.1.15	S	FF	VDI 2066	113	0.0145	0.15	<0.3	mg/m³
96	4.1.15	S	FF	VDI 2066	2 061	0.3	0.15	<0.3	mg/m³
97	4.1.15	S	FF	VDI 2066	700	0.1	0.15	<0.3	mg/m³
98	4.1.16	S	FF	VDI 2066 Bl. 1	9 700	1.5	0.15	<0.3	mg/m³
99	4.1.18	S	FF	EN 13284-1, VDI 2066 Bl.1	158	0.05	0.15	<0.3	mg/m³
100	4.1.10 / 8.12.1.1	S	FF	VDI 2066 Bl. 1, EN 13284-1	3 490	0.5	0.15	<0.3	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
101	4.1.10 / 8.12.1.1	S	FF	VDI 2066 Bl. 1, EN 13284-1	4 550	0.5	0.15	<0.3	mg/m³
102	4.1	S	FF; FF	VDI 2066 Bl. 1, EN 13284-1	2 130	0.3	0.15	<0.3	mg/m³
103	4.1.10	S	FF; FF	EN 13284-1	19 600	3	0.15	<0.3	mg/m³
104	4.1.19	S	FF; S	EN 13284-1	77	0.05	0.15	<0.3	mg/m³
105	4.1.1	S	TO; FF; S; S; S; S	EN 13284-1	544	0.1	0.15	0.150	mg/m³
106	4.1.8	S	FF	VDI 2066 Bl.1	<10.3	0.0015	0.15	<0.3	mg/m³
107	4.1	S	FF	EN 13284, VDI 2066 Bl.1	2 730	0.5	0.15	<0.3	mg/m³
108	4.2	S	FF	VDI 2066 Bl.1	1 092	0.15	0.15	<0.3	mg/m³
109	4.1.19	S	FF	EN 13284-1, VDI 2066 Bl.1	757	0.115	0.15	<0.3	mg/m³
110	4.1.19	S	FF	EN 13284-1, VDI 2066 Bl.1	36	0.005	0.15	<0.3	mg/m³
111	4.1.18	C	FF	EN 13284-1, VDI 2066 Bl.1	1 420	0.2	0.15	<0.3	mg/m³
112	4.1.18	C	FF	EN 13284-1, VDI 2066 Bl.1	417	0.1	0.15	<0.3	mg/m³
113	4.1.18	S	FF	EN 13284-1, VDI 2066 Bl.1	980	0.15	0.15	<0.3	mg/m³
114	4.1.19	S	FF*2	VDI 2066 Bl.1	3 279	0.4	0.15	<0.3	mg/m³
115	4.1.18	S	FF; F	EN 13284-1, VDI 2066 Bl.1	420	0.05	0.15	<0.3	mg/m³
116	4.1	S	FF; FF	EN 13284-1, VDI 2066 Bl.1	126	0.015	0.15	<0.3	mg/m³
117	4.1.8	S	FF	VDI 2066 Bl. 1	788	0.15	0.16	<0.32	mg/m³
118	4.1.18	S	FF	EN 13284, VDI 2066/1	1 500	0.2	0.16	0.16	mg/m³
119	4.1.15	S	CY; FF	VDI 2066 Bl. 1	19 400	3.65	0.165	<0.33	mg/m³
120	4.1	S	FF	VDI 2066 Bl. 1	3 590	0.5	0.165	<0.33	mg/m³
121	4.1.8	S	FF	VDI 2066 Bl. 1	659	0.1	0.165	<0.33	mg/m³
122	4.1	C	S; CART	EN 13284-1:2002, VDI 2066 BL.1:2006	9 510	2.8	0.165	<0.33	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, “filter”, cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
123	4.1.19	S	FF	EN 13284-1, VDI 2066 Bl.1	647	0.11	0.165	<0.33	mg/m³
124	4.1.10	S	F	VDI 2066	2 625	0.45	0.17	<0.34	mg/m³
125	4.1	S	FF	VDI 2066 Bl.1	1 273	0.5	0.175	<0.35	mg/m³
126	4.1.10	S	F	VDI 2066	714	0.15	0.2	<0.4	mg/m³
127	4.1.10	S	F	VDI 2066 Bl. 1	400	0.1	0.2	<0.4	mg/m³
128	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	620	0.115	0.2	<0.4	mg/m³
129	4.1	S	FF	VDI 2066 Bl.1	2 116	0.4	0.2	0.2	mg/m³
130	4.1	S	FF	EN 13284-1, VDI 2066 Bl. 1	4 420	1	0.2	0.2	mg/m³
131	4.1	S	FF	EN 13284-1	284	0.05	0.2	<0.4	mg/m³
132	4.1	S	FF	VDI 2066/1	1 225	0.2	0.2	0.2	mg/m³
133	4.1.2	S	FF	EN 13284-1	600	0.5	0.2	0.2	mg/m³
134	4.1.8	S	FF	VDI 2066 Bl. 1	5 320	1	0.2	<0.4	mg/m³
135	4.1.10	S	FF	VDI 2066	798	0.15	0.2	<0.4	mg/m³
136	4.1.10	S	FF	VDI 2066 Bl. 1	5 400	1	0.2	<0.4	mg/m³
137	4.1.10	S	FF	VDI 2066 Bl. 1	900	0.15	0.2	<0.4	mg/m³
138	4.1.16	S	FF	EN 13284-1	7 400	1	0.2	0.200	mg/m³
139	4.1.18	S	FF	EN 13284-1, VDI 2066 Bl.1	364	0.05	0.2	<0.4	mg/m³
140	4.1.21	S	FF	EN 13284-1	12 200	-	0.2	< 0.400	mg/m³
141	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	2 300	0.5	0.2	0.2	mg/m³
142	4.1.8	S	FF	VDI 2066 Bl.1	2 200	0.5	0.2	0.2	mg/m³
143	4.1.8	C	FF	VDI 2066 Bl.1	6 856	1	0.2	<0.4	mg/m³
144	4.1.8	C	FF	VDI 2066 Bl.1	2 825	0.7	0.2	0.2	mg/m³
145		S	FF	VDI 2066 Bl.1	1 089	0.2	0.2	0.2	mg/m³
146	4.1.18	C	FF	EN 13284-1, VDI 2066 Bl.1	1 109	0.15	0.2	<0.4	mg/m³
147	4.3.	S	FF	EN 13284-1, VDI 2066 Bl.1	1 358	0.2525	0.2	<0.4	mg/m³
148	4.2.2	C	FF; FF	VDI 2066 Bl.1	3 018	0.8	0.2	0.2	mg/m³
149	4.1.10	S	FF	VDI 2066	893	0.2	0.24	0.24	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
150	4.1.15	S	FF	VDI 2066 Bl. 1; EN 13284-1	6 550	1.75	0.249	<0.498	mg/m³
151		S	F	EN 13284-1, VDI 2066 Bl. 1	1 100	0.285	0.25	<0.5	mg/m³
152	4.1	S	FF	EN 13284-1	1 370	0.5	0.25	<0.5	mg/m³
153	4.1.10	S	FF	VDI 2066 Bl. 1	1 900	0.5	0.25	<0.5	mg/m³
154	4.1.21	C	FF	VDI 2066 Bl.1	4 220	1	0.25	<0.5	mg/m³
155	4.1	S	FF*3	VDI 2066 Bl. 1	3 870	1	0.25	<0.5	mg/m³
156	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	300	0.085	0.25	<0.5	mg/m³
157	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	400	0.1	0.25	<0.5	mg/m³
158	4.1.15	S	FF	VDI 2066	2 556	0.5	0.25	<0.5	mg/m³
159	4.1	S	FF	EN 13284-1, VDI 2066 Bl.1	19	0.0065	0.25	<0.5	mg/m³
160	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	760	0	0.265	<0.53	mg/m³
161	4.1.15	S	FF	VDI 2066/1	150	0.04	0.27	0.27	mg/m³
162		S	FF	VDI 2066 Bl. 1	7 110	2	0.285	<0.57	mg/m³
163	4.1	C	F	EN 13284-1, VDI 2066 Bl. 1	2 680	1	0.3	0.3	mg/m³
164	4.1.8	S	FF	EN 13284-1	1 430	0	0.3	0.3	mg/m³
165	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	1 060	-	0.3	0.3	mg/m³
166	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	7 170	2	0.3	0.3	mg/m³
167	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	1 880	1	0.3	0.3	mg/m³
168	4.1.10	S	FF	VDI 2066	565	0.2	0.3	0.3	mg/m³
169	4.1.10	S	FF	VDI 2066 Bl. 1	700	0.2	0.3	<0.6	mg/m³
170	4.1.10	S	FF	EN 13284-1, VDI 2066 Bl.1	9 100	3	0.3	0.3	mg/m³
171	4.1.16	S	FF	EN 13284-1	6 410	2	0.3	0.3	mg/m³
172	4.1.16	S	FF	EN 13284-1	3 450	1	0.3	0.3	mg/m³
173	4.1.21	C	FF	VDI 2066 Bl.1	1 170	0.35	0.3	<0.6	mg/m³
174	4.1.21	S	FF	VDI 2066 Bl. 1	16 700	5	0.3	<0.6	mg/m³
175	4.1.8	S	SP; COX	EN 13284-1	10 860	5	0.3	0.3	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
176	4.1.8	S	FF	VDI 2066 Bl.1	333	0.1	0.3	0.3	mg/m³
177	4.1.8	C	FF	VDI 2066 Bl.1	3 177	0.9	0.3	0.3	mg/m³
178	4.2	S	FF	VDI 2066 Bl.1	1 846	0.5	0.3	0.3	mg/m³
179	4.2	S	FF	VDI 2066 Bl.1	-	0.6	0.3	0.3	mg/m³
180	4.2	S	FF	VDI 2066 Bl.1	4 027	1	0.3	0.3	mg/m³
181	4.2	S	FF	VDI 2066 Bl.1	1 268	0.36	0.3	0.3	mg/m³
182	4.1.15	S	S*2/FF	VDI 2066/1	11 158	4	0.3	0.3	mg/m³
183	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	3 920	1.3	0.33	0.33	mg/m³
184	4.1.10	S	FF	VDI 2066	6 964	2.3	0.33	0.33	mg/m³
185	4.1	S	FF	EN 13284-1	1 480	0.55	0.35	<0.7	mg/m³
186	4.1.10	S	FF	VDI 2066	36 021	10	0.35	<0.7	mg/m³
187	4.1.10	S	FF	VDI 2066 Bl. 1	300	0.1	0.35	<0.7	mg/m³
188	4.1.15	S	FF	VDI 2066/1	180	0.06	0.35	0.35	mg/m³
189	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	760	0.27	0.37	0.37	mg/m³
190	4.1.15	S	FF	VDI 2066/1	110	0.03	0.38	0.38	mg/m³
191	4.1.15	S	FF	VDI 2066/1	720	0.28	0.39	0.39	mg/m³
192	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	2 210	1	0.4	0.4	mg/m³
193	4.1.15	S	CY; FF	VDI 2066 Bl. 1	23 700	9.66	0.4	0.4	mg/m³
194	4.1.8	S	FF	EN 13284-1	1 440	1	0.4	0.4	mg/m³
195	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	670	-	0.4	0.4	mg/m³
196	4.1.10	S	FF	VDI 2066	554	0.2	0.4	0.4	mg/m³
197	4.1	C	S; FF; F	EN 13284-1, VDI 2066 Bl. 1	772	0.3	0.4	0.4	mg/m³
198	4.1.10	S	FF	VDI 2066 Bl. 1	7 900	3	0.4	0.4	mg/m³
199	4.1.13	S	FF	VDI 2066 Bl. 1	1 000	0.4	0.4	0.4	mg/m³
200	4.1.15	S	FF	VDI 2066	1 030	0.4	0.4	0.4	mg/m³
201	4.1.21	S	FF	EN 13284-1	12 300	4	0.4	0.400	mg/m³
202	4.1.21	S	FF	EN 13284-1	3 290	2	0.4	0.400	mg/m³
203	4.1.8	S	FF; S	EN 13284-1	15 820	8	0.4	0.4	mg/m³
204		S	FF	VDI 2066 Bl.1	623	0.2	0.4	0.4	mg/m³
205		S	FF	VDI 2066 Bl.1	773	0.3	0.4	0.4	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, “filter”, cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
206	4.2.2	S	FF; FF	VDI 2066 Bl.1	4 738	1.8	0.4	0.4	mg/m³
207	4.3	S	CY; FF	EN 13284-1, VDI 2066 Bl. 1	4 850	2	0.415	<0.83	mg/m³
208	4.1.15	S	CY; FF	VDI 2066 Bl.1	1 320	1.67	0.4165	<0.833	mg/m³
209	4.1	S	F; HE; S	EN 13284-1	121	0.055	0.41665	<0.833 3	mg/m³
210	4.1.15	S	F	VDI 2066	65	0.028	0.43	0.43	mg/m³
211	4.1.10	S	FF	VDI 2066	870	0.4	0.43	0.43	mg/m³
212		S	FF	VDI 2066 Bl. 1	12 100	5	0.435	<0.87	mg/m³
213		S	FF	VDI 2066 Bl. 1	44 700	19	0.435	<0.87	mg/m³
214	4.1	S	F; S	VDI 2066 Bl.1, VDI 3868 Bl.1, EN 13284	-	0.225	0.45	<0.9	mg/m³
215	4.1.8	S	CY; FF	EN 13284-1	7 190	3	0.45	<0.9	mg/m³
216	4.1	S	FF	EN 13284-1	2 500	1.165	0.455	<0.91	mg/m³
217	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	500	-	0.5	0.5	mg/m³
218	4.1.10	S	CY; FF	EN 13284-1	7 540	4	0.5	0.5	mg/m³
219	4.1	S	FF	VDI 2066 Bl. 1	4 080	2	0.5	0.5	mg/m³
220	4.1.10	S	FF	VDI 2066 Bl. 1	600	0.3	0.5	0.5	mg/m³
221	4.1.16	S	FF	VDI 2066 Bl. 1	7 100	4	0.5	0.5	mg/m³
222	4.1.16	S	FF	EN 13284-1	34 200	18	0.5	0.500	mg/m³
223	4.1	S	FF; C; C; C; C; F	EN 13284-1, VDI 2066 Bl. 1	1 710	1	0.5	0.5	mg/m³
224	4.1.8	S	FF; S	EN 13284-1	17 810	8	0.5	0.5	mg/m³
225	4.1.8	C	FF	VDI 2066 Bl.1	9 091	5	0.5	0.5	mg/m³
226	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	3 800	2	0.53	0.53	mg/m³
227	4.1.15	S	FF	VDI 2066 Bl.1	3 170	0.83	0.533	0.533	mg/m³
228	4.1.15	S	FF	VDI 2066/1; EN 14284	120	0.07	0.54	0.54	mg/m³
229	4.1.7	S	FF	VDI 2066	1 431	1	0.55	<1.1	mg/m³
230	4.1.8	S	FF; S	VDI 2066 Bl. 1	<2	1	0.56	0.56	mg/m³
231	4.1.16	S	FF; FF	EN 13284-1	1 590	1	0.566	0.566	mg/m³
232	4.1	S	F; HE; S	EN 13284-1	71	0.0335	0.5665	<1.133	mg/m³
233	4.1.8	S	F; F; AC	EN 13284/1	793	0.44937	0.56667	0.57	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, “filter”, cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m^3/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
234	4.1.15	S	CY; FF	VDI 2066 Bl.1	26 700	16	0.6	0.6	mg/m^3
235	4.1.8	C	FF	EN 13284-1, VDI 2066 Bl.1	-	0.5	0.6	0.6	mg/m^3
236	4.1.10	S	FF	VDI 2066 Bl. 1	29 100	18	0.6	0.6	mg/m^3
237	4.1.16	S	FF	VDI 2066/1	1 800	1	0.6	0.6	mg/m^3
238	4.2	S	FF	VDI 2066 Bl.1	13	0.009	0.6	0.6	mg/m^3
239		S	FF	VDI 2066 Bl.1	466	0.2	0.6	0.6	mg/m^3
240		S	FF	VDI 2066 Bl.1	586	0.3	0.6	0.6	mg/m^3
241	4.2.2	C	FF; FF	VDI 2066 Bl.1	2 066	1.3	0.6	0.6	mg/m^3
242	4.1.15	S	FF	VDI 2066/1; EN 14284	60	0.04	0.62	0.62	mg/m^3
243	4.1.16	S	FF	VDI 2066/1	960	0.6	0.62	0.62	mg/m^3
244	4.1.8	S	F; F; AC	EN 13284/1	526	0.32875	0.625	0.625	mg/m^3
245	4.1.15	S	FF	VDI 2066 Bl.1	593	0.5	0.667	0.667	mg/m^3
246	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	700	-	0.7	0.7	mg/m^3
247	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	1 180	1	0.7	0.7	mg/m^3
248	4.1.10	S	FF	VDI 2066	352	0.2	0.7	0.7	mg/m^3
249	4.1.10	S	FF	VDI 2066	484	0.3	0.7	0.7	mg/m^3
250	4.1.10	S	FF	VDI 2066, EN 13284-1	1 580	1	0.7	0.7	mg/m^3
251	4.1.15	S	FF	VDI 2066	282	0.2	0.7	<1.4	mg/m^3
252	4.1.15	S	FF	VDI 2066 Bl.1	2 760	2	0.7	0.7	mg/m^3
253	4.1.16	S	FF	VDI 2066 Bl. 1	5 500	4	0.7	0.7	mg/m^3
254	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	840	1	0.73	0.73	mg/m^3
255	4.1 / 8.3	S	F	VDI 2066 Bl.1	2 010	1.5	0.75	0.75	mg/m^3
256	4.1.16	S	S; FF	VDI 2066 Bl.1	16 600	12.5	0.75	<1.5	mg/m^3
257	4.1.8	S	FF	VDI 2066 Bl. 1	1 510	1.3	0.77	0.77	mg/m^3
258	4.1.16	S	FF	VDI 2066 Bl. 1	10 933	8.3	0.77	0.77	mg/m^3
259	4.1.21	S	FF	VDI 2066 Bl. 1	1 190	0.95	0.78	<1.56	mg/m^3
260	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	6 030	4.8	0.8	<1.6	mg/m^3

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs)		
							[mg/m³]	Original Unit	
261	4.1.8	S	FF	VDI 2066 Bl.1	1 179	1	0.8	0.8	mg/m³
262	4.1.15	S	FF	VDI 2066/1	201	0.16	0.8	0.8	mg/m³
263	4.1.15	S	FF	VDI 2066 Bl.1	2 030	1.66	0.8	0.8	mg/m³
264	4.1.21	S	FF	EN 13284-1	5 340	4	0.8	0.800	mg/m³
265		S	FF	VDI 2066 Bl. 1	2 450	2	0.8	<1.6	mg/m³
266		S	FF	VDI 2066 Bl. 1	3 510	3	0.8	<1.6	mg/m³
267	4.1.8	S	FF	VDI 2066/1	1 970	1.6	0.8	0.8	mg/m³
268	4.1.8	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	3 750	3.3	0.83	0.83	mg/m³
269	4.1.15	S	CY; FF	VDI 2066 Bl.1	5 360	4.66	0.833	0.833	mg/m³
270	4.1.15	S	FF	VDI 2066/1	200	0.18	0.89	0.89	mg/m³
271	4.1.10	S	F	VDI 2066 Bl. 1	500	0.45	0.9	<1.8	mg/m³
272	4.1.10	S	FF	VDI 2066 Bl. 1	6 700	6	0.9	0.9	mg/m³
273	4.1.21	S	FF	EN 13284-1	1 380	1	0.9	0.900	mg/m³
274	4.2	S	FF	VDI 2066 Bl.1	1 461	1.4	0.9	0.9	mg/m³
275	4.1.16	S	FF	VDI 2066/1	80	0.08	0.97	0.97	mg/m³
276	4.1.16	-	CY; FF; FF	EN 13284-1	6 180	6	1	1	mg/m³
277	4.1	S	FF	VDI 2066 Bl. 1	6 880	7	1	1	mg/m³
278	4.1.2	S	FF	EN 13284-1	23 880	24	1	1	mg/m³
279	4.1.2	S	FF	EN 13284-1	530	1	1	0.001	g/m³
280	4.1.2	S	FF	EN 13284-1	300	0.5	1	0.001	g/m³
281	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	5 400	7	1	1	mg/m³
282	4.1.10	S	FF	VDI 2066 Bl. 1	1 700	2	1	1	mg/m³
283	4.1.15	S	FF	VDI 2066 Bl.1	4 750	4.67	1.03	1.03	mg/m³
284	4.1.15	S	FF	VDI 2066 Bl.1	743	1	1.033	1.033	mg/m³
285	4.1.8	S	FF	VDI 2066 Bl. 1	1 130	1.3	1.04	1.04	mg/m³
286	4.1.8	S	FF	EN 13284-1	1 980	2	1.1	1.1	mg/m³
287	4.1.10	S	FF	VDI 2066	4 594	5	1.1	1.1	mg/m³
288	4.1.10	S	FF	VDI 2066 Bl. 1	3 900	4	1.1	1.1	mg/m³
289	4.1.16	S	FF	VDI 2066 Bl. 1	12 500	14	1.1	1.1	mg/m³
290	4.1.10	S	FF	VDI 2066	939	1.1	1.18	1.18	mg/m³
291	4.1.8	S	FF	VDI 2066 Bl. 1	55 200	65	1.2	1.2	mg/m³
292	4.1.8	S	FF	EN 13284-1	7 420	10	1.2	1.2	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, “filter”, cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
293	4.1.10	S	FF	VDI 2066 Bl. 1	16 400	19	1.2	1.2	mg/m³
294	4.1.8	S	FF	VDI 2066 Bl.1	46	0.06	1.2	1.2	mg/m³
295	4.1.16	S	FF; HE	VDI 2066/1	5 100	6.56	1.29	1.29	mg/m³
296	4.1.8	S	F	EN 13284-1	1 830	2	1.3	1.3	mg/m³
297	4.1	S	FF	VDI 2066 Bl. 1	17 000	22	1.3	1.3	mg/m³
298	4.1.8	S	FF	EN 13284-1	1 680	2	1.3	1.3	mg/m³
299	4.1.8	S	FF	VDI 2066 Bl.1	678	0.8	1.3	1.3	mg/m³
300	4.1.16	S	FF	EN 13284-1	35 700	45	1.3	1.30	mg/m³
301	4.2	S	FF	VDI 2066 Bl.1	9	0.011	1.3	1.3	mg/m³
302	4.1.10	S	FF	VDI 2066	1 025	1.3	1.31	1.31	mg/m³
303	4.1.10	S	F	VDI 2066	695	1	1.4	1.4	mg/m³
304	4.1	S	F; C; C; F	EN 13284-1, VDI 2066 Bl. 1	1 600	2	1.4	1.4	mg/m³
305	4.1.8	S	FF	EN 13284-1	13 900	19	1.4	1.4	mg/m³
306	4.1.10	S	FF	VDI 2066	695	2	1.4	1.4	mg/m³
307	4.1.15	S	FF	VDI 2066	213	0.3	1.4	1.4	mg/m³
308	4.1.16	S	FF	VDI 2066 Bl. 1	1 900	3	1.4	1.4	mg/m³
309		S	FF	VDI 2066 Bl. 1	3 080	4	1.4	1.4	mg/m³
310	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	1 070	1.5	1.4	1.4	mg/m³
311	4.1.8	S	FF	VDI 2066/1	3 330	4.7	1.4	1.4	mg/m³
312	4.1.10	S	FF	VDI 2066	871	1.3	1.45	1.45	mg/m³
313	4.1	S	F	EN 13284-1	1 100	2	1.5	1.5	mg/m³
314	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	3 420	5	1.5	1.5	mg/m³
315	4.1.8	S	F	EN 13284-1	190	0.3	1.5	1.5	mg/m³
316	4.1	S	FF	VDI 2066 Bl. 1	5 300	8	1.5	1.5	mg/m³
317	4.1	S	FF	VDI 2066/1	2 744	4	1.5	1.5	mg/m³
318	4.1.16	S	FF	VDI 2066 Bl. 1	3 400	5	1.5	1.5	mg/m³
319	4.1.16	S	FF	VDI 2066/1	2 767	4	1.5	1.5	mg/m³
320	4.1.10	S	FF	VDI 2066	739	1	1.51	1.51	mg/m³
321	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 620	2.5	1.55	<3.1	mg/m³
322	4.1	S	F	EN 13284-1, VDI 2066 Bl. 1	2 000	3.1	1.6	1.6	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m^3/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
323	4.1	S	FF	VDI 2066 Bl. 1	3 380	6	1.6	1.6	mg/m^3
324	4.1.15	S	FF	VDI 2066 Bl.1	510	0.8	1.6	1.6	mg/m^3
325	4.1.21	S	F	VDI 2066 Bl. 1	18 700	30.5	1.635	<3.27	mg/m^3
326		S	F	EN 13248-1, VDI 2066 Bl.1	750	1.3	1.67	1.67	mg/m^3
327	4.1.10	S	F	VDI 2066	764	1	1.7	1.7	mg/m^3
328		S	FF	VDI 2066 Bl. 1	1 640	3	1.7	<3.4	mg/m^3
329	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	1 290	2.3	1.77	1.77	mg/m^3
330	4.1	S	F	EN 13284-1	1 400	2	1.8	1.8	mg/m^3
331	4.1.10	S	FF	VDI 2066 Bl. 1	2 700	5	1.8	1.8	mg/m^3
332	4.1.15	S	FF	VDI 2066	<260	245	1.9	1.9	mg/m^3
333	4.1.8	C	FF	VDI 2066 Bl.1	3 528	6.6	1.9	1.9	mg/m^3
334	4.1.8	S	F	EN 13284-1, VDI 2066 Bl.1	300	0.6	1.96	1.96	mg/m^3
335	4.1	S	FF	VDI 2066 Bl. 1	2 350	4	1.97	1.97	mg/m^3
336	4.1	S	FF	VDI 2066/1	260	0.5	2	2	mg/m^3
337	4.1	S	FF	VDI 2066 Bl. 1	2 640	5	2	2	mg/m^3
338	4.1.13	S	FF	VDI 2066 Bl. 1	400	1	2	2	mg/m^3
339		S	FF	VDI 2066 Bl. 1	21 700	43	2	2	mg/m^3
340	4.1.10	S	FF	EN 13284-1, VDI 2066 Bl.1	15 300	31	2	2	mg/m^3
341	4.1.10	S	FF	VDI 2066	4 171	8.4	2.02	2.02	mg/m^3
342	4.1	S	FF	VDI 2066/1	920	1.9	2.09	2.09	mg/m^3
343	4.1.8	S	FF	VDI 2066 Bl.1	1 183	2.6	2.1	2.1	mg/m^3
344	4.1	S	FF	VDI 2066 Bl. 1	22 200	49	2.2	2.2	mg/m^3
345	4.1.10	S	FF	VDI 2066 Bl. 1	6 300	14	2.2	2.2	mg/m^3
346	4.1.16	S	FF	VDI 2066 Bl.1	5 510	12	2.2	2.2	mg/m^3
347	4.1	-	FF	EN 13284-1, VDI 2066 Bl. 1	4 330	9.5	2.235	<4.47	mg/m^3
348		S	FF	VDI 2066 Bl. 1	6 980	16	2.3	2.3	mg/m^3
349	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 010	2.6	2.5	2.5	mg/m^3
350	4.1.21	S	FF	EN 13284-1	51 600	130	2.5	2.50	mg/m^3
351	4.1	S	FF	VDI 2066/1	190	0.5	2.57	2.57	mg/m^3

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
352	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	470	1.3	2.67	2.67	mg/m³
353	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	2 060	6	2.8	2.8	mg/m³
354	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	220	0.63	2.8	2.8	mg/m³
355	4.1	S	FF	VDI 2066 Bl. 1	2 640	8	2.9	2.9	mg/m³
356	4.5	C	CART	VDI 2066 BL.1:2006	2 227	-	3	3	mg/m³
357	4.1.10	S	FF	VDI 2066 Bl. 1	2 400	7	3.1	3.1	mg/m³
358		S	FF	VDI 2066 Bl. 1	29 100	94	3.2	3.2	mg/m³
359	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	5 500	18	3.3	3.3	mg/m³
360	4.1.21	S	FF	VDI 2066 Bl. 1	5 830	20	3.4	3.4	mg/m³
361	4.1.8	S	CY*2; FF; S	EN 13284-1	4 840	17	3.4	3.4	mg/m³
362	4.1.10	S	FF	VDI 2066	1 431	5	3.48	3.48	mg/m³
363	4.1.8	S	FF	VDI 2066 Bl. 1	7 830	27	3.5	3.5	mg/m³
364	4.1.1	S	FF	VDI 2066 Bl. 1	2 270	8	3.7	3.7	mg/m³
365	4.1.15	S	FF	VDI 2066	877	3.3	3.7	3.7	mg/m³
366	4.1.15	S	FF	EN 13284; VDI 2066 Bl. 1	9 020	33.8	3.8	3.8	mg/m³
367	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	880	1.1	4	4	mg/m³
368	4.1	S	FF	VDI 2066 Bl. 1, EN 13284-1	5 570	20	4	4	mg/m³
369	4.1.8	S	FF	VDI 2066 Bl. 1	4 980	21	4.1	4.1	mg/m³
370	4.1.10	S	FF; S*2	EN 13284-1, VDI 2066 Bl.1	71	0	4.1	4.1	mg/m³
371	4.1	S	FF	EN 13284-1, VDI 2066 Bl. 1	4 180	17.5	4.18	4.18	mg/m³
372	4.1.10	S	FF	VDI 2066 Bl. 1	7 300	31	4.2	4.2	mg/m³
373	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	720	-	4.4	4.4	mg/m³
374	4.1.10	S	FF	VDI 2066 Bl. 1	3 100	14	4.5	4.5	mg/m³
375	4.1.10	S	FF	VDI 2066	524	2.4	4.6	4.6	mg/m³
376	4.1.7	S	FF; FF	VDI 2066/1	846	4	4.7	4.7	mg/m³
377	4.1	S	F	EN 13284-1	2 300	16	5.1	5.1	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
378	4.1.15	S	CY; FF	VDI 2066 Bl. 1	21 700	115	5.3	5.3	mg/m³
379	4.1.4	S	FF	EN 13284-1	2 240	12	5.3	5.3	mg/m³
380	4.1.16	S	FF	VDI 2066 Bl.1	1 730	9	5.4	5.4	mg/m³
381	4.1.10	S	FF	VDI 2066	1 155	5	5.5	5.5	mg/m³
382	4.1	S	FF	EN 13284-1, VDI 2066 Bl.1	738	4	5.8	5.8	mg/m³
383	4.1.21	S	FF	EN 13284-1	77 400	470	6.1	6.10	mg/m³
384	4.1.8	S	CART	EN 13284-1, VDI 2066 Bl.1	2 820	18	6.2	6.2	mg/m³
385	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	880	6	6.3	6.3	mg/m³
386	4.1	S	FF; S	EN 13284-1	9 970	67	6.6	6.6	mg/m³
387	4.1	S	F	EN 13284-1, VDI 2066 Bl. 1	1 230	9	7	7	mg/m³
388	4.1.15	S	FF	EN 13284-1	680	5	7	7	mg/m³
389	4.1.10	S	FF	VDI 2066 Bl. 1	13 700	105	7.6	7.6	mg/m³
390	4.1.10	S	FF	VDI 2066 Bl. 1	11 100	85	7.7	7.7	mg/m³
391	4.1.10	S	FF	VDI 2066	639	5.1	7.96	7.96	mg/m³
392	4.1.10	S	FF	VDI 2066 Bl. 1	10 200	85	8.3	8.3	mg/m³
393	4.1	S	FF	VDI 2066/1	910	7.8	8.5	8.5	mg/m³
394	4.1.16	S	F	EN 13284-1, VDI 2066 Bl. 1	604	2.8	8.7	8.7	mg/m³
395	4.1.10	S	FF	VDI 2066 Bl. 1	7 600	66	8.7	8.7	mg/m³
396	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	1 530	15.5	10.1	10.1	mg/m³
397	4.1	C	S; FF; CART	EN 13284-1:2002, VDI 2066 BL.1:2006	7 640	79	10.3	10.3	mg/m³
398	4.1.15	S	FF; FF	VDI 2066 Bl.1	2 974	30.8	10.4	10.4	mg/m³
399	4.1.2	S	FF	VDI 2066 Bl. 1	2 682	27.7	10.6	10.6	mg/m³
400	4.1	S	F	EN 13284-1:2002, VDI 2066 BL.1:2006	660	8	12	12	mg/m³
401	4.1.13	S	FF	VDI 2066 Bl. 1	400	5	12.1	12.1	mg/m³
402	4.1.16	S	FF; S*4	VDI 2066 Bl. 1	19 400	248	12.8	12.8	mg/m³
403	4.1.10	S	FF	VDI 2066 Bl. 1	10 200	141.9	13.9	13.9	mg/m³

#	Type of instal-lation	Waste gas system including fabric filter, "filter", cartridge filter or mem-brane filter		Dust Measurement Method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
404	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	2 110	31	14.65	14.65	mg/m³
405	4.1.10	S	FF	VDI 2066 Bl. 1	6 600	100	15.1	15.1	mg/m³
406	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	3 040	55	18.1	18.1	mg/m³
407	4.1.21	S	FF	EN 13284-1	1 290	27	20.6	20.6	mg/m³
408	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	2 160	51.5	21.73	21.73	mg/m³
409	4.1.8	S	FF	EN 13284-1, VDI 2066 Bl.1	4 900	140	22	22	mg/m³
410	4.1	S	F	EN 13284-1, VDI 2066 Bl.1	1 440	34.6	24	24	mg/m³
411	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	680	16	24.17	24.17	mg/m³
412	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	1 340	35	26.3	26.3	mg/m³
413	4.1	S	F	EN 13248-1, VDI 2066 Bl.1	200	6	28.6	28.6	mg/m³
414	4.1.15	S	FF	EN 13284-1	1 170	57	48.3	48.3	mg/m³
415	4.1.16	C	FF; Q; S; S	VDI 2066 BL.1:2006	2 201	130	57.7	57.7	mg/m³
416	4.1.10	S	FF	VDI 2066	511	35.8	70	70	mg/m³
417	4.1.21	S	F; CY	EN 13284-1	1 130	83	73.7	73.7	mg/m³
418	4.1.2	S	FF	EN 13284-1	298	34	110	0.11	g/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 4 – Dust data – Scrubbers or dip tanks

Table 26 shows the mean concentration values of dust and the related mean mass flow associated with scrubbers or dip tanks where these are not combined with fabric filters, “filters” (assumed to be fabric filters), cartridge filters or similar. The values are sorted by increasing mean concentration.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 26: Dust emissions from sources with scrubbers or dip tanks

#	Type of installation	Waste gas system including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.15	S	S	VDI 2066/1	30	0.0005	0.015	<0.03	mg/m³
2	4.1.15	S	CY; S; C	VDI 2066/1; EN 14284	20	0	0.03	0.03	mg/m³
3	4.1.2	S	S; TO	VDI 2066 Bl. 1	162 235	5.5	0.05	<0.1	mg/m³
4	4.1.15	S	S	VDI 2066/1	10	0.001	0.075	<0.15	mg/m³
5	4.1.8	S	DT	EN 13284-1, VDI 2066 Bl.1	125	-	0.1	<0.2	mg/m³
6	4.1	C	S	EN 13284-1:2002, VDI 2066 BL.1:2006	23 210	3	0.1	<0.2	mg/m³
7	4.1.8	S	S	EN 13284-1	8 370	1	0.1	0.1	mg/m³
8	4.1 / 4.2	S	S	EN 13284-1:2002, VDI 2066 Bl. 1:2006	1 480	0.15	0.1	<0.2	mg/m³
9	4.1	C	S	EN 13284-1, VDI 2066 Bl.1	4 200	0.5	0.1	<0.2	mg/m³
10	4.1	C	S	EN 13284-1:2002, VDI 2066 BL.1:2006	10 960	1	0.105	<0.21	mg/m³
11	4.1.15	S	S*x	VDI 2066/1	24 993	3	0.127	<0.254	mg/m³
12	4.1.7	C	S; AB; AB	VDI 2066 Bl.1	4 710	0.5	0.145	<0.29	mg/m³
13	4.1.8	S	DT	EN 13284-1, VDI 2066 Bl.1	990	-	0.15	<0.3	mg/m³
14	4.1.7	S	S	VDI 2066	336	0.043	0.15	<0.3	mg/m³
15	4.1.10	S	S	EN 13284-1	4 670	2.5	0.15	<0.3	mg/m³

#	Type of instal-lation	Waste gas sys-tem including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
16	4.1.16	S	S	VDI 2066/1	4 933	0.5	0.15	<0.3	mg/m³
17	4.1.16	S	S	VDI 2066/1	4 733	0.5	0.15	<0.3	mg/m³
18	4.1.16	S	S	EN 13284-1	3 000	0.5	0.15	<0.3	mg/m³
19	4.1.15	S	S; CY	VDI 2066	819	0.12	0.15	<0.3	mg/m³
20	4.1.10	S	S; S	EN 13284	549	0.1	0.15	<0.3	mg/m³
21	4.1	S	S	VDI 2066 Bl.1	859	0.15	0.2	0.2	mg/m³
22	4.1	S	S	EN 13284-1:2002, VDI 2066 BL.1:2006	2 020	0.5	0.2	<0.4	mg/m³
23	4.1.8	S	S	EN 13284-1	6 660	2	0.2	0.2	mg/m³
24	4.1.10	S	S	VDI 2066 Bl. 1	2 600	0.5	0.2	<0.4	mg/m³
25	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	11 400	1	0.2	0.2	mg/m³
26	4.1.16	S	SP; S; S; CY	EN 13284-1, VDI 2066 Bl. 1	7 345	1.5	0.2	<0.4	mg/m³
27	4.1.16	S	SP; S; S; CY	EN 13284-1, VDI 2066 Bl. 1	7 267	1.5	0.2	<0.4	mg/m³
28	4.1.15	S	S*2	VDI 2066 Bl.1	4 612	1	0.2	0.2	mg/m³
29	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	11 800	2.65	0.215	<0.43	mg/m³
30	4.1	S	S	VDI 2066/1	180	0.05	0.22	<0.44	mg/m³
31	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	11 000	2.65	0.235	<0.47	mg/m³
32	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	9 000	2.5	0.25	<0.5	mg/m³
33	4.1.6	S	TO; S*2	EN 13284-1	8 933	2.3	0.25	<0.5	mg/m³
34	4.1.16	S	S	VDI 2066/1	4 700	1	0.25	<0.5	mg/m³
35	4.1.16	S	S	VDI 2066/1	4 500	1	0.25	<0.5	mg/m³
36	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	5 000	1.35	0.285	<0.57	mg/m³
37	4.1	C	S; S	EN 13284-1:2002, VDI 2066 BL.1:2006	26 360	8	0.295	<0.59	mg/m³
38	4.1.1	C	S	EN 13284-1, VDI 2066 Bl.1	1 610	0.25	0.3	0.3	mg/m³
39	4.1.2	S	S*2	EN 13284-1	5 200	1	0.3	0.3	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
40	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	13 000	4	0.3	0.3	mg/m³
41	4.1.2	C	TO; S; Q	EN 13284-1, VDI 2066 Bl. 1	9 269	3	0.3	<0.6	mg/m³
42	4.1	S	S	VDI 2066/1	475	0.2	0.3	0.3	mg/m³
43	4.1	C	S*2; S	EN 13284-1, VDI 2066 Bl.1	3 160	1	0.335	<0.67	mg/m³
44	4.1	C	S	EN 13284-1:2002, VDI 2066 Bl.1	47 950	17	0.35	0.35	mg/m³
45	4.1.16	S	S*2	VDI 2066 Bl.1	12 100	4.5	0.35	<0.7	mg/m³
46	4.1.10	S	CY; S	EN 13284-1	33 000	13	0.4	0.4	mg/m³
47	4.1.15	S	S	EN 13284-1	4 401	0.775	0.4	<0.8	mg/m³
48	4.1.16	-	SP; S	EN 13284-1	10 100	4	0.4	0.4	mg/m³
49	4.1.10	S	S	VDI 2066 Bl.1	3 105	1	0.4	<0.8	mg/m³
50	4.1.15	S	S; CY	VDI 2066 Bl.1	3 461	1.3	0.4	<0.8	mg/m³
51	4.1.10	S	TO, Q, S	VDI 2066 Bl.1	3 222	1.3	0.4	0.4	mg/m³
52	4.1.15	S	S	VDI 2066	170	0.05	0.415	<0.83	mg/m³
53	4.1	C	S; S; S	EN 13284-1:2002, VDI 2066 BL.1:2006	24 850	10	0.42	0.42	mg/m³
54	4.1.2	C	TO; S; Q	EN 13284-1, VDI 2066 Bl. 1	9 807	4.5	0.46	0.46	mg/m³
55	4.1.8	S	DT	EN 13284-1, VDI 2066 Bl.1	43	-	0.5	0.5	mg/m³
56	4.1.8	S	S	EN 13248-1, VDI 2066 Bl.1	1 760	1	0.5	0.5	mg/m³
57	4.1.16	S	S	EN 13284-1, VDI 2066 Bl. 1	3 200	1.5	0.5	0.5	mg/m³
58	4.1.2	C	SCR; Q; S*3; TO	VDI 2066 Bl.1	2 985	2	0.5	0.5	mg/m³
59		C	S	VDI 2066 Bl.1	964	0.5	0.5	0.5	mg/m³
60	4.1.4	S	S	VDI 2066 Bl.1, VDI 2457 Bl.1	775	0.459	0.6	0.6	mg/m³
61	4.1.2	C	SCR; Q; S*3; TO	VDI 2066-1	2 805	2	0.6	0.6	mg/m³
62	4.1.10	S	S	VDI 2066 Bl.1	3 481	2	0.6	0.6	mg/m³

#	Type of instal-lation	Waste gas sys-tem including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
63	4.1	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	2 800	2	0.7	0.7	mg/m³
64	4.1	S	S; S	EN 13284-1	12 500	9	0.7	0.7	mg/m³
65	4.1	C	TO,S*2	VDI 2066/1	34 005	17	0.7	0.7	mg/m³
66	4.1.15	S	S; CY	VDI 2066	1 024	1	0.75	0.75	mg/m³
67	4.1.1	S	S	EN 13284-1	3 060	2	0.8	0.800	mg/m³
68	4.1.13	S	S	VDI 2066 Bl. 1	11 300	9	0.8	0.8	mg/m³
69	4.1.13	S	S	VDI 2066 Bl. 1	5 300	4	0.8	0.8	mg/m³
70	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	6 000	5	0.8	0.8	mg/m³
71	10.3.1	C	SNCR; Q; S; S	VDI 2066 Bl.1:2006	5 542	-	0.8	0.8	mg/m³
72	10.3.1	C	SNCR; Q; S; S	VDI 2066 Bl.1:2006	5 867	-	0.8	0.8	mg/m³
73	4.1.10	S	S	VDI 2066 Bl.1	1 061	0.9	0.8	0.8	mg/m³
74	4.1.15	S	S	VDI 2066 Bl.1	4 381	3.4	0.8	0.8	mg/m³
75	4.1	C	S	EN 13284-1, VDI 2066 Bl.1	1 690	1.5	0.85	<1.7	mg/m³
76	10.3.1	C	SNCR; Q; S; S	VDI 2066 Bl.1:2006	5 657	-	0.85	0.85	mg/m³
77	4.1.8	S	DT	EN 13284-1, VDI 2066 Bl.1	92	-	0.9	0.9	mg/m³
78	4.1.15	S	S	VDI 2066	343	0.3	0.9	0.9	mg/m³
79	4.1.16	S	S*3	EN 13284-1, VDI 2066 Bl. 1	933	0.8	0.9	0.9	mg/m³
80	4.1.10	S	S	VDI 2066 Bl.1	649	0.5	0.9	0.9	mg/m³
81	4.1	S	S	VDI 2066 Bl. 1, EN 13284-1	7 260	6	1	1	mg/m³
82	4.1.10	S	S	VDI 2066, EN 13284-1	11 400	12	1	1	mg/m³
83	4.1.2	S	S; S*2	EN 13284-1	3 500	3	1	1	mg/m³
84	4.1.2	C	TO; S; Q	EN 13284-1, VDI 2066 Bl. 1	9 681	12	1	1	mg/m³
85	4.1.10	S	S	VDI 2066 Bl.1	10 454	10	1	1	mg/m³
86	4.1.15	S	S	VDI 2066 Bl.1	2 378	2.3	1	1	mg/m³
87	4.1.2	S	S; S*2	EN 13284-1	3 440	4	1.1	1.1	mg/m³

#	Type of installation	Waste gas system including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
88	4.1.10	S	S	VDI 2066 Bl. 1	9 900	12	1.2	1.2	mg/m³
89	4.1.2	S	S; TO	EN 13284-1, VDI 2066 Bl. 1	146 839	171.3	1.2	1.2	mg/m³
90	4.1.15	S	S	VDI 2066/1	900	1.1	1.28	1.28	mg/m³
91	4.1.8	S	S	EN 13284-1	6 930	4.5	1.3	1.3	mg/m³
92	4.1.15	S	S	VDI 2066	9 877	13	1.3	1.3	mg/m³
93	4.1.10 / 8.12.1.1	S	S	VDI 2066 Bl. 1, EN 13284-1	7 100	9	1.3	1.3	mg/m³
94	4.1.15	S	S*2; S	EN 13284; VDI 2066/1	1 760	2.3	1.3	1.3	mg/m³
95	4.1.15	S	S	VDI 2066/1	4 572	6.2	1.4	1.4	mg/m³
96	4.1	S	S	EN 13284-1, VDI 2066 Bl. 1	4 110	6	1.5	1.5	mg/m³
97	4.1.7, 4.1.12, 4.1.14	S	S; S	EN 13284-1	574	0.85	1.5	<3	mg/m³
98	4.1	S	DT	EN 13284-1, VDI 2066 Bl.1	86	-	1.6	1.6	mg/m³
99	4.1.16	S	S*2	VDI 2066 Bl.1	9 450	16	1.6	1.6	mg/m³
100	4.1.15	S	CY; S; C	VDI 2066/1	110	0.2	1.7	1.7	mg/m³
101	4.1.8	S	S	VDI 2066 Bl. 1	26 900	49	1.8	1.8	mg/m³
102	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	6 100	-	1.8	1.8	mg/m³
103	4.1.15	S	C; S	VDI 2066	1 225	2	1.98	1.98	mg/m³
104	4.1.2	S	S*3; AC*2	EN 13284-1	640	2	2	0.002	g/m³
105	4.1	S	S; DS	EN 13284, VDI 2066 Bl. 1	11 800	20	2	2	mg/m³
106	4.1.10	S	S; S	EN 13284	17 200	34	2	2	mg/m³
107	4.1.10	S	S	VDI 2066 Bl. 1	10 400	22	2.1	2.1	mg/m³
108	4.1	S	S; S	VDI 2066/1	670	1.4	2.1	2.1	mg/m³
109	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	14 000	-	2.2	2.2	mg/m³
110	4.1.15	S	S; S	EN 13284-1	510	1	2.2	2.2	mg/m³
111	4.1.8	S	S	EN 13248-1, VDI 2066 Bl.1	7 780	18	2.3	2.3	mg/m³
112	4.1.15	S	S; S	EN 13284-1	6 681	15.24	2.3	2.3	mg/m³

#	Type of instal-lation	Waste gas sys-tem including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
113	4.1	S	S	VDI 2066/1	2 820	6.4	2.3	2.3	mg/m³
114	4.1.16	S	S*2; S*2; COX; COX	EN 13284-1	7 900	19	2.4	2.4	mg/m³
115	4.1.16	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	11 200	27	2.4	2.4	mg/m³
116	4.1	S	DT	EN 13284-1, VDI 2066 Bl.1	74	-	2.6	2.6	mg/m³
117	4.1.16	S	S	VDI 2066 Bl. 1	2 600	7	2.6	2.6	mg/m³
118	4.1.15	S	S	VDI 2066	1 160	3	2.8	2.8	mg/m³
119	4.1.16	S	S*2	EN 13284-1, VDI 2066 Bl. 1	300	0.8	2.8	2.8	mg/m³
120	4.1.16	S	S*2	EN 13284-1, VDI 2066 Bl. 1	800	2.3	2.9	2.9	mg/m³
121	4.1.19	S	TO; S	EN 13284-1	1 160	3	3	3	mg/m³
122	4.1	S	S	VDI 2066/1	1 452	4.5	3.1	3.1	mg/m³
123	4.1.8	C	CY; TO; S	VDI 2066 Bl.1	331	1.2	3.5	3.5	mg/m³
124	4.1.16	S	S*2; S*2; CAT	EN 13284-1	18 010	64	3.6	3.6	mg/m³
125	4.1.17	S	CY; S	VDI 2066 Bl. 1	190 600	714	3.7	3.7	mg/m³
126	4.1.10	S	S; ESP; S*2; S*2	VDI 2066 Bl. 1	51 400	211.8	4.1	4.1	mg/m³
127	4.1.17	S	S; S	VDI 2066 Bl. 1	11 900	48	4.1	4.1	mg/m³
128	4.1.16	S	S*2; S*2; CAT	EN 13284-1	17 580	84	4.8	4.8	mg/m³
129	4.1.2	S	S; DS	EN 13284-1, VDI 2066 Bl. 1	8 270	40	4.8	4.8	mg/m³
130	4.1.2	S	CY*2; S; DS	EN 13284-1	8 960	44	4.9	4.9	mg/m³
131	4.1.10	S	S	VDI 2066 Bl. 1	1 100	6	5.1	5.1	mg/m³
132	4.1.8	S	S	EN 13284-1:2002	36 800	210	5.7	5.7	mg/m³
133	4.1.1	S	S; CY; DS	EN 13284-1	3 090	18	5.8	5.80	mg/m³
134	4.1	S	S	VDI 2066 Bl.1	2 585	15	5.8	5.8	mg/m³
135	4.1.8	S	S	EN 13248-1, VDI 2066 Bl.1	10 700	65	6.1	6.1	mg/m³
136	4.1.16	S	S*2	EN 13284-1, VDI 2066 Bl. 1	400	3	6.3	6.3	mg/m³
137	4.1.15	S	S	EN 13284-1	8 130	52	6.4	6.4	mg/m³

#	Type of instal-lation	Waste gas sys-tem including scrubbers or dip tank (without fabric filter or cartridge filter or membrane filter)		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
138	4.1	S	S; DS; C; S	EN 13284-1, VDI 2066 Bl.1	10 300	74	7.2	7.2	mg/m³
139	4.1.8	S	CY; S	VDI 2066 Bl. 1:2006-11; EN 13284-1:2002-04	11 582	90	7.8	7.8	mg/m³
140	4.1.19	S	TO; S	EN 13284-1	1 341	11	8.1	8.1	mg/m³
141	4.1.15	S	S	VDI 2066/1; EN 13284/1	7 633	65	8.5	8.5	mg/m³
142	4.1	S	S*2	EN 13284, VDI 2066 Bl.1	55	1	9	0.009	g/m³
143	4.1	S	S	VDI 2066/1	30	0.3	9.93	9.93	mg/m³
144	4.1.8	S	S	VDI 2066 Bl. 1:2006-11; EN 13284-1:2002-04	19 272	190	10.1	10.1	mg/m³
145	4.1.2	S	S; HE	EN 13284-1, VDI 2066 Bl. 1	31 100	333	10.7	10.7	mg/m³
146	4.1.19	S	S	EN 13284-1	31	0.5	12.7	12.7	mg/m³
147	4.1	S	CY*2; ESP; S	VDI 2066 Bl. 1	13 400	171	12.8	12.8	mg/m³
148	4.1.2	S	CY; S; HE	EN 13284-1, VDI 2066 Bl. 1	30 408	380	12.9	12.9	mg/m³
149	4.1.16	S	S	VDI 2066 Bl. 1	9 100	130	14.2	14.2	mg/m³
150	4.1.8	S	CY; S	VDI 2066 Bl. 1:2006-11; EN 13284-1:2002-04	15 794	238	15.1	15.1	mg/m³
151	4.1	S	CY*2; ESP; S	VDI 2066 Bl. 1	31 800	489	15.4	15.4	mg/m³
152	4.1.15	S	CY; S	VDI 2066 Bl. 2	27 849	435	15.6	15.6	mg/m³
153	4.1	S	S	VDI 2066/1	40	0.9	23.7	23.7	mg/m³
154	4.1.15	S	S	VDI 2066	151	4	29.1	29.1	mg/m³
155	4.1.1	S	S	EN 13284-1	111	16	149	149.0	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 5 – Dust data – Cyclone Or Electrostatic Precipitator

Table 27 shows the mean concentration values of dust and the related mean mass flow associated cyclones or electrostatic precipitators where these are not combined with fabric filters or scrubbers. The values are sorted by increasing mean concentration.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 27: Dust emissions from sources with cyclone or electrostatic precipitator

#	Type of instal-lation	Waste gas system including cyclone or electrostatic precipitator		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	S	ESP	VDI 2066 Bl.1	3 343	0.1665	0.05	<0.1	mg/m³
2	4.1.8	S	CY	EN 13284-1, VDI 2066 Bl.1	5 700	0.6	0.1	0.1	mg/m³
3	4.1.8	S	CY	EN 13284-1, VDI 2066 Bl.1	2 700	0.7	0.2	0.2	mg/m³
4	4.1.8	S	CY	EN 13284-1:2002, VDI 2066 BL.1:2006	530	0.27	0.47	0.47	mg/m³
5	4.1.8	S	CY	EN 13284-1, VDI 2066 Bl.1	5 600	3	0.5	0.5	mg/m³
6	4.1.8	S	CY	VDI 2066 Bl. 1	16 200	35	2.2	2.2	mg/m³
7	4.1.8	S	CY	VDI 2066 Bl. 1	26 100	60	2.3	2.3	mg/m³
8	4.1.8	S	CY	EN 13284-1; VDI 2066 Bl. 1	37 097	115	3.1	3.1	mg/m³
9	4.1	S	CY	EN 13284-1:2002, VDI 2066 BL.1:2006	740	3	3.63	3.63	mg/m³
10	4.1.8	S	CY	VDI 2066 Bl. 1	14 600	59	4	4	mg/m³
11	4.1.17	S	CY	VDI 2066 Bl. 1	111 000	583	5.2	5.2	mg/m³
12	4.1.7	S	CY	VDI 2066/1	800	6	7.6	7.6	mg/m³
13	4.1.8	S	CY	EN 13284-1; VDI 2066 Bl. 1	45 294	385	8.5	8.5	mg/m³
14		S	ESP	VDI 2066 Bl. 1	37 000	335	4.3	8.6	mg/m³
15	4.1.8	S	CY	VDI 2066 Bl. 1	11 800	112	9.5	9.5	mg/m³
16	4.1.21	S	ESP	VDI 2066 Bl. 1	14 600	154	5.3	10.6	mg/m³
17	4.1.21	S	ESP	VDI 2066 Bl. 1	13 800	167	6.0	12	mg/m³

#	Type of instal-lation	Waste gas system includ-ing cyclone or electrostatic precipitator		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
18	4.1	S	ESP	VDI 2066 Bl. 1	27 600	359	6.5	13	mg/m³
19	4.1.4	S	CY; CY	EN 13284-1	1 330	23	17.2	17.2	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 6 – Dust data – No dust-specific abatement technique

Table 28 shows the mean concentration values of dust and the related mean mass flow from sources where no dust-specific abatement is installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 28: Dust emissions from sources without dust-specific treatment system

#	Type of instal-lation	Waste gas system		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	-	none	EN 13284-1, VDI 2066 Bl.1	297	-	0.3	0.3	mg/m³
2	4.1.8	-	none	EN 13284-1; VDI 2066 Bl. 1		-	0.6	0.6	mg/m³
3	4.1.8	-	none	EN 13284-1, VDI 2066 Bl.1	293	-	0.6	0.6	mg/m³
4	4.1.8	-	none	EN 13284-1, VDI 2066 Bl.1	140	-	0.7	0.7	mg/m³
5	4.1.8 / 8.1	C	TO	EN 13284-1	1.1	-	0.78	0.78	mg/m³
6	4.1.8 / 8.1	C	TO	EN 13284-1	1.2	-	0.96	0.96	mg/m³
7	4.1.8 / 8.1	C	TO	EN 13284-1	1.0	-	1.08	1.08	mg/m³
8	4.1.8	-	none	EN 13284-1, VDI 2066 Bl.1	244	-	1.4	1.4	mg/m³
9	4.1.8 / 8.1	C	TO	EN 13284-1	1.0	-	1.52	1.52	mg/m³
10	4.1.8 / 8.1	C	TO	EN 13284-1	1.2	-	1.52	1.52	mg/m³
11	4.1	-	none	EN 13284-1, VDI 2066 Bl.1	124	-	1.6	1.6	mg/m³
12	4.1.8 / 8.1	C	TO	EN 13284-1	1.2	-	1.64	1.64	mg/m³
13	4.1.8 / 8.1	C	TO	EN 13284-1	1.1	-	1.65	1.65	mg/m³
14	4.1	-	none	EN 13284-1,	119	-	1.7	1.7	mg/m³

#	Type of instal-lation	Waste gas system		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs)		
							[mg/m³]	Original Unit	
				VDI 2066 Bl.1					
15	4.1.8 / 8.1	C	TO	EN 13284-1	1.1	-	1.74	1.74	mg/m³
16	4.1.8 / 8.1	C	TO	EN 13284-1	1.1	-	2.36	2.36	mg/m³
17	4.1	-	none	EN 13284-1, VDI 2066 Bl.1	152	-	2.9	2.9	mg/m³
18	4.1.8 / 8.1	C	TO	EN 13284-1	1.1	-	3.33	3.33	mg/m³
19	4.2	-	none	VDI 2066 Bl.1	5.5	0.0005	0.1	<0.2	mg/m³
20	4.1.7	-	none	VDI 2066	0.24	0.001	3.9	3.9	mg/m³
21	4.1.15	-	none	VDI 2066/1	10	0.0012	0.1	<0.2	mg/m³
22	4.1.15	-	none	VDI 2066/1	10	0.0073	0.7	0.7	mg/m³
23	4.1.7	S	C	VDI 2066 Bl. 1	47	0.01	0.215	<0.43	mg/m³
24	4.1.15	-	none	VDI 2066 Bl.1	12 215	0.0145	1.2025	1.2025	mg/m³
25	4.1	-	none	VDI 2066 Bl.1	102	0.02	0.2	<0.4	mg/m³
26	4.1.2	-	none	EN 13284-1, VDI 2066 Bl. 1	560	0.05	0.1	<0.2	mg/m³
27	4.1.8	S	none	VDI 2066 Bl. 1	1 448	0.05	0.1	<0.2	mg/m³
28	4.1	-	none	EN 13284-1:2002, VDI 2066 BL.1:2006	450	0.085	0.3	<0.6	mg/m³
29	4.1.8	C	COX	VDI 2066/1	2 885	0.1	0.05	<0.1	mg/m³
30	4.1	-	none	EN 13284-1:2002, VDI 2066 Bl.1	370	0.1	0.2	<0.4	mg/m³
31	4.1.7	S	C	VDI 2066 Bl. 1	72	0.1	1.6	1.6	mg/m³
32	4.1.11	S	C	EN 13284-1:2002, VDI 2066 BL.1:2006	1 820	0.2	0.1	<0.2	mg/m³
33	4.1.1	S	TO	VDI 2066 Bl. 1	209	0.2	0.9	0.900	mg/m³
34	4.1	-	none	EN 13284-1, VDI 2066 Bl. 1	202	0.2	1.1	<2.2	mg/m³
35	4.1.2	C	TO	EN 13284-1	806	0.3	0.35	<0.7	mg/m³
36	4.2	S	C	VDI 2066 Bl.1		0.4	0.2	0.2	mg/m³
37	1.2	C	TO, SCR	VDI 2066-1	8 617	0.5	0.15	<0.3	mg/m³
38	4.1.8	-	none	VDI 2066 Bl.1	500	0.5	0.15	<0.3	mg/m³
39	4.1	C	TO	EN 13284-1:2002, VDI 2066 Bl.1	2 230	0.5	0.25	<0.5	mg/m³

#	Type of instal-lation	Waste gas system		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
40	4.1.8	-	none	EN 13284-1	320	0.5	1.5	1.5	mg/m³
41	4.1	S	TO; C	EN 13284-1, VDI 2066 Bl.1	40	0.5	1.6	1.6	mg/m³
42	4.1.11	S	none	EN 13284-1	10 360	1	0.1	0.1	mg/m³
43	4.1.8	-	none	EN 13284-1	3 400	1	0.6	0.6	mg/m³
44	4.1.2	S	TO	EN 13284-1, VDI 2066 Bl. 1	1 200	1	0.6	0.6	mg/m³
45	4.1	-	none	EN 13284-1, VDI 2066 Bl.1	325	1	2	2	mg/m³
46	4.1	-	none	EN 13284-1, VDI 2066 Bl. 1	354	1	3.1	3.1	mg/m³
47	4.1	C	TO	EN 13284-1, VDI 2066 Bl.1	16 424	1.5	0.1	<0.2	mg/m³
48	4.1.16	-	none	VDI 2066/1	4 500	1.5	0.3	<0.6	mg/m³
49	4.1.2	C	TO	N. N.	1 838	1.65	0.9	<1.8	mg/m³
50	4.1	-	none	EN 13284-1	11 500	2	0.183	<0.366	mg/m³
51	4.1.8	-	none	EN 13284-1	3 230	2	0.8	0.8	mg/m³
52	4.1.8	S	TO	EN 13284-1	2 530	2	0.8	0.8	mg/m³
53	4.1.8	-	none	VDI 2066 Bl.1	900	2	2.7	2.7	mg/m³
54	4.1	-	none	VDI 2066/1	793	2	3.1	3.1	mg/m³
55	4.1	-	none	EN 13284-1, VDI 2066 Bl.1	308	2	11.9	11.9	mg/m³
56	4.1.8	C	TO	VDI 2066 Bl.1	896	2.2445	2.5	2.5	mg/m³
57	4.1.8	C	TO	VDI 2066 Bl.1	3 263	2.41	0.77	0.77	mg/m³
58	4.1	-	none	EN 13284-1, VDI 2066 Bl.1	13 400	3	0.2	<0.4	mg/m³
59	4.1.8	-	none	EN 13284-1	7 520	3	0.4	0.4	mg/m³
60		-	none	VDI 2066/1	3 833	3	0.9	0.9	mg/m³
61	4.1.8	S	TO	EN 13284-1	2 140	3	1.1	1.1	mg/m³
62	4.1.8	-	none	VDI 2066 Bl.1	1 000	3	2.5	2.5	mg/m³
63	1.2	C	TO, SCR	EN 13284-1, VDI 2066 Bl. 1	9 559	4.5	1.15	<2.3	mg/m³
64	4.1	-	none	VDI 2066 Bl.1	2 652	4.7	1.7	1.7	mg/m³
65	4.1.15	S	none	EN 13284-1	4 040	6	1.5	1.5	mg/m³
66	4.1.15	S	none	EN 13284-1	2 100	6	2.8	2.8	mg/m³
67	4.1.2	-	none	EN 13284-1, VDI 2066 Bl. 1	2 400	7	2.7	2.7	mg/m³

#	Type of instal-lation	Waste gas system		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
68	4.1	-	none	EN 13284-1, VDI 2066 Bl. 1	788	7	8.37	8.37	mg/m³
69	4.1.8	C	TO	VDI 2066 Bl.1	1 509	7.72	5.13	5.13	mg/m³
70	4.1.15	-	none	EN 13284-1	2 406	8.0025	3.3	3.3	mg/m³
71	4.1.6	-	none	VDI 2066 Bl. 1	30 300	8.3	0.283	<0.566	mg/m³
72	4.1.16	-	none	VDI 2066/1	5 767	9	1.5	1.5	mg/m³
73	4.1	-	none	EN 13284-1	21 300	9.7	0.215	<0.43	mg/m³
74	4.1.12	-	none	EN 13284-1	6 870	10	2	2	mg/m³
75	4.1.15	S	DS	VDI 2066 Bl. 1;EN 13284-1	3 365	10	2.98	2.98	mg/m³
76	4.1.16	-	none	VDI 2066/1	5 733	11	1.9	1.9	mg/m³
77	4.1	-	none	EN 13284-1	1 600	15	9.3	9.3	mg/m³
78	4.1.19	S	TO; SCR	EN 13284-1	7 000	19	2.8	2.8	mg/m³
79	4.1.15	-	none	EN 13284; VDI 2066 Bl. 1	6 310	21.3	3.4	3.4	mg/m³
80	4.1.1	-	none	VDI 2066-1	18 735	21.5	1.2	<2.4	mg/m³
81	4.1.19	S	TO; SCR	EN 13284-1	7 000	24	3.4	3.4	mg/m³
82	4.1.7	-	none	VDI 2066	1 360	24.5	17.8	17.8	mg/m³
83	4.1.1	-	none	VDI 2066-1	22 403	37	2	2	mg/m³
84	4.1.19	S	TO; SCR	EN 13284-1	7 000	44	6.7	6.7	mg/m³
85	4.1.8	-	none	EN 13284-1, VDI 2066 Bl.1	2 700	68	25	25	mg/m³
86	4.1.16	-	none	VDI 2268/1-4	382 312	470	1.23	1.23	mg/m³
87	4.1.13	-	none	VDI 2066 Bl. 1	65 800	478	7.3	7.3	mg/m³
88	4.1.16	-	none	VDI 2268/1-4	300 654	500	1.65	1.65	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 7 – Dust data – Other treatment systems

Table 29 shows the mean concentration values of dust and the related mean mass flow from other sources where the waste gas treatment systems for dust could not be identified.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (SR = Solvent recovery, N. N. = not specified). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented with 50 % of the measurement results originally indicated with “<“.

One of the data set originates from a fertilizer production (no. 4.1.17 of 4. BImSchV) and shows a relatively high dust concentration (> 20 mg/Nm³) as well as a high mass flow (> 200 g/h). No information about the waste gas treatment system was provided. Note that dust measurements from other sources of fertilizer production reported mean concentrations of 3.7 mg/Nm³ associated with scrubbers, respectively 4.1 mg/Nm³ associated with a combination of cyclone and scrubber (see above, Annex 4, # 125 and #127), as well as 5.2 mg/Nm³ associated with a cyclone (see above, Annex 5, #11).

Table 29: Dust emissions from other sources where dust treatment system is not clear

#	Type of installation	Waste gas system		Dust Measurement method	Mean Volume Flow (*) [m³/h]	Dust Mean Mass Flow [g/h]	Dust Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs)		
							[mg/m³]	Original Unit	
1	4.1.7	S	SR	EN 13284-1, VDI 2066 Bl.1	1 080	0.2	0.2	<0.4	mg/m³
2	4.1.17	?	N. N.	VDI 2066-1	173 064	5 691	32.9	32.9	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 8 – TOC data – Thermal Oxidation and Catalytic Oxidation

Table 30 shows the mean concentration values of total organic carbon and the related mean mass flow associated with thermal oxidation or catalytic oxidation systems. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 30: TOC emissions from sources with thermal oxidation or catalytic oxidation

#	Type of installation	Waste gas system including thermal oxidation or catalytic oxidation		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619;13526	16 700	1	0.05	<0.1	mg/m³
2	4.1.2	C	TO; S; Q	VDI 3481 Bl. 3	9 269	1	0.1	<0.2	mg/m³
3	4.1.2	C	TO; S; Q	VDI 3481 Bl. 3	9 681	1	0.1	<0.2	mg/m³
4	4.1.2	C	SCR; Q; S*3; TO	VDI 3481 Bl.3	2 805	0.5	0.1	<0.2	mg/m³
5	4.1.8	C	COX	FID	2 885	0.5	0.13	<0.27	mg/m³
6	4.1	S	TO	EN 12619, EN 13526	60	0.5	0.15	<0.3	mg/m³
7	4.1.2	C	SCR; Q; S*3; TO	VDI 3481 Bl.3	2 985	0.5	0.15	<0.3	mg/m³
8	4.1.19	C	TO	VDI 3481 Bl.3	4 552		0.25	<0.5	mg/m³
9	1.2	C	TO, SCR	VDI 3481 Bl. 3	8 617	1.5	0.25	<0.5	mg/m³
10	4.1	C	TO	EN 12619	800	0.5	0.3	0.3	mg/m³
11	4.1.8	S	TO	EN 12619	2 140	0.5	0.3	0.3	mg/m³
12	4.1.2	S	S; TO	VDI 3481 Bl. 3	162 235	47	0.3	0.3	mg/m³
13	4.1.8	C	TO	EN 12619			0.4	0.4	mg/m³
14	4.1.8	C	S; COX	EN 12619, EN 13526	945	0.5	0.4	<0.8	mg/m³
15	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	17 539	7	0.4	<0.8	mg/m³
16	4.1.8	C	TO	EN 12619			0.46	0.46	mg/m³
17	4.1.1	C	TO; Q; S; S	EN 12619	4 278	5	0.5	<1	mg/m³

#	Type of installation	Waste gas system including thermal oxidation or catalytic oxidation		TOC Measurement method	Mean Volume Flow (*) [m^3/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
18	4.1.2	C	TO; S; Q	EN 12619	9 807	5	0.5	<1	mg/m^3
19	4.1.8	C	TO	EN 12619			0.5	0.5	mg/m^3
20	4.1.10	C	TO, Q, S	VDI 3481 Bl.3	2 799	1.5	0.5	<1	mg/m^3
21	4.1.2	S	S; TO	EN 12619	146 839	93	0.6	0.6	mg/m^3
22	4.1.8	C	TO	EN 12619			0.6	0.6	mg/m^3
23	4.1.16	S	S*2; S*2; COX; COX	EN 12619	7 900	5	0.6	0.6	mg/m^3
24	4.1	C	TO	EN 12619	15 750	8	0.65	<1.3	mg/m^3
25	4.1.19	S	TO; SCR	N. N.	7 000	4	0.7	0.7	mg/m^3
26	4.1.10	S	TO, Q, S	VDI 3481 Bl.3	3 848	2.2	0.7	0.7	mg/m^3
27	4.1.8	C	TO	EN 12619			0.71	0.71	mg/m^3
28	4.1.16	S	FF; TO	N. N.	3 020	3	0.8	0.8	mg/m^3
29	4.1.7	S	COX	EN 12619	380	0.5	0.8	<1.6	mg/m^3
30	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	15 600	12	0.8	0.8	mg/m^3
31	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	16 500	13	0.8	0.8	mg/m^3
32	4.1.8	C	CY; TO; S	VDI 3481 Bl.3	331		0.9	0.9	mg/m^3
33	4.1.1	S	TO	EN 12619	480	0.485	0.95	<1.9	mg/m^3
34	4.1.18	C	C; S*2; TO	EN 12619:2013	100	0	1	<2	mg/m^3
35	4.1.8	S	TO	EN 12619:2013, VDI 3481 Bl.3:1995	8 300	8.5	1	<2	mg/m^3
36	4.1.8	C	TO	EN 13284-1, VDI 2066 Bl.1	10 860	10	1	<2	mg/m^3
37	4.1.8	S	TO	EN 13526, EN 12619, VDI 3481-1	10 570	10	1	<2	mg/m^3
38	4.1	S	TO; S*2	EN 13526, VDI 3481-1	2 280	2.5	1	<2	mg/m^3
39	4.1	C	TO	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	21 730	21.5	1	<2	mg/m^3
40	4.1.8	C	TO	VDI 3481 Bl.3	1 509		1	1	mg/m^3

#	Type of instal-lation	Waste gas system includ-ing thermal oxi-dation or cata-lytic oxidation		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
41	4.1.8	C	TO	VDI 3481 Bl.3 + 6, EN 12619, EN 13526	32 100	32	1	<2	mg/m³
42	4.1.10	C	TO	VDI 3841 Bl.3	6 816	7	1	1	mg/m³
43	4.1.2	S	TO	VDI 2449 Bl. 2; EN 12619	14 800	20	1.05	<2.1	mg/m³
44	4.1.18	C	TO	EN 12619:1999, VDI 3481 Bl.3+4+6, EN 13526:2002	1 026	2.1	1.1	1.1	mg/m³
45	4.1.19	S	TO; S	FID EN 13526	1 340	2	1.1	1.1	mg/m³
46	4.1.10	C	TO, Q, S	VDI 3481 Bl.3	3 298	4	1.1	1.1	mg/m³
47	1.2	C	TO, SCR	EN 12619	9 559	8	1.2	<2.4	mg/m³
48	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	15 519	19	1.2	1.2	mg/m³
49	4.1.18	C	TO; S; S	EN 12619, VDI 3481 Bl.3	1 350		1.25	<2.5	mg/m³
50	4.1.19	S	TO; SCR	N. N.	7 000	9	1.3	1.3	mg/m³
51	4.1.8	C	TO	VDI 3481 Bl.3	3 263		1.3	1.3	mg/m³
52	8	C	TO; Q; S; S; DD	VDI 3481/1; EN 12619; EN 13526	16 126	21	1.3	1.3	mg/m³
53	4.1.8	C	TO	EN 12619			1.34	1.34	mg/m³
54	4.1	C	TO	EN 13526:2002, VDI 3481 Bl.3	2 230	2	1.35	<2.7	mg/m³
55	4.1.1	C	TO; Q; S; BU; SCR	EN 12619, DIN 13526, VDI 3481 Bl.3	1 180	1.5	1.45	<2.9	mg/m³
56	4.1	C	TO	VDI 3481 Bl. 3	19 820	34	1.7	1.7	mg/m³
57	4.1	C	TO	VDI 3481 Bl.3 + 6, EN 12619, EN 13526	16 424	30	1.75	<3.5	mg/m³
58	4.1	C	TO	EN 12619	18 700	34	1.8	1.8	mg/m³
59	4.1.18	C	TO	EN 12619, VDI 3481 Bl.3	594	1.22	2	2	mg/m³
60	4.1.18	C	C; S*2; TO	EN 12619:2013	85	0.2	2	2	mg/m³
61	4.1.2	S	TO	EN 13526	777	1.8	2.2	2.2	mg/m³

#	Type of instal-lation	Waste gas system including thermal oxidation or catalytic oxidation		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
62	4.1.19	S	TO; S	EN 13526	1 160	2	2.2	2.2	mg/m³
63	4.1.8	C	TO	VDI 3481 Bl.3	896		2.3	2.3	mg/m³
64	4.1.8	C	C; COX	EN 12619	36	0	2.4	2.4	mg/m³
65	4.1.2	C	TO	EN 12619	1 880	5	2.5	2.5	mg/m³
66	4.1.16	S	FF; TO; S		3 850	11	2.7	2.7	mg/m³
67	4.1.2	C	TO	EN 12619	806	3	2.9	2.9	mg/m³
68	4.1.2	S	TO	EN 12619, EN 13526, VDI 3481 Bl. 1	1 200	3	3	3	mg/m³
69	4.1.8	S	SP; COX	EN 12619	10 860	34	3.1	3.1	mg/m³
70	4.1.8	C	TO	VDI 3481 Bl.3+6, EN 12619, EN 13526	1 030	2	3.7	3.7	mg/m³
71	4.1.8	S	TO	EN 12619	2 530	11	4.5	4.5	mg/m³
72	4.1.7	S	COX	EN 12619	183	0.85	4.7	4.7	mg/m³
73	4.1.18	C	S*3; S; S; S; S; COX	EN 12619:2013	982	5	4.93	4.93	mg/m³
74	4.1.8	S	FF; S; COX	EN 12619	10 300	71	6.9	6.9	mg/m³
75	4.10	C	TO	EN 13526	18 500	140	7.4	7.4	mg/m³
76	4.1.19	S	TO; SCR	N. N.	7 000	55	8	8	mg/m³
77	4.1.18	C	S; S; S; S; COX	EN 12619	1 100	10	9.2	9.2	mg/m³
78	4.1.19	S	TO	EN 12619	6 660	64.7	9.9	9.86	mg/m³
79	4.1.6	S	TO; S*2	EN 13526	8 933	103.8	10.7	10.7	mg/m³
80	4.1.8	S	COX	EN 12619	18 500	225	12.1	12.1	mg/m³
81	4.1.18	C	S*3; S; S; S; S; COX	EN 12619:2013	1 250	22	17.28	17.28	mg/m³
82	4.1.8	C	TO	EN 12619, EN 13526	538	10	18.6	18.6	mg/m³
83	4.1.8	C	TO	EN 13526	3 740	70	19.7	19.7	mg/m³
84	4.1.7	S	COX	EN 12619	233	4.8	20.5	20.5	mg/m³
85	4.1.2	S	TO	EN 13526	718	31	42.9	42.9	mg/m³
86	4.1.2	C	COX	VDI 3481 Bl. 3+4	6 140	298	48.5	48.5	mg/m³
87	4.1.2	C	COX	VDI 3481 Bl. 3+4	8 130	453	55.7	55.7	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 9 – TOC data – Activated Carbon, Biofilter or Clay Adsorption

Table 31 shows the mean concentration values of total organic carbon and the related mean mass flow associated with activated carbon systems (AC), biofilters (BF) or adsorption on clay (AD). The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the results originally indicated with “<“.

Table 31: TOC emissions from sources with activated carbon filter, biofilter or clay adsorption

#	Type of installation	Waste gas system including activated carbon or biofilter or clay adsorption		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	S	S; AC	EN 13526, EN 12619, VDI 3481-1	67	0.05	1	<2	mg/m³
2	4.1.19	S	S*2; S*2; AC	EN 12619:2013, VDI 3481 Bl.3:1995	810	1	1	<2	mg/m³
3	4.1.2	S	**BF**	EN 12619	12 591	14	1.1	1.1	mg/m³
4	4.1.8	S	C; AC; FF	EN 12619	635	1	1.2	1.2	mg/m³
5	4.1.2	S	AC	EN 12619	2 120	3	1.2	1.2	mg/m³
6	4.1.4	S	C; AC	EN 12619	177	0.863	2.35	<4.7	mg/m³
7	4.1.2	S	AC	EN 12619	2 120	6	2.9	2.9	mg/m³
8	4.1	S	S; AC	EN 12619	2 290	8	3.5	<7	mg/m³
9	4.1.2	S	S*3; AC*2	EN 12619	640	3	4.4	4.4	mg/m³
10	4.1	S	S; AC	EN 12619	2 290	9.5	4.4	<8.8	mg/m³
11	4.1.2	S	**BF**	EN 12619, EN 13526	12 300	88	7.2	7.2	mg/m³
12	4.1.8	C	AC	VDI 3481 Bl.3	983	8.1	8.3	8.3	mg/m³
13	4.1.4	S	C; AC	EN 12619	5.6	0.048	9.1	9.1	mg/m³
14	4.1	C	C; C; AC	VDI 3481 Bl.3		0.35	10	<20	mg/m³
15	4.1.4	C	AC; S*3	VDI 3481 Bl.3	2 333	25	10.8	10.8	mg/m³
16	4.1.10	S	AC	EN 12619	5.0	0.06	12.8	12.8	mg/m³
17	4.1.8	S	AC	EN 13526	198	2.66	13.9	13.9	mg/m³
18	4.1.2	S	S*3; AC*2	EN 12619	420	8	19	19	mg/m³

#	Type of instal-lation	Waste gas system includ-ing activated carbon or biofilter or clay adsorp-tion		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
19	4.1.8	C	AC	VDI 3481 Bl.3	342	14.4	42.1	42.1	mg/m³
20	4.1.4	S	AC	EN 12619	15	0.665	47.3	47.3	mg/m³
21	4.1.4	S	C; AC	EN 12619	18	1.39	93	93	mg/m³
22	4.1.8	S	AC; F; F	EN 12619: 1999	20	1.5	181.5	181.5	mg/m³
23	4.1.7	S	S; AC	EN 13526, VDI 3481 Bl.3	459	101	219.2	219.2	mg/m³
24	4.1.4	S	C; AC	EN 12619	2.9	0.858	341	341	mg/m³
25	4.1.4	S	S; AC	VDI 3481-2	92	51	651	651	mg/m³
26	4.1.4	S	C; AC; S	EN 12619	55	79.9	1 483	1 483	mg/m³
27	4.1	S	AC	EN 12619, EN 13526	4.2	20	4 603	4 603	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 10 – TOC data – Scrubbers

Table 32 shows the mean concentration values of total organic carbon and the related mean mass flow associated with scrubber systems where these are not combined with thermal oxidation or catalytic oxidation nor activated carbon systems. The values are sorted by increasing mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 32: TOC emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m^3/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1		C	SNCR; Q; S; S	EN 12619:1999, EN 13526:2002	5 867	-	0.15	<0.3	mg/m3
2		C	SNCR; Q; S; S	EN 12619:1999, EN 13526:2002	5 542	-	0.475	<0.95	mg/m3
3		C	SNCR; Q; S; S	EN 12619:1999, EN 13526:2002	5 657	-	0.7	0.7	mg/m3
4	4.1.19	S	S	EN 12619	3.2	0.0015	0.5	<1	mg/m3
5	4.3	S	S	EN 12619, EN 13526	15	0.004	0.25	<0.5	mg/m3
6	4.1.19	S	S	EN 12619	16	0.01	0.5	<1	mg/m^3
7	4.3	S	S	EN 12619, EN 13526	74	0.0195	0.25	<0.5	mg/m^3
8	4.1.19	S	S	EN 12619	84	0.04	0.5	<1	mg/m^3
9	4.1.19	S	S	VDI 3481 Bl.3	<13	0.05	1	<2	mg/m^3
10	4.1.10	S	S	VDI 3481 Bl.3	1.0	0.21	210	210	mg/m^3
11	4.1.10	C	S	VDI 3481 Bl.3	48	0.328	7 000	7 000	mg/m^3
12	4.3	S	S	EN 12619, EN 13526	156	0.363	2.3	2.3	mg/m^3
13	4.3	S	S	EN 12619, EN 13526	1 310	0.5	0.4	<0.8	mg/m^3
14	4.1.11	S	S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	15	0.6	41.8	41.8	mg/m^3
15	4.1	C	C; S	VDI 3481 Bl.3		0.6	52	52	mg/m^3
16	4.1.4	S	S	EN 12619	31	0.692	21.9	21.9	mg/m^3
17	4.1.10	S	S	VDI 3481 Bl.3	2.5	0.97	444	444	mg/m^3

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
18	4.1	C	S	VDI 3481 Bl.3		0.98	36	36	mg/m³
19	4.1.21	C	C; S	EN 12619	74	1	17.1	17.1	mg/m³
20	4.1.10	S	S	EN 12619	1 100	1.5	1.5	<3	mg/m³
21	4.1.2	S	S*4; S*4	EN 12619	110	1.55	8.8	<17.6	mg/m³
22	4.1	C	S*2	EN 12619, EN 13526, VDI 3481 Bl. 1	515	1.6	3.1	3.1	mg/m³
23	4.1.7	S	S; S	VDI 3481 Bl. 3	574	1.8	2.3	2.3	mg/m³
24	4.1.10	S	S	EN 12619	2 020	2	1.2	1.2	mg/m³
25	4.1.13	S	S; S	EN 12619	1 115	2	1.4	1.4	mg/m³
26	4.1	C	S; FF; F	EN 12619, EN 13526, VDI 3481 Bl. 1	772	2	2.9	2.9	mg/m³
27	4.1.10	S	S	VDI 3481 Bl.3	6 077	2.5	0.5	<1	mg/m³
28	4.1.8	S	S	EN 12619, VDI 3481 Bl.3	166	2.6	16	16	mg/m³
29	4.1	C	S	VDI 3481 Bl.3	392	2.8	7.4	7.4	mg/m³
30	4.1.6	S	S; S	EN 12619	8.0	3	304	304	mg/m³
31	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	EN 12619, EN 13526	5 020	4	0.866	0.866	mg/m³
32	4.1.8	S	S	EN 12619:2013, VDI 3481 Bl.3:1995	280	4	13.9	13.9	mg/m³
33	4.1.11	S	S; DS	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	2.5	4.17	1 745.83	1 745.83	mg/m³
34	4.1.15	S	S	VDI 3481/3	24 993	4.5	0.2	<0.4	mg/m³
35	4.1.16	S	S*2; S*2; CAT; CAT	EN 12619	7 900	5	0.6	0.6	mg/m³
36	4.1.8	S	S	EN 12619:2013, VDI 3481 Bl.3:1995	310	5	18.2	18.2	mg/m³
37	4.1.19	S	S	EN ISO 25140	18	5	377	377	mg/m³
38	4.1.16	S	S*2; S*2; CAT	EN 12619	17 580	6	0.4	0.4	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
39	4.1.16	S	S*2; S*2; CAT	EN 12619	18 010	7	0.4	0.4	mg/m³
40	4.1.10	S	S	EN 12619	4 670	8	1.8	1.8	mg/m³
41	4.1	S	S; S	EN 12619:2013	330	8	23.4	23.4	mg/m³
42	4.1.19	S	S	EN 13526	31	8	624	624	mg/m³
43	4.1.18	S	S	EN 12619:2013	1 387	9	6.16	6.16	mg/m³
44	4.1	S	S; S	EN 13526	670	9	13	13	mg/m³
45	4.1.10	S	S	VDI 3481 Bl.3	735	9.5	13	13	mg/m³
46	4.1.8	S	CY*2; FF; S	EN 12619	4 840	11	2.4	2.4	mg/m³
47	4.1.2	S	S	EN 12619	1 230	11	8.7	8.7	mg/m³
48	4.1.7	C	S; S	EN 13526	11	11.5	10	<20	mg/m³
49	4.1.7	S	S; C	EN 13526	72	12	177.7	177.7	mg/m³
50	4.1	S	S	EN 13526, EN 12619	1 448	12.3	8.4	8.4	mg/m³
51	4.1.2	S	S*4; S*4	EN 12619	110	12.7	115.6	115.6	mg/m³
52	4.1	S	S; S	EN 12619:2013	440	13	29.1	29.1	mg/m³
53	4.1.16	S	FF; S	EN 12619	69	13.2	192	192	mg/m³
54	4.1	S	S	VDI 3481 Bl.3	13	13.4	1 042	1 042	mg/m³
55	4.1	C	S; S; S	EN 12619, EN 13526	35	14	405	405	mg/m³
56	4.1.7	S	C; S	VDI 3481/2 resp. sheet 281401; VDI 3481/3	4.9	14.8	1 856	1 856	mg/m³
57	4.1.8	S	S	EN 12619	6 930	15	2.1	2.1	mg/m³
58	4.1.8	S	S	VDI 3481 Bl.3	4 723	15	3.2	3.2	mg/m³
59	4.1/4.2	C	N.N.; C; S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl. 3:1995	3 720	15	4	4	mg/m³
60	4.1	S	S	VDI 3481 Bl.3	10	15.9	1 536	1 536	mg/m³
61	4.1.16	S	S*2; S*2; CAT	EN 12619	18 200	18	1	1	mg/m³
62	4.1	C	S; S; S	EN 12619:2013, VDI 3481 Bl.3:1995	18 020	18	1	<2	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
63	4.1	C	S*2; S	EN 13526, VDI 3481 Bl.3	3 160	20	6.4	6.4	mg/m³
64	4.1.2	S	S*2	EN 12619	5 260	20.3	3.9	3.9	mg/m³
65	4.1.8	S	S	EN 12619	10 700	21	2	2	mg/m³
66	4.1.8	S	S	EN 12619	8 370	22	2.6	2.6	mg/m³
67	4.1.18	S	S	EN 12619:2013	1 850	22	11.82	11.82	mg/m³
68	4.1.10	S	S; S	VDI 3481 Bl.3	1 705	22	12.9	12.9	mg/m³
69	4.1	S	S	VDI 3481 Bl.3	291	22.5	76	76	mg/m³
70	4.1	C	S	EN 13562:2002, EN 12619:1999, VDI 3481-1:1995	23 210	23	1	<2	mg/m³
71	4.1.8	S	S; S	FID	2 210	23	10.4	10.4	mg/m³
72	4.1.7	S	S	EN 12619	336	24	70.6	70.6	mg/m³
73	4.1.8	S	S	EN 12619	7 780	27	3.4	3.4	mg/m³
74	4.1.7	S	C; S	VDI 3481/2-3; 281401	17	28	1 753	1 753	mg/m³
75	4.1	S	S	EN 12619	5.0	28	5 504.8	5 504.8	mg/m³
76	4.1	C	S; S	EN 12619:2013, VDI 3481 Bl.3:1995	26 360	29	1.1	<2.2	mg/m³
77	4.1	C	S	VDI 3481 Bl.3	964	29	30.1	30.1	mg/m³
78	4.1.2	S	S; S*2	EN 12619	3 440	30.6	9	9	mg/m³
79	4.1.8	S	S	EN 12619	1 760	32	18.1	18.1	mg/m³
80	4.1.7	C	S; S	EN 13526	11	33	2 865	2 865	mg/m³
81	4.1.8	S	S	EN 12619	2 020	33.7	16.6	16.6	mg/m³
82	4.1	C	C; S*2; S; S*3	EN 13526, VDI 3481 Bl.3	8 930	34	3.9	3.9	mg/m³
83	4.1.2	S	S*2	EN 12619	5 200	34.2	6.6	6.6	mg/m³
84	4.1.8	S	S	EN 12619	1 770	36	20.2	20.2	mg/m³
85	4.1.7	C	S; S	EN 13526	11	39	53	53	mg/m³
86	4.1.10	S	S	VDI 3481 Bl.3	10 454	45	4.2	4.2	mg/m³
87	4.1	S	S	EN 13526	2 820	45	15.9	15.9	mg/m³
88	4.1	C	S	EN 12619	3 820	53	13.9	13.9	mg/m³
89	4.1.2	S	S	EN 12619	3 810	53.3	14.9	14.9	mg/m³
90	4.1/4.2	C	S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl. 3:1995	2 660	55	18.1	18.1	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
91	4.1.7	C	S; AB; AB	EN 12619	4 710	57	12.3	12.3	mg/m³
92	4.1.2	S	S	EN 12619	2 210	61	27.7	27.7	mg/m³
93	4.1.15	S	S*2; S	EN 12619	1 760	62	35	35	mg/m³
94	4.1.18	S	S; S	EN 12619, VDI 3481 Bl.3	13	69.1	5 480.6	5 480.6	mg/m³
95	4.1.10	C	S; S; S	VDI 3481 Bl.3	2 716	72	26.5	26.5	mg/m³
96	4.1	C	S; FF; CART	EN 12619:2013, VDI 3481 Bl.3:1995	9 960	80	8.05	8.05	mg/m³
97	4.1.8	S	S	EN 12619	6 660	80	12.1	12.1	mg/m³
98	4.1.4	S	S	EN 12619	775	80.9	103	103	mg/m³
99	4.1.8	S	S	EN 12619	3 540	85	23.9	23.9	mg/m³
100	4.1.7	S	C; S	VDI 3481/2; 281401	17	85	4 769	4 769	mg/m³
101	4.1/4.2	C	C; C; S; S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl. 3:1995	3 830	87	22.7	22.7	mg/m³
102	4.1.8	C	S; S; S	EN 12619	35	88	2 441	2 441	mg/m³
103	4.1.8	S	S*2; S; S	EN 12619	229	95	412	412	mg/m³
104	4.1.8	S	S	VDI 3481 Bl.3	5 384	95.2	17.8	17.8	mg/m³
105	4.1.15	S	C; S	EN 12619	1 225	96	78.1	78.1	mg/m³
106	4.1.8	S	CY; S	EN 12619	11 923	112	9.4	9.4	mg/m³
107	4.1	C	S; S	EN 13526, VDI 3481 Bl.3	9 030	112	12.5	12.5	mg/m³
108	4.1.10	S	S	VDI 3481 Bl.3	3 553	120.1	33.8	33.8	mg/m³
109	4.1.2	C	C; S; S; S	EN 12619	210	131	634	634	mg/m³
110	4.1	C	S; S; S	EN 12619:2013, VDI 3481 Bl.3:1995	24 850	134	5.4	5.4	mg/m³
111	4.1	C	S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	47 950	138	2.9	2.9	mg/m³
112	4.1	S	S*2	FID	7 200	147	20.4	20.4	mg/m³
113	4.1.10	C	S; S; S	VDI 3481 Bl.3	3 525	153	43.4	43.4	mg/m³
114	4.1.8	S	CY; S	EN 12619	11 582	160	13.7	13.7	mg/m³
115	4.1.10	S	S	VDI 3481 Bl.3	2 689	160	59.5	59.5	mg/m³
116	4.1.2	S	S; S*2	EN 12619	3 500	168	47.9	47.9	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers		TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
117	4.1.2	S	S; S*2	EN 12619	3 490	170	48.9	48.9	mg/m³
118	4.1.2	S	S*2	EN 12619	4 900	172	35.2	35.2	mg/m³
119	4.1.19	S	S	EN 13526	8 060	173	22	22	mg/m³
120	4.1	C	Q; S*2	EN 12619, EN 13526	29	174	5 721	5 721	mg/m³
121	4.1.10	C	S*2	VDI 3481 Bl.3	29 032	180	6.2	6.2	mg/m³
122	4.1.2	S	S*2	VDI 3481 Bl.3	5.0	189	37 876	37 876	mg/m³
123	4.1/4.2	C	S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl. 3:1995	2 660	191	71.8	71.8	mg/m³
124	4.1.2	S	S; S*2	EN 12619	3 490	208	59.6	59.6	mg/m³
125	4.1.2	S	S	EN 12619	19 840	212	10.7	10.7	mg/m³
126	4.1.16	S	S	EN 12619	2 950	218	73.9	73.9	mg/m³
127	4.1.8	S	S	EN 12619	19 272	250	13.2	13.2	mg/m³
128	4.1.10	S	S	VDI 3481 Bl.3	9 442	271	28.7	28.7	mg/m³
129	4.1/4.2	C	S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl. 3:1995	3 300	282	85.4	85.4	mg/m³
130	4.1.7	C	S	VDI 3481 Bl.3	13	307	23 355	23 355	mg/m³
131	4.1.4	S	S	EN 12619	767	375	483	483	mg/m³
132	4.1.8	S	S	EN 12619	16 058	400	24.9	24.9	mg/m³
133	4.1.16	S	FF; S*3	EN 13526	19 400	434	22.4	22.4	mg/m³
134	4.1.8	S	CY; S	EN 12619	15 794	435	27.5	27.5	mg/m³
135	4.1.7	C	S; S	EN 13526	1 143	439	384	384	mg/m³
136	4.1	C	S	EN 13562	46 900	460	9.8	9.8	mg/m³
137	4.1.8	S	FF; S	EN 12619	15 820	514	32.5	32.5	mg/m³
138	4.1.17	S	CY; S	EN 12619	190 600	546	2.8	2.8	mg/m³
139	4.1.8	S	FF; S	EN 12619	17 810	608	34.1	34.1	mg/m³
140	4.1	C	S; S; S; DS; S	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	46 670	762	16.3	16.3	mg/m³
141	4.1	S	S*2; S*2	EN 12619	35 810	899	25.1	25.1	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 11 – TOC data – No Waste Gas Treatment for TOC

Table 33 shows the mean concentration values of total organic carbon (TOC) and the related mean mass flow from sources where no waste gas treatment for TOC is installed (no treatment or mechanical treatment, not including thermal oxidation, catalytic oxidation, activated carbon, biofilter, adsorption on clay, scrubbers, or condensers). The values are presented according to the type of waste gas treatment system. They are sorted by increasing mass flow values.

The second column indicates the process category number (compare Annex 2), the third column shows the type of waste gas treatment system (see section 2.5, page 76 for explanation of abbreviations). The forth column informs about the measurement method. The fifth column indicates the mean mass flow, and the sixth and seventh column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 33: TOC emissions from sources without TOC-specific waste gas treatment

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
1	4.1.18	FF	EN 12619:2013		0	1	<2	mg/m³
2	4.3	CY	EN 12619:2013	490	0	2.75	2.75	mg/m³
3	4.1.12	none	EN 12619	115	0	0.2	0.2	mg/m³
4	4.2	none	VDI 3481 Bl.3		0.01	1.5	<3	mg/m³
5	4.1.8	FF	VDI 3481 Bl.3		0.05	4.9	4.9	mg/m³
6	4.1	none	EN 12619	1 085	0.06	13.7	13.7	mg/m³
7	4.1	FF	EN 12619, VDI 3481 Bl.3	158	0.28	1 770.6	1 770.6	mg/m³
8	4.1.8	none	EN 12619	5.3	0.3	1	1	mg/m³
9	4.2	none	VDI 3481 Bl.3	4.3	0.37	65	65	mg/m³
10	4.1.10	FF	EN 12619	2 100	0.5	0.15	<0.3	mg/m³
11	4.1.10	FF	EN 12619	1 900	0.5	0.15	<0.3	mg/m³
12	4.1.2	none	EN 12619, EN 13526, VDI 3481 Bl. 1	320	0.5	1	<2	mg/m³
13	4.1.11	none	EN 13526, VDI 3481 Bl.3	5.0	0.5	26.1	26.1	mg/m³
14	4.1.10	FF	EN 12619	5 900	1	0.15	<0.3	mg/m³
15	4.1.10	FF	EN 12619	5 400	1	0.15	<0.3	mg/m³
16	4.1.8	FF	VDI 3481 Bl.3	560	1	19.7	19.7	mg/m³
17	4.1	none	EN 12619	2.1	1	3.7	3.7	mg/m³
18	4.1	none	EN 12619, EN 13526	48	1	4	4	mg/m³
19	4.1.8	none	VDI 3481 Bl. 3	288	1.1	1	<2	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
20	4.2	none	VDI 3481 Bl.3	334	1.21	320	320	mg/m³
21	4.1	none	EN 12619:2013, VDI 3481 Bl.3:1995	1 113	1.25	4.1	<8.2	mg/m³
22	4.1.7	none	VDI 3481 Bl.3	3.7	1.45	9 126	9 126	mg/m³
23	4.1.8	FF	VDI 3481 Bl.3	1 020	1.5	1.5	1.5	mg/m³
24	4.1	none	VDI 3481/2	280	1.7	57.6	57.6	mg/m³
25	4.3	CY	EN 12619:2013	60	2	38.6	38.6	mg/m³
26	4.1.11	none	EN 13526, VDI 3481 Bl.3		2.3	53.35	53.35	mg/m³
27	4.2	none	VDI 3481 Bl.3	30	2.3	183.8	183.8	mg/m³
28	4.2	none	VDI 3481 Bl.3	30	2.37	377	377	mg/m³
29	4.2	FF; FF	VDI 3481 Bl.3		2.5	0.5	<1	mg/m³
30	4.1	none	EN 12619, EN 13526	12	2.7	361.9	361.9	mg/m³
31	4.1.11	none	EN 12619:2013, VDI 3481 Bl.3:1995	6.0	3	5.9	5.9	mg/m³
32	4.1.18	FF	EN 12619, VDI 3481 Bl.3	1 420	4	2.7	2.7	mg/m³
33	4.1.11	none	EN 13526, VDI 3481 Bl.3	7.0	4	138.8	138.8	mg/m³
34	4.1.11	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	480	4.3	2.4	2.43	mg/m³
35	4.1.8	none	VDI 3481 Bl.3	28	4.3	3.9	3.9	mg/m³
36	4.2	FF	VDI 3481 Bl.3	1 846	4.81	2.8	2.8	mg/m³
37	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	1 820	5	1	<2	mg/m³
38	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	1 117	5	1	<2	mg/m³
39	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	7 290	5	1	<2	mg/m³
40	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	7 290	5	1	<2	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
41	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	7 290	5	1	<2	mg/m³
42	4.1.18	F	EN 12619:2013	480	5	9.8	9.8	mg/m³
43	4.1.8	none	EN 12619	7 290	5	12.4	12.4	mg/m³
44	4.1.11	none	EN 13526, VDI 3481 Bl.3	7 290	5	132.5	132.5	mg/m³
45	4.1.11	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	380	5	3 533.3	3 533.3	mg/m³
46	4.1.8	none	VDI 3481 Bl.3	36	5.1	18.8	18.8	mg/m³
47	4.2	FF	VDI 3481 Bl.3	2 117.25	5.31	2.5	2.5	mg/m³
48	4.1.8	none	EN 13526, EN 12619, VDI 3481-1	1.0	6.5	1.1	<2.2	mg/m³
49	4.1.11	none	EN 13526, VDI 3481 Bl.3		6.5	144.8	144.8	mg/m³
50	4.1	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	7 290	7	2.45	<4.9	mg/m³
51	4.1.15	none	EN 12619	43	8.7	1 447	1 447	mg/m³
52	4.1.8	none	EN 12619	2 910	9	3.3	3.3	mg/m³
53	4.1.4	none	EN 12619	6.0	9	7.2	7.2	mg/m³
54	4.1.8	none	EN 12619	2 700	10	1.7	1.7	mg/m³
55	4.1.8	F	EN 12619	1 830	10	6.6	6.6	mg/m³
56	4.1.8	none	EN 12619, VDI 3481 Bl.3	1 260	10	14	14	mg/m³
57	4.2	FF	VDI 3481 Bl.3	4 027	11.3	2.8	2.8	mg/m³
58	4.1.10	none	EN 12619, EN 13526	7 520	12	1 906	1 906	mg/m³
59	4.1.8	none	EN 12619	770	14	2.8	2.8	mg/m³
60	4.1.8	none	EN 12619, EN 13526		14	2.8	2.8	mg/m³
61	4.1.7	none	EN 12619	3 400	14	11	11	mg/m³
62	4.1.8	F	EN 13526, EN 12619, VDI 3481-1	16 220	15	1	<2	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
63	4.1.8	F	EN 13526, EN 12619, VDI 3481-1	13 230	15	1	<2	mg/m³
64	4.1.8	F	EN 13526, EN 12619, VDI 3481-1	16 190	15	1	<2	mg/m³
65	4.1.16	none	EN 12619	4 900	16	41.2	41.2	mg/m³
66	4.1.11	none	EN 13526, VDI 3481 Bl.3	1 255	16	92	92	mg/m³
67	4.1	CART*2	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	1 320	17	12.7	12.7	mg/m³
68	4.1.8	none	EN 12619, EN 13526	400	18	6.7	6.7	mg/m³
69	4.1	none	EN 13526, VDI 3481 Bl.3	180	19	1.4	<2.8	mg/m³
70	4.1.8	FF	EN 12619	7 420	20	2.6	2.6	mg/m³
71	4.1.8	FF	EN 12619	1 790	20	11	11	mg/m³
72	4.2	FF	VDI 3481 Bl.3	2 879.5	20.3	6.7	6.7	mg/m³
73	4.2	FF	VDI 3481 Bl.3	13.425	20.36	1 650	1 650	mg/m³
74	4.1.18	FF	EN 12619:1999, VDI 3481 Bl.3+4+6, EN 13526:2002	982	21	21.2	21.2	mg/m³
75	4.3	CY	EN 12619:2013	5 267.5	22	4.1	4.1	mg/m³
76	4.1.18	FF	EN 12619, VDI 3481 Bl.3	417	22	23.8	23.8	mg/m³
77	4.1.11	none	EN 13526, VDI 3481 Bl.3	2 710	22.3	2 594.9	2 594.9	mg/m³
78	4.1	none	EN 13526, VDI 3481 Bl.3	13 400	23	7.1	7.1	mg/m³
79	4.1.8	none	EN 12619	8 114	23.5	2.9	2.9	mg/m³
80	4.1.11	none	EN 13526, VDI 3481 Bl.3	10	23.8	1 997.8	1 997.8	mg/m³
81	4.1.8	CY; FF	EN 12619	7190	24	3.4	3.4	mg/m³
82	4.1.8	none	EN 12619	3 170	25	3.5	3.5	mg/m³
83	4.1.4	CY; CY	EN 12619	1330	26	19.2	19.2	mg/m³
84	4.1.8	none	EN 12619,	10	30	16	16	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
			VDI 3481 Bl.3					
85	4.1.8	none	EN 12619	7 070	32	1.9	1.9	mg/m³
86	4.1.8	none	EN 12619	2 150	32	1.9	1.9	mg/m³
87	4.1	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	17 000	32	5.1	5.1	mg/m³
88	4.1.8	DS	EN 12619:2013, VDI 3481 Bl.3:1995	1690	32	19.2	19.2	mg/m³
89	4.1.8	none	EN 12619	17 000	36	2.1	2.1	mg/m³
90	4.1.18	none	EN 12619	6 370	36	44.6	44.6	mg/m³
91	4.1.8	none	EN 12619	17 000	37	2.2	2.2	mg/m³
92	4.1.8	none	EN 12619	810	37	2.2	2.2	mg/m³
93	4.1	FF	EN 12619	2 120	37	17.7	17.7	mg/m³
94	4.1.11	DS	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	3 860	37.5	9.75	<19.5	mg/m³
95	4.1.21	F; CY	FID EN 12619	1 130	38	33.9	33.9	mg/m³
96	4.1.8	none	EN 12619	17 000	40	13.8	13.8	mg/m³
97	4.1	none	EN 12619	17 000	40	20.5	20.5	mg/m³
98	4.1	none	EN 12619	3 230	40	2 791	2 791	mg/m³
99	4.1.8	none	EN 12619	2 112	42	7.5	7.5	mg/m³
100	4.1	none	EN 12619	14	44	550.5	550.5	mg/m³
101	4.1.2	none	EN 12619	5 600	45	37 000	37	g/m³
102	4.1	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	<159	48	7.97	7.97	mg/m³
103	4.1.11	DS	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	3 620	49	13.5	13.5	mg/m³
104	4.1.6	none	EN 13526	1.2	50	1.5	<3	mg/m³
105	4.1.8	FF	VDI 3481 Bl.3	2 201	52.7	24	24	mg/m³
106	4.1.8	F	EN 13526, EN 12619, VDI 3481-1	16 790	53	2.96	2.96	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
107	4.1.8	none	EN 12619	6 060	55	9.8	9.8	mg/m³
108	4.1.2	none	EN 12619	30 300	58	39 000	39	g/m³
109	4.1.2	none	EN 12619	5 600	64	35 000	35	g/m³
110	4.1.11	none	EN 13526, VDI 3481 Bl.1	1.5	65	2 160.5	2 160.5	mg/m³
111	4.1.8	none	EN 12619		66	9.4	9.4	mg/m³
112	4.1.8	none	VDI 3481 Bl.3	30	69.2	1 449	1 449	mg/m³
113	4.1.18	FF	EN 12619	264	74	281.3	281.3	mg/m³
114	4.1.11	none	EN 12619:2013, VDI 3481 Bl.3:1995	7 070	77	185	185	mg/m³
115	4.1.2	none	EN 12619, EN 13526, VDI 3481 Bl. 1	48	80	34	34	mg/m³
116	4.1.8	none	EN 12619	420	81.7	11.7	11.7	mg/m³
117	4.1.11	ESP	EN 13526, VDI 3481 Bl.3	2 930	93	31.8	31.8	mg/m³
118	4.1.6	none	EN 12619	2 400	94	130	94	mg/m³
119	4.1.18	FF	EN 12619, VDI 3481 Bl.3	1 109	100	99.3	99.3	mg/m³
120	4.1.8	FF	VDI 3481 Bl.3	2 689	109.2	40.6	40.6	mg/m³
121	4.1.18	FF	EN 12619, EN 13526, VDI 3841 Bl.1	533	115	225.5	225.5	mg/m³
122	4.1.8	none	EN 12619	7 000	116	3.1	0.0031	g/m³
123	4.1	F	EN 13526, VDI 3481-1	16 280	124	7.65	7.65	mg/m³
124	4.1.8	none	VDI 3481 Bl.3	37 490	132.8	3 354	3 354	mg/m³
125	4.1.11	none	EN 12619:2013, VDI 3481 Bl.3:1995	1 354	133	1 122.6	1 122.6	mg/m³
126	4.1.8	none	VDI 3481 Bl.3	(50 values)	136.3	7	7	mg/m³
127	4.3	CY	EN 12619:2013	5935	141	23.675	23.675	mg/m³
128	4.1.10	none	VDI 3481 Bl.3	120	142	8 113	8 113	mg/m³
129	4.1.8	none	EN 12619	19 500	144	2.9	0.0029	g/m³
130	4.1.8	none	EN 12619	18	144	19.8	0.0198	g/m³
131	4.1.8	none	EN 12619	49 230	152	12.6	12.6	mg/m³
132	4.1.8	none	EN 12619,	7 280	160	2.4	2.4	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
			EN 13526, VDI 3481 Bl. 1					
133	4.1.8	FF	EN 12619	13 900	164	11.8	11.8	mg/m³
134	4.1.2	DS	EN 12619	710	188	265	265	mg/m³
135	4.1	F	EN 13526, VDI 3481-1	18 560	192	10.3	10.3	mg/m³
136	4.1.18	FF	EN 12619, VDI 3481 Bl.3	364	195	535	535	mg/m³
137	4.1	FF	EN 12619	3 380	207	61.2	61.2	mg/m³
138	4.1.8	F	DIN EN 12619	190	220	1 164	1 164	mg/m³
139	4.1.8	none	EN 12619, EN 13526, VDI 3481 Bl. 1	12 000	240	4.9	4.9	mg/m³
140	4.1.8	none	EN 12619	65 866	251	19.2	0.0192	g/m³
141	4.1.10	FF	EN 12619	9100	273	30	30	mg/m³
142	4.1.11	none	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	49 619	286	9 540	9 540	mg/m³
143	4.1	none	EN 12619:2013, VDI 3481 Bl.3:1995	13 100	308	10 120	10 120	mg/m³
144	4.1.10	none	EN 12619, EN 13526	30	329	25 042	25 042	mg/m³
145	4.1.8	none	EN 12619	27	339	3.5	3.5	mg/m³
146	4.1.18	FF; F	EN 12619:1999, VDI 3481 Bl.3+4+6, EN 13526:2002	421	340	792.2	792.2	mg/m³
147	4.1.2	none	DIN EN 12619		371	15 500	15.5	g/m³
148	4.1.8	none	EN 12619	97 660	642	33.4	0.0334	g/m³
149	4.1.8	none	EN 12619	27	831	47	0.047	g/m³
150	4.1.8	none	EN 12619, EN 13526, VDI 3481 Bl. 1	19 220	830	53.9	53.9	mg/m³
151	4.1.8	none	EN 12619, EN 13526, VDI 3481 Bl. 1	17 690	1 350	65.5	65.5	mg/m³
152	4.1.8	none	EN 12619,	15 328	1 900	237	237	mg/m³

#	Type of instal-lation	Waste gas system	TOC Measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original value	
			EN 13526, VDI 3481 Bl. 1					
153	4.1.8	none	EN 12619	18 478	2 706	30.8	30.8	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 12 – TOC data – Other waste gas treatment systems

Table 34 shows the mean concentration values of total organic carbon and the related mean mass flow associated with other waste gas treatment systems for TOC, in particular condensers. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (C = condensation, FF = Fabric filter, HE = Heat exchanger, MF = Membrane filtration, RU = recovery unit, SP = several specific filter systems, SR = solvent recovery, N. N. = no information). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented with 50 % of the results originally indicated with "<".

Table 34: TOC emissions from sources with other waste gas treatment systems

#	Type of instal-lation	Waste gas system		TOC measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	S	Flare	EN 12619	3 000	1.5	0.5	<1	mg/m³
2	4.1.8	S	Flare	EN 12619, EN 13526	3 416	1.5	0.5	<1	mg/m³
3	4.1	S	SP	EN 13526, VDI 3481-1	4 410	4.5	1	<2	mg/m³
4	4.1.11	C	RU	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	10	0.05	5.05	5.05	mg/m³
5	4.1.8	C	C	EN 12619	15 757	112	7.1	7.1	mg/m³
6	4.1.17	?	N. N.	VDI 3481 Bl. 3	173 064	1 355	7.8	7.8	mg/m³
7	4.1	S	FF;C;C;C;C;F	EN 12619	1 710	18	10.8	10.8	mg/m³
8	4.1	S	C	EN 12619	7.3	0.1	13.3	13.3	mg/m³
9	4.2	S	C	VDI 3481 Bl.3	1 615	56.7	35.1	35.1	mg/m³
10	4.1.8	S	C	EN 12619	10	1	109.1	109.1	mg/m³
11	4.1	S	C	EN 12619	66	8	129.2	129.2	mg/m³
12	4.1.15	S	C	EN 12619	15	3.1	206	206	mg/m³
13	4.1.8	S	C	EN 12619	10	4	383.8	383.8	mg/m³
14	4.1.11	C	C	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	70	72.6	1 202.14	1 202.14	mg/m³
15	4.1	S	C	EN 12619, EN 13526, VDI 3481 Bl. 1	13	16	1 218	1 218	mg/m³

#	Type of instal-lation	Waste gas system		TOC measurement method	Mean Volume Flow (*) [m³/h]	TOC Mean Mass Flow [g/h]	TOC Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
16	4.1.10	S	C; SR; MF	VDI 3481 Bl.3	32	42	1 320	1 320	mg/m³
17	4.1.8	S	C	EN 12619	10	15	1 515.7	1 515.7	mg/m³
18	4.1.11	C	C	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	100	149	1 715	1 715	mg/m³
19	4.1.11	C	C	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	100	128.9	1 735.93 8	1 735.93 8	mg/m³
20	4.1.11	C	C; C	EN 13526, VDI 3481 Bl.1	46	68	1 930.7	1 930.7	mg/m³
21	4.1	S	C	EN 12619	3.4	7	2 024	2 024	mg/m³
22	4.1.11	C	C	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	130	202.48	2 250	2 250	mg/m³
23	4.1	S	C	EN 12619:2013, VDI 3481 Bl.3:1995	14	48	2 740	2 740	mg/m³
24	4.1.8	S	C	EN 12619	10	29	2 921.3	2 921.3	mg/m³
25	4.1.11	C	C; C	EN 12619:2013, VDI 3481 Bl.3:1995	80	197	3 900	3 900	mg/m³
26	4.1	S	C; C	EN 12619	4.7	25	5 438	5 438	mg/m³
27	4.1.11	C	HE	EN 13526:2002, EN 12619:1999, VDI 3481 Bl.3:1995	0.2	1.275	6 291.63	6 291.63	mg/m³
28	4.1.10	S	C; SR	VDI 3481 Bl.3	7.0	109	15 566	15 566	mg/m³
29	4.1.7	S	C	EN 13526	23	381	16 580	16 580	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 13 – NOx data – Thermal oxidation

Table 35 shows the mean concentration values of NOx and the related mean mass flow from sources where thermal oxidation systems are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). Where SCR or "DeNOx" systems are explicitly mentioned, they are highlighted in bold letters.

The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 35: NOx emissions from sources with thermal oxidation

#	Type of installation	Waste gas system including thermal oxidation		NOx Measurement method	Mean Volume Flow (*) [m^3/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	4.1.1	C	TO; Q; S; S	EN 14792	4 278	0	0	0	mg/m^3
2	4.1.2	S	S; TO	EN 14792	162 235	166.5	1.05	<2.1	mg/m3
3	4.1.8	S	Flare	EN 14792	3 000	7.5	2.5	<5	mg/m^3
4	4.1.2	S	S; TO	DIN 33962	146 839	367.3	2.5	<5	mg/m3
5	4.1.8	C	TO	EN 14792	650	2	3.1	3.1	mg/m^3
6	4.1.8	C	TO	EN 14792	3 740	10	3.6	3.6	mg/m^3
7	4.1.2	S	TO	EN 14792	14 800	80	5.1	5.1	mg/m^3
8	4.1.8	S	Flare	EN 14792	3 416	18	5.3	5.3	mg/m^3
9	4.1.16	S	FF; TO; S	EN 14792	3 850	23	6	6	mg/m^3
10	4.1	C	TO	EN 14792	16 424	100	7.3	7.3	mg/m^3
11	4.1.8	C	TO	EN 14792	32 100	280	8.7	8.7	mg/m^3
12	4.10; 4.1.8	C	TO	DIN 33962	18 500	162.7	9	0.009	g/m^3
13	4.1.18	C	TO	EN 14792	594	5.4	9.2	9.2	mg/m^3
14	4.1.2	C	TO; S; Q	Photometric measurement of selective UV absorption	9 807	118	12	0.012	g/m^3
15	4.1.6	S	TO; S*2	EN 14792	8 933	118.39	13.3	<0.026 6	g/m^3
16	4.1	C	TO	EN 14792:2006	21 730	311	14.1	14.1	mg/m^3
17	4.1.2	C	TO	EN 14792	806	11	14.7	14.7	mg/m^3
18	4.1	C	TO	EN 14792	19 820	343	17.3	17.3	mg/m^3

#	Type of instal-lation	Waste gas system including thermal oxidation		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
19	4.1.2	C	TO; S; Q	EN 14792	9 681	237	20	0.02	g/m³
20	4.1.16	S	FF; TO	EN 14792	3 020	69	22.3	22.3	mg/m³
21	4.1	S	TO; S*2	EN 14792	2 280	56.7	25	0.025	g/m³
22	4.1.6/8 *	C	TO; Q; S; S; DD	VDI 3482/4-5	16 400	424	25.8	25.8	mg/m³
23	4.1.2	C	TO	EN 14792	1 888	50	26.5	26.5	mg/m³
24	4.1	C	TO	EN 14792	18 700	502	26.9	26.9	mg/m³
25	4.1.19	S	TO	EN 14792	6 660	192.6	28.8	28.8	mg/m³
26	4.1.2	C	TO; S; Q	EN 14792	9 269	319	30	0.03	g/m³
27	4.1.6/8 *	C	TO; Q; S; S; DD	VDI 3482/4-5	16 400	500	30.5	30.5	mg/m³
28	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	17 539	536.3	30.6	30.6	mg/m³
29	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	16 126	551.33 3333	34.2	34.2	mg/m³
30	4.1.8	S	TO	EN 14792:2006	8 300	284	34.3	34.3	mg/m³
31	4.1.16	S	TO	EN 14792	4 533	156	34.6	34.6	mg/m³
32	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	16 500	583	35.3	35.3	mg/m³
33	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	15 600	585	37.5	37.5	mg/m³
34	4.1.1	S	TO; FF; S; S; S; S	EN 14792	544	21	39	39,0	mg/m³
35	4.1.8	C	TO	EN 14792	10 860	440	41	0.041	g/m³
36	4.1.8	C	CY; TO; S	EN 14792	331		41.4	41.4	mg/m³
37	4.1.19	C	TO; **DeNOx;** S; Q; S	EN 14792	4 552		42.8	42.8	mg/m³
38	4.1.18	C	C; S*2; TO	EN 14792	100	4	42.85	42.85	mg/m³
39	4.1	C	TO	EN 14792	800	35	43.4	43.4	mg/m³
40	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	16 700	726.3	43.5	43.5	mg/m³
41	4.1.2	S	TO	EN 14792	1 200	50	44	0.044	g/m³
42	4.1.16	C	S; TO	EN 14792	3 700	180	47	47	mg/m3

#	Type of installation	Waste gas system including thermal oxidation		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
43	4.1.1, 4.1.2, 4.1.3, 4.1.6,4.1.11;4.1.13,4.1.15	S	TO	EN 14792	480	22	50	0.05	g/m³
44	4.1.16	C	TO	EN 14792	2 630	140	50	0.05	g/m³
45	4.1.19	S	TO; **SCR**		7 000	350	51.4	51.4	mg/m³
46	4.1.8	C	TO	EN 14792	1 030	32	53.3	53.3	mg/m³
47	4.1.6/8 *	C	TO; Q; S; S; DD	EN 14792	15 519	876	56.5	56.5	mg/m³
48	4.1.1	C	TO; Q; S; BU; **SCR**	EN 14792	799	47	59	59	mg/m³
49	4.7	S	BU; C; AD; FF	EN 14792	45 900	2723	59	0.059	g/m³
50	4.1.19	S	TO; **SCR**		7 000	414	59.9	59.9	mg/m³
51		C	TO	EN 14792	15 750	740	62	0.062	g/m³
52	4.1.2	C	**SCR;** Q; S*3; TO	EN 14792	2 805	176	63	0.063	g/m³
53	4.1.16	C	TO	EN 14792	1 663	128.5	66	0.066	g/m³
54	4.1.18	C	C; S*2; TO	EN 14792	85	6	66.88	66.88	mg/m³
55	4.1.19	S	TO; S	EN 14792	1 340	90	68	68	mg/m³
56	4.1.2	S	TO	DIN 33962:1997	718	50	68.5	68.5	mg/m³
57	4.1.2	S	TO	EN 14792	777	54	69.3	69.3	mg/m³
58	4.1	S	TO	EN 14792	60		72	0.072	g/m³
59	4.1.8	S	TO	EN 14792	10 570	790	74	0.074	g/m3
60	4.1.18	C	TO	EN 14792	1 026	77.1	75.2	75.2	mg/m³
61	4.1.8	S	TO	EN 14792	2 530	191	76	0.076	g/m³
62	4.1.19	S	TO; **SCR**	N. N.	7 000	504	76.4	76.4	mg/m³
63	4.1.8 / 8.1	C	TO	EN 14792			77.61	77.61	mg/m³
64	4.1.21	C	TO; FF	EN 14792	287	24	83	83	mg/m³
65	4.1.2	C	**SCR;** Q; S*3; TO	EN 14792	2 985	247	83	0.083	g/m³
66	4.1.1	C	TO	EN 14792	879	80	87	87	mg/m³
67	4.1.8 / 8.1	C	TO	EN 14792			87.53	87.53	mg/m³

#	Type of instal-lation	Waste gas system including thermal oxidation		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
68	4.1.2	C	TO	EN 14792	1 460	145	99.1	99.1	mg/m³
69	4.1.21	C	TO; FF	EN 14792	208	21	100	100	mg/m³
70	4.1.2, 4.1.7	S	TO	Electrochemical cell	3 955		114	114	mg/m³
71	4.1.8 / 8.1	C	TO	EN 14792			119.55	119.55	mg/m³
72	4.1.8 / 8.1	C	TO	EN 14792			123.24	123.24	mg/m³
73	4.1	C	TO,S*2	EN 14792	34 009	3350	124.8	124.8	mg/m³
74	4.1.8 / 8.1	C	TO	EN 14792			125.38	125.38	mg/m³
75	4.1.19	S	TO; S	EN 14792	1 160	150	127	127	mg/m³
76	4.1.8 / 8.1	C	TO	EN 14792			134.25	134.25	mg/m³
77	4.1.8 / 8.1	C	TO	EN 14792			139.6	139.6	mg/m³
78	4.1.18	C	TO; S; S	EN 14792	1 350	190	140.8	140.8	mg/m³
79	4.1.8 / 8.1	C	TO	EN 14792			147.2	147.2	mg/m³
80	4.1.8 / 8.1	C	TO	EN 14792			159.08	159.08	mg/m³
81	4.1	C	TO	EN 14792:2006	2 230	239	160	0.16	g/m³
82	4.1.8 / 8.1	C	TO	EN 14792			177.2	177.2	mg/m³
83	4.1.10	S	TO, Q, S	EN 14792	3 221	612	190	190	mg/m³
84	4.1	S	**SCR**	EN 14792:2006	2 520	394	199.2	199.2	mg/m³
85	4.1.8	C	TO	UV Absorption	1 509		206	206	mg/m³
86	4.1.8	S	TO	EN 14792	2 140	457	214	0.214	g/m³
87	4.1.8	C	TO	UV Absorption	3 263		236.7	236.7	mg/m³
88	4.1.8	C	TO	UV Absorption	896		245.5	245.5	mg/m³
89	4.1.1	S	TO	EN 14792	209	70	335	335.0	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 14 – NOx and CO data – Thermal oxidation, TOC < 5 mg/Nm³

Table 36 shows mean concentration values of NOx and CO associated with thermal or catalytic oxidation systems where TOC concentrations are below 5 mg/Nm3. The values are sorted by increasing NOx concentration.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth shows the waste gas volume. The sixth, seventh and eighth column indicate the mean concentration value for NOx, CO and TOC. Values below the detection limit are presented with 50 % of the measurement results originally indicated with "<".

Table 36: NOx and CO emissions from sources with thermal oxidation and TOC below 5 mg/Nm³

#	Type of installation	Waste gas system including thermal or catalytic oxidation		Mean Volume Flow (*) [m³/h]	NOx Mean Concentration [mg/Nm³]	CO Mean Concentration [mg/Nm³]	TOC Mean Concentration [mg/Nm³]
1	4.1.2	S	S; TO	162 235	1.05	20.8	0.3
2	4.1.8	C	S; COX	945	1.3	0.75	0.4
3	4.1.8	C	C; COX	36	1.55	47	2.4
4	4.1.8	S	SP; COX	10 860	2	4	3.1
5	4.1.7	S	COX	380	2.5	1.5	0.8
6	4.1.2	S	S; TO	146 839	2.5	32.3	0.6
7	4.1.8	S	Flare	3 000	2.5	1	0.5
8	4.1.2	S	TO	14 800	5.1	3.7	1.05
9	4.1.8	S	Flare	3 416	5.3	1	0.5
10	4.1.16	S	FF; TO; S	3 850	6	39	2.7
11	4.1.18	C	S*3; S; S; S; S; COX	982	6.93	1	4.93
12	4.1	C	TO	16 424	7.3	26.1	1.75
13	4.1.8	C	TO	32 100	8.7	4.2	1
14	4.1.18	C	TO	594	9.2	3	2
15	4.1.2	C	TO; S; Q	9 807	12	3.5	0.5
16	4.1.8	C	COX	2 885	12.4	12.8	0.1333
17	4.1	C	TO	21 730	14.1	58.5	1
18	4.1.2	C	TO	806	14.7	1.25	2.9
19	4.1	C	TO	19 820	17.3	1.3	1.7
20	4.1.2	C	TO; S; Q	9 681	20	0.65	0.1
21	4.1.16	S	FF; TO	3 020	22.3	7.1	0.8
22	4.1	S	TO; S*2	2 280	25	11.3	1
23	4.1.6/8	C	TO; Q; S; S; DD	16 400	25.8	0.65	0.2
24	4.1.2	C	TO	1 880	26.5	1.25	2.5

#	Type of installa-tion	Waste gas system including thermal or catalytic oxidation		Mean Volume Flow (*) [m³/h]	NOx Mean Concentration [mg/Nm³]	CO Mean Concentration [mg/Nm³]	TOC Mean Concentration [mg/Nm³]
25	4.1	C	TO	18 700	26.9	0.8	1.8
26	4.1.2	C	TO; S; Q	9 269	30	1	0.1
27	4.1.6/8	C	TO; Q; S; S; DD	16 400	30.5	0.65	0.4
28	4.1.6/8	C	TO; Q; S; S; DD	17 539	30.57	3.57	0.4
29	4.1.6/8	C	TO; Q; S; S; DD	16 126	34.2	1.8	1.3
30	4.1.8	S	TO	8 300	34.3	11.7	1
31	4.1.6/8	C	TO; Q; S; S; DD	16 500	35.3	0	0.8
32	4.1.6/8	C	TO; Q; S; S; DD	15 600	37.5	0	0.8
33	10.3.1	C	SNCR; Q; S; S	5 867	39.5	6	0.15
34	4.1.8	C	TO	10 860	41	2.5	1
35	4.1.8	C	CY; TO; S	331	41.4	6.9	0.9
36	4.1.19	C	TO	4 552	42.8	2.7	0.25
37	4.1.18	C	C; S*2; TO	100	42.85	0.007	1
38	4.1	C	TO	800	43.4	5.3	0.3
39	4.1.6/8	C	TO; Q; S; S; DD	16 700	43.5	4.73	0.05
40	4.1.2	S	TO	1 200	44	17	3
41	4.1.1, 4.1.2, 4.1.3, 4.1.6,4.1.11;4.1.13,4.1.15	S	TO	480	50	2.5	0.95
42	4.1.19	S	TO; SCR	7 000	51.4	12.4	1.3
43	4.1.8	C	TO	1 030	53.3	57.4	3.7
44	4.1.6/8	C	TO; Q; S; S; DD	15 519	56.47	6.37	1.2
45	4.1.19	S	TO; SCR	7 000	59.9	13.1	8
46		C	TO	15 750	62	2.5	0.65
47	4.1.2	C	SCR; Q; S*3; TO	2 805	63	4	0.1
48	4.1.18	C	C; S*2; TO	85	66.88	5	2
49	4.1.19	S	TO; S	1 340	68	49.9	1.1
50	4.1.2	S	TO	777	69.3	0.95	2.2
51	4.1	S	TO	60	72	6.5	0.15
52	4.1.8	S	TO	10 570	74	16.3	1
53	4.1.18	C	TO	1 026	75.2	3	1.1
54	4.1.8	S	TO	2 530	76	1.6	4.5

#	Type of installa-tion	Waste gas system including thermal or catalytic oxidation		Mean Volume Flow (*) [m^3/h]	NOx Mean Concentration [mg/Nm^3]	CO Mean Concentration [mg/Nm^3]	TOC Mean Concentration [mg/Nm^3]
55	4.1.19	S	TO; SCR	7 000	76.4	14.4	0.7
56	4.1.2	C	SCR; Q; S*3; TO	2 985	83	4	0.15
57	4.1.19	S	TO; S	1 160	127	54.3	2.2
58	4.1.18	C	TO; S; S	1 350	140.8	1.25	1.25
59	4.1	C	TO	2 230	160	15.7	1.35
60	4.1.8	C	TO	1 509	206	24.2	1
61	4.1.8	S	TO	2 140	214	3.9	0.3
62	4.1.8	C	TO	3 263	236.7	1	1.3
63	4.1.8	C	TO	896	245.5	17.9	2.3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 15 – NOx data – Scrubbers and other cold treatment systems

Table 37 shows the NOx mean concentration values and the related mean mass flow from sources where scrubbers or other cold treatment systems are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 37: NOx emissions from other sources with scrubbers or other cold treatment systems

#	Type of instal-lation	Waste gas system including scrubbers or other cold treatment		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1	S	S	EN 14792	92	1.7	0.0185	<0.037	mg/m³
2	4.1.16	S	FF; S		69	0.05	0.5	<1	mg/m³
3	4.1.21	C	C; S	EN 14792	74	0.05	0.5	<0.001	g/m³
4	4.1.10	S	S; S	EN 14792	1 711	1.5	1	<2	mg/m³
5	4.1.10	C	S*2	EN 14792	29 000	29	1	<2	mg/m³
6	4.1.2	S	CY; S; HE	Photometric measurement of selective UV absorption	30 408	30	1	<2	mg/m³
7	4.1.8	C	S; COX	EN 14792	945	1	1.3	<2,6	mg/m³
8	4.1	S	S; S	VDI 2456 Bl. 10	12 500	18	1.485	<2.97	mg/m³
9	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 040	1.5	1.5	<3	mg/m³
10	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 150	1.5	1.5	<3	mg/m³
11	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 100	1.5	1.5	<3	mg/m³
12	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 160	1.5	1.5	<3	mg/m³
13	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 040	1.5	1.5	<3	mg/m³
14	4.1.16	S	F; S; GW; AD	NDIR adapted to EN 14792	1 170	2	1.5	<3	mg/m³
15	4.1.10	S	S	EN 14792	8 542	20.5	2.4	2.4	mg/m³
16	4.1	C	S*2; S	EN 14792	3 160	8	2.5	<0.005	g/m³

#	Type of instal-lation	Waste gas system including scrubbers or other cold treatment		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
17	4.1	C	C; S*2; S; S*3	EN 14792	8 930	20	2.5	<0.005	g/m³
18	4.1	C	S	EN 14792:2006	10 960	27.5	2.5	<5	mg/m³
19	4.1	C	S	EN 14792:2006	47 950	120	2.5	<5	mg/m³
20	4.1.15	S	S*2; FF	EN 14792	11 158	35	2.55	<5.1	mg/m³
21	4.1.15	S	S (several)	EN 14792	24 993	64	2.55	<5.1	mg/m³
22	4.1	C	S; CART	EN 14792:2006	9 510	26.5	2.75	<5.5	mg/m³
23	4.1.18	C	S*3; S; S; S; S; COX	EN 14792	1 250	4	3.02	3.02	mg/m³
24	4.1	S	S	EN 14792	390	2	4	0.004	g/m³
25	4.1.2	S	S; HE	EN 14792	31 100	124	4	4	mg/m³
26	4.1	C	S; S	EN 14792:2006	26 360	122	4.625	<9.25	mg/m³
27	4.1.10	S	S	EN 14792	3 553	16.7	4.7	4.7	mg/m³
28	4.1	C	S; S; S	EN 14792:2006	18 020	85.5	4.75	<9.5	mg/m³
29	4.1.10	S	S; S	EN 14792	17 200	80	5	5	mg/m³
30	4.1.15	S	S	EN 14792	7 633	39.5	5.15	<10.3	mg/m³
31	4.1	S	S*3	EN 14792	9 253	47.5	5.15	<10.3	mg/m³
32	4.1.16	S	S	EN 14792	442	2.7	6	6	mg/m³
33	4.1.10	S	S	EN 14792	3 172	20.3	6.4	6.4	mg/m³
34	4.1.18	C	S*3; S; S; S; S; COX	EN 14792	982	7	6.93	6.93	mg/m³
35	4.1.8	S	S	EN 14792	1	0.008	8.1	0.0081	g/m³
36	4.1	C	S; FF; CART	EN 14792:2006	12 680	110	8.65	<17.3	mg/m³
37	4.1	S	S; DS	EN 14792	11 800	120	10	10	mg/m³
38	4.1	C	S; S; S	EN 14792:2006	24 850	266	10.7	10.7	mg/m³
39	4.1.8	S	FF; S; COX	EN 14792	10 300	113	11	0.011	g/m³
40	4.1.17	S	CY; S	EN 14792	185 400	2 220	11.9	11.9	mg/m³
41	4.1.16	S	S	EN 14792	2 600	33	12.6	12.6	mg/m³
42	4.1.8	S	FF; S	EN 14792	17 810	79	13	0.013	g/m³
43	4.1	S	S	VDI 2456	475	7	14.5	14.5	mg/m³
44	4.1	C	S; S; S; DS; S	EN 14792:2006	46 670	781	16.7	16.7	mg/m³
45	4.1.18	C	S; S; S; S; COX	EN 14792	1 100	23	19	19	mg/m3
46	4.1.10	S	S	EN 14792	9 900	206	20.8	20.8	mg/m³
47	4.1.10	S	S	EN 14792	10 400	267	25.6	25.6	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers or other cold treatment		NOx Measurement method	Mean Volume Flow (*) [m^3/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
48	4.1.17	S	CY; S	EN 14792	190 600	5 011	26.2	26.2	mg/m^3
49	10.3.1	C	SNCR; Q; S; S	EN 14792:2006	5 542		28.5	0.0285	g/m^3
50	4.1	S	S; DS; C; S	EN 14792	10 300	350	30	0.03	g/m^3
51	4.1	S	S	EN 14792:2006	23 270	736	31.5	31.5	mg/m^3
52	4.1.16	-	S;SP	EN 14792	10 100	320	32	32	mg/m^3
53	10.3.1	C	SNCR; Q; S; S	EN 14792:2006	5 657		32.5	0.0325	g/m^3
54	4.1	C	S	EN 14792:2006	23 210	894	38.5	38.5	mg/m^3
55	4.1	C	S	EN 14792:2006	5 867	894	38.5	38.5	mg/m^3
56	4.1.8	S	FF; S	EN 14792	15 820	232	42	0.042	g/m^3
57	4.1	S	S	EN 14792	274	17.7	64.6	64.6	mg/m^3
58	4.1.19	S	S*2; S*2; AC	EN 14792:2006	1 010	67	66.3	66.3	mg/m^3
59	4.1.16	S	FF; S*8	EN 14792	19 400	1 591	82	82	mg/m^3
60	4.1.13	S	S; S	EN 14792	1 115	170	94	94	mg/m^3
61	4.1.10	S	S; ESP; AC	EN 14792	32 900	3 567	108.4	108.4	mg/m^3
62	4.1	S	S*4	DIN 33962	414	251	606.5	606.5	mg/m^3
63	4.1	S	S	EN 14792	1	4	1 827	<3 653.97	mg/m^3
64	4.1.17	S	S; S	VDI 2456	11 200	5 654	505	505	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 16 – NOx data – No Thermal Oxidation, No Scrubber

Table 38 shows the NOx mean concentration values and the related mean mass flow from sources where no thermal oxidation nor scrubbers are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment system (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 38: NOx emissions from other sources with scrubbers or other cold treatment systems

#	Type of installation	Waste gas system without thermal oxidation or scrubbers		NOx Measurement method	Mean Volume Flow (*) [m^3/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	4.1	-	none	EN 14792	1 820	1.85	0.5755	<1.151	mg/m^3
2	4.1.8	C	C; COX	EN 14792	36	0.05	1.55	<3.1	mg/m^3
3	4.1.8	S	SP; COX	EN 14792	10 860	21	2	0.002	g/m^3
4	4.1.8	S	COX	EN 14792	18 500	38	2.05	<4.1	mg/m^3
5	4.1.7	S	COX	EN 14792	233	0.6	2.5	<5	mg/m^3
6	4.1.7	S	COX	EN 14792	380	1	2.5	<5	mg/m^3
7	4.1.10	S	FF	EN 14792	11 100	28	2.5	<5	mg/m^3
8	4.1.10	S	FF	EN 14792	6 600	26.5	4	<8	mg/m^3
9	4.1.10	S	FF	EN 14792	13 700	55	4	<8	mg/m^3
10	4.1.16	S	FF	EN 14792	1 900	9	4.9	4.9	mg/m^3
11	4.1.17	S	CY	VDI 2456	111 000	610.5	5.5	<11	mg/m^3
12	4.1.10	S	FF	EN 14792	6 300	56	8.8	8.8	mg/m^3
13	4.1.15	S	CY; FF	EN 14792	23 700	50	10	<0.02	g/m^3
14	4.1.17	?	N. N.	EN 14792	173 064	1 857	10.7	10.7	mg/m^3
15	4.1.21	S	FF	EN 14792	77 400	950.01	12.3	12.3	mg/m^3
16	4.1.8	C	COX	EN 14792	2 885	35.7	12.4	12.4	mg/m^3
17	4.1.10	S	FF	EN 14792	10 200	132.3	13	13	mg/m^3
18	4.1	S	F	EN 14792	16 280	49	13.15	<26.3	mg/m^3
19	4.1.10	S	FF	EN 14792	7 300	104	14.3	14.3	mg/m^3
20	4.1.15	S	CY; FF	EN 14792	19 400	229	18.3	<0.0366	g/m^3
21	4.1	S	FF	EN 14792	5 570	122	22	22	mg/m^3
22	4.1.16	S	FF	EN 14792	10 933	249	22.8	22.8	mg/m^3
23	4.1	S	F	EN 14792	18 560	144	26.7	0.0267	g/m^3

#	Type of installation	Waste gas system without thermal oxidation or scrubbers		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
24	4.1.10	S	FF	EN 14792	23 300	695	29.8	29.8	mg/m³
25	4.1.15	S	CY; FF	EN 14792	21 700	227	31	0.031	g/m³
26	4.1.8	S	F	EN 14792:2006	26 010	251	31	31	mg/m³
27	4.1.12	-	none	EN 14792	1 085	38	35.7	35.7	mg/m³
28	4.1.6	-	none	EN 14792	30 300	1294	44	0.044	g/m³
29	4.1.13	-	none	EN 14792	65 800	3177	48.3	48.3	mg/m³
30	4.1.16	-	none	EN 14792	869	50	60	60	mg/m³
31	4.1.16	S	FF; HE	EN 14792	5 100	338	66.3	66.3	mg/m³
32	4.1.15	-	none	EN 14792	5 833	387.8	66.7	66.7	mg/m³
33	4.1.12	-	none	DIN 33962	6 870	336	67.1	67.1	mg/m³
34	4.1.7	-	none	EN 14792	152	7	69	69	mg/m³
35	4.1	-	none	EN 14792	882	19	70	0.07	g/m³
36	4.1	-	none	EN 14792	332	18.7	71.77	71.8	mg/m³
37	4.1	-	none	EN 14792:2006	370	23	73	0.073	g/m³
38	4.1.8	-	none	EN 14792				78	mg/m³
39	4.1.15	S	none	EN 14792	5 330	463.3	87	87	mg/m³
40	4.1.16	-	none	EN 14792	367	20	98	98	mg/m³
41	4.1.16	-	none	EN 14792	600	23	104	104	mg/m³
42	4.1	-	none	DIN 33962	479	51	106.03	106.03	mg/m³
43	4.1.16	-	none	EN 14792	567	21	106.9	106.9	mg/m³
44	4.1	?	N. N.	EN 14792	40	4	107	0.107	g/m³
45	4.1.7	S	SR	EN 14792	1 080	101	107	0.107	g/m³
46	4.1.16	-	none	EN 14792	567	21	108.4	108.4	mg/m³
47	4.1.16	-	none	EN 14792	800	24	118	118	mg/m³
48	4.1.11	-	none	EN 14792	2 870	343	119.6	119.6	mg/m³
49	4.1.15	-	none	EN 14792	764	70	124	124	mg/m³
50	4.1.16	-	none	EN 14792	633	30	130	130	mg/m³
51	4.1.16	-	none	EN 14792	567	25	136	136	mg/m³
52	4.1.12	-	none	EN 14792	2 200	273	150	0.15	g/m³
53	4.1	-	none	EN 14792	11 500	1 850	161	0.161	g/m³
54	4.1.1	-	none	VDI 2456 Bl. 3 + 6	22 403	3 420	164	164	mg/m³
55	4.1.1	-	none	EN 14792	18 735	3 220	182	182	mg/m³
56	4.1.2	-	none	EN 14792	560	60	198	0.198	g/m³
57	4.1.16	S	F	EN 14792	604	240	750	0.75	g/m³

#	Type of installa-tion	Waste gas system with-out thermal oxidation or scrubbers		NOx Measurement method	Mean Volume Flow (*) [m³/h]	NOx Mean Mass Flow [g/h]	NOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
58	4.1.16	S	F	EN 14792	620	290	770	0.77	g/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 17 – NH_3 data – SCR or SNCR

Table 39 shows the mean concentration values of NH3 and the related mean mass flow from sources where SCR or SNCR are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 39: NH3 emissions from sources with SCR or SNCR

#	Type of instal-lation	Waste gas system with SCR or SNCR		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
1	4.1.2	C	SCR; Q; S*3; TO	VDI 3496 Bl.1, DIN 38406 E5	2 985	0.6	0.2	0.2	mg/m³
2	10.3.1	C	SNCR; Q; S; S	Own method based on VDI 3496 Bl.1	5 867			0.3	mg/m³
3	10.3.1	C	SNCR; Q; S; S	Own method based on VDI 3496 Bl.1	5 542			0.55	mg/m³
4	4.1.19	S	TO; SCR	DIN 38406 E5	7 000	7	1	1	mg/m³
5	4.1.19	S	TO; SCR	DIN 38406 E5	7 000	9.4	1.4	1.4	mg/m³
6	4.1.19	S	TO; SCR	DIN 38406 E5	7 000	9	1.4	1.4	mg/m³
7	4.1.2	C	SCR; Q; S*3; TO	DIN 38406 E5, VDI 3496 Bl.1	2 805	4.447	1.6	1.6	mg/m³
8	10.3.1	C	SNCR; Q; S; S	Own method based on VDI 3496 Bl.1	5 657			1.85	mg/m³
9	4.1.1	C	TO; Q; S; BU; SCR	VDI 3496-1	1 180	15	12.68	12.68	mg/m³

#	Type of instal-lation	Waste gas system with SCR or SNCR		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original	Unit
10	4.1.1	C	TO; Q; S; BU; SCR	VDI 3496 Bl.1	799	9.9	13.72	<27.44	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 18 – NH_3 data – Scrubbers

Table 40 shows the mean concentration values of NH3 and the related mean mass flow from sources where scrubbers are installed. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 40: NH3 emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system with scrubbers		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original	Unit
1	4.1	C	C; S	N. N.	12	0.002	0.2	0.2	mg/m³
2	4.1	S	C; S	VDI 3496 Bl.1	23	0.005	0.05	<0.1	mg/m³
3	4.1.18	C	S; S; S; S; COX	Own method	1 100	0.01	0.01	<0.02	mg/m³
4	4.1	S	C; S	VDI 3496 Bl.1	112	0.02	0.2	0.2	mg/m³
5	4.1	C	S	VDI 3496 Bl.1	392	0.02	0.055	<0.11	mg/m³
6	4.1.8	C	S; S; S	VDI 3496 Bl. 1	35	0.05	1.18	1.18	mg/m³
7	4.1.18	C	S*3; S; S; S; S; COX	VDI 3496 Bl.1	982	0.05	0.02	<0.04	mg/m³
8	4.1.18	C	C; S*2; TO	VDI 3496 Bl.1	85	0.05	0.02	<0.04	mg/m³
9	4.1.16	S	S*2	Own method no.15: sampling with a series of wash bottles and photometric determination	2 730	0.2	0.075	<0.15	mg/m³

#	Type of instal-lation	Waste gas system with scrubbers		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs)		
							[mg/m³]	Original Unit	
10	4.1	C	Q; S*2	EN ISO 11732, VDI 3496 Bl. 1:1982	29	0.2	6.4	6.4	mg/m³
11	4.1.2	S	S*3; AC*2	VDI 3496 Bl. 1	420	0.5	0.55	<1.1	mg/m³
12	4.1.10	S	S; S	VDI 3496 Bl.1	2 992	0.5	0.1	<0.2	mg/m³
13	4.1	C	S	Own method based on VDI 2467 Bl.2	4 210	0.5	0.075	<0.15	mg/m³
14	4.1.15	S	S*2	VDI 3496-1	364	0.8	2.2	2.2	mg/m³
15	4.1.15	S	S	VDI 3496 Bl.1	4 381	0.8	0.2	0.2	mg/m³
16	4.1.16	C	S; TO	VDI 3496/1, VDI 2461/2	3 700	1	0.3	<0.6	mg/m³
17	4.1.8	S	FF; S	VDI 3496 Bl. 1	7 780	1.165	0.15665	<0.3133	mg/m³
18	4.1	S	F; C; S*3	Own method based on VDI 2461 Bl.1, DIN 38406 E5	20	1.8	97.9	97.9	mg/m³
19	4.1.4	S	C; AC; S	Own method no.15: sampling with a series of wash bottles and photomet-ric determina-tion	31	1.86	57.8	57.8	mg/m³
20	4.1	C	S	Own method based on VDI 2461 Bl.1, EN 38406E5	10 690	2.45	0.21	<0.42	mg/m³
21	4.1	C	C; S*2; S*3	Own method based on VDI 2461 Bl.1, DIN 38406 E5	9 160	4.7	0.5	0.5	mg/m³
22	4.1	S	S	Own method based on VDI 3496 Bl.1	5 700	5	0.9	<1.8	mg/m³
23	4.1	S	S	VDI 3496/1	8 780	6.08	0.69	0.69	mg/m³
24	4.1.2	S	S*2	Own method based on VDI 3496 Bl.1	5 260	7	1.3	1.3	mg/m³
25	4.1.15	S	S*2	VDI 3496/1; DIN38406E5	27 147	7	0.3	0.3	mg/m³

#	Type of instal-lation	Waste gas system with scrubbers		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
26	4.1.19	C	S; F	VDI 2461 Bl.1, DIN 48406 E5	5 930	7.2	1.33	1.33	mg/m³
27	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	VDI 2467 Bl.2	5 060	10	1.9	1.9	mg/m³
28	4.1	S	S; DS	VDI 2461 Bl. 1	11 800	10	1	1	mg/m³
29	4.1.4	S	C; AC; S	Own method no.15: sampling with a series of wash bottles and photomet-ric determina-tion	79	11	163	163	mg/m³
30	4.1.17	S	S; S	VDI 2461 Bl. 2	11 900	12	1	1	mg/m³
31	4.1.16	S	S	VDI 2461/2	2 900	15	5.33	5.33	mg/m³
32	4.1.10	S	S; S	DIN 38405-E5-1	17 200	16	0.9	0.9	mg/m³
33	4.1.16	S	FF; TO; S	VDI 3496 Bl. 1	3 850	16	4.1	4.1	mg/m³
34	4.1.2	S	S; S*2	VDI 3496 Bl. 1	3 500	19.3	5.5	5.5	mg/m³
35	4.1.15	S	S	VDI 3496 Bl. 1	9 023	43	4.7	4.7	mg/m³
36	4.1.2	S	CY; S; HE	VDI 3496	30 408	50	1.6	1.6	mg/m³
37	4.1.15	S	S	VDI 2467 Part 2	8 130	77	9.5	9.5	mg/m³
38	4.1.17	S	CY; S	Own method no.15: sampling with a series of wash bottles and photomet-ric determina-tion	190 600	101	0.5	0.5	mg/m³
39	4.1.8	S	S	VDI 3496 Bl. 1	26 900	109	4	4	mg/m³
40	4.1.2	S	S; HE	VDI 2461 Bl. 1	31 100	192	6.2	6.2	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 19 – NH_3 data – No SCR or SNCR or scrubbers

Table 41 shows the mean concentration values of NH_3 and the related mean mass flow from sources where no SCR, SNCR or scrubbers are installed. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 41: NH3 emissions from sources without SNCR, SCR or scrubbers

#	Type of installation	Waste gas system without SCR, SNCR or scrubbers		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.2	C	TO	Own method based on VDI 3496 Bl. 1	806	0.045	0.05	<0.1	mg/m³
2	4.3	S	CY	VDI 3496 Bl.1	1 838	0.05	0.579	0.579	mg/m³
3	4.1.2	C	TO	Own method based on VDI 3496 Bl. 1	13 330	0.095	0.05	<0.1	mg/m³
4	4.1.8	S	SP	Own method based on VDI 2457 Bl. 1, VDI 2066 Bl. 1, EN ISO 11732 (E23)	111 000	0.25	0.15	<0.3	mg/m³
5	4.1.16	S	TO	VDI 2461/2	5 268	0.5	0.15	<0.3	mg/m³
6	4.3	S	CY	VDI 3496 Bl.1	1 700	0.7	0.123	0.123	mg/m³
7	4.1.19	C	F	VDI 2461 Bl.1, DIN 48406 E5	4 533	1.15	0.1	<0.2	mg/m³
8	4.1.19	C	F	VDI 2461 Bl.1, DIN 48406 E5	13 970	2.885	0.2	<0.4	mg/m³
9	4.1.8	S	SP	Own method based on VDI 2457 Bl. 1, VDI 2066 Bl. 1, EN ISO 11732 (E23)	10 933	3	0.8	0.8	mg/m³
10	4.1.16	S	FF	VDI 3496 Bl. 1	60	3.1	0.293	<0.586	mg/m³
11	4.1.16	S	FF; TO	VDI 3496 Bl. 1	173 064	5	1.5	1.5	mg/m³
12	4.1	-	none	VDI 3496 Bl. 1	11 800	6.5	3.5	3.5	mg/m³
13	4.1.8	-	none	Own method based on VDI 2457 Bl. 1, VDI 2066 Bl. 1, EN ISO 11732 (E23)	4 200	8	0.7	0.7	mg/m³

#	Type of instal-lation	Waste gas system with-out SCR, SNCR or scrubbers		NH_3 Measurement method	Mean Volume Flow (*) [m³/h]	NH_3 Mean Mass Flow [g/h]	NH_3 Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
14	4.1.8	-	none	Own method based on VDI 2457 Bl. 1, VDI 2066 Bl. 1, EN ISO 11732 (E23)	26 100	9	12.1	12.1	mg/m³
15	4.1.17	S	CY	VDI 2461 Bl. 2	14 410	10	0.1	<0.2	mg/m³
16	4.1.19	C	F	VDI 2461 Bl.1, DIN 48406 E5	3 020	17.1	1.2	1.2	mg/m³
17	4.1	S	F	Own method based on VDI 3496 Bl. 1	16 200	20	7.5	7.5	mg/m³
18	4.1.8	S	CY	VDI 3496 Bl. 1	14 600	26	1	1	mg/m³
19	4.1.8	S	CY	VDI 3496 Bl. 1	1 820	32	1.97	1.97	mg/m³
20	4.1.8	S	CY	VDI 3496 Bl. 1	11 800	42	2.9	2.9	mg/m³
21	4.1.17	S	C	Partial flow sam-pling	2 000	43	296	296	mg/m³
22	4.1.8	S	CY	VDI 3496 Bl. 1	41 500	52	4.43	4.43	mg/m³
23	4.1.17	?	N. N.	VDI 3496 Bl. 1, DIN 38406 E5	700	110	0.6	0.6	mg/m³
24	4.1.17	S	C	Partial flow sam-pling	56 400	113.5	682.34	682.34	mg/m³
25	4.1.8	S	FF	VDI 3496 Bl. 1	55 200	358	8.63	8.63	mg/m³
26	4.1.8	S	FF	VDI 3496 Bl. 1	37 200	1 076	19.1	19.1	mg/m³
27	4.1.8	S	FF	VDI 3496 Bl. 1	147	1 076	19.5	19.5	mg/m³
28	4.1.8	S	FF	Own method based on VDI 2457 Bl. 1, VDI 2066 Bl. 1, EN ISO 11732 (E23)	166	1 599	43	43	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 20 – SOx data – Scrubbers

Table 42 shows the mean concentration values of SOx and the related mean mass flow from sources where scrubbers are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 42: SOx emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system with scrubbers		SOx Measurement method	Mean Volume Flow (*) [m^3/h]	SOx Mean Mass Flow [g/h]	SOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	10.3.1	C	SNCR; Q; S; S	EN 14791	5 542		0.0005	<0.001	mg/m^3
2	4.1.10	S	S; S	EN ISO 10304	17 200	1	0.05	<0.1	mg/m^3
3	4.1.6	S	S; S	EN 14791	12	0.003	0.1	0.1	mg/m^3
4	4.1.10	S	S	EN 14791	2 400	0.191	0.1	<0.2	mg/m^3
5	4.1.10	S	S	EN 14791	10 400	1.5	0.1	<0.2	mg/m^3
6	4.1.10	S	S	EN 14791	9 900	1.5	0.15	<0.3	mg/m^3
7	4.1.15	S	S*2; FF	EN 14791	11 158	3	0.2	<0.4	mg/m^3
8	4.1.17	S	S; S	EN 14791	11 200	2.5	0.25	<0.5	mg/m^3
9	4.1.10	S	S	EN 14791	382	0.1	0.3	<0.6	mg/m^3
10	4.1	C	TO,S*2	EN 14791	34 010	8.5	0.3	<0.6	mg/m^3
11	4.1.2	C	SCR; Q; S*3; TO	EN 14791	2 985	1.05	0.35	<0.7	mg/m^3
12	4.1.10	S	S; S	EN 14791	1 711	0.7	0.4	<0.8	mg/m^3
13	4.1.10	S	TO, Q, S	EN 14791	3 327	1.5	0.4	<0.8	mg/m^3
14	4.1.2	C	TO; S; Q	EN 14791	9 269	3.5	0.4	<0.8	mg/m^3
15	4.1.2	C	TO; S; Q	EN 14791	9 681	3.5	0.4	<0.8	mg/m^3
16	4.1	S	S*3	EN 14791	9 253	3.5	0.45	<0.9	mg/m^3
17	4.1.16	C	FF; Q; S; S	EN 14791:2006	2 193	5	0.57	0.57	mg/m^3
18	4.1	C	S; S; S	EN 14791:2006	18 020	15.6	0.85	<1.7	mg/m^3
19	4.1	C	S; S; S	EN 14791:2006	24 850	22.5	0.9	<1.8	mg/m^3
20	10.3.1	C	SNCR; Q; S; S	EN 14791	5 867		1	0.001	g/m^3

#	Type of instal-lation	Waste gas system with scrubbers		SOx Measurement method	Mean Volume Flow (*) [m³/h]	SOx Mean Mass Flow [g/h]	SOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
21	4.1	C	S; S	EN 14791:2006	26 360	27.35	1.05	<2.1	mg/m³
22	4.1	C	S	EN 14791:2006	47 950	55	1.15	<2.3	mg/m³
23	4.1.10	C	S; S; S	EN 14791	3 517	4.8	1.3	1.3	mg/m³
24	4.1.2	C	SCR; Q; S*3; TO	EN 14791	2 805	3.808	1.4	1.4	mg/m³
25	4.1.16	S	F; S; GW; AD	NDIR	1 040	1.5	1.5	<3	mg/m³
26	4.1.16	S	F; S; GW; AD	NDIR	1 150	1.5	1.5	<3	mg/m³
27	4.1.16	S	F; S; GW; AD	NDIR	1 100	1.5	1.5	<3	mg/m³
28	4.1.16	S	F; S; GW; AD	NDIR	1 160	1.5	1.5	<3	mg/m³
29	4.1.16	S	F; S; GW; AD	NDIR	1 040	1.5	1.5	<3	mg/m³
30	10.3.1	C	SNCR; Q; S; S	EN 14791	5 657		1.5	<0.003	g/m³
31	4.1.10	S	S	EN 14791	243	0.4	1.6	1.6	mg/m³
32	4.1.10	S	S; ESP; S*2; S*2	EN 14791	51 400	90.65	1.75	<3.5	mg/m³
33	4.1.2	C	TO; S; Q	EN 14791	9 807	18	1.8	1.8	mg/m³
34	4.1.15	S	S	EN 14791	7 633	17	2.25	<4.5	mg/m³
35	4.1.16	S	S; AC	NDIR	98	0	3	0.003	g/m³
36	4.1.16	S	F; S; GW; AD	NDIR	1 170	4	3.1	3.1	mg/m³
37	4.1.16	S	S	EN 14791	2 600	8	3.2	3.2	mg/m³
38	4.1.15	S	S*2	EN 14791	27 147	97	3.6	3.6	mg/m³
39	4.1.13	S	S; S	EN 14791	1 115	10	3.7	3.7	mg/m³
40	4.1	C	S; S; S; DS; S	EN 14791:2006	46 670	189	4.05	<8.1	mg/m³
41	4.1.10	S	S	EN 14791	3 548	27	7.7	7.7	mg/m³
42	4.1.19	C	S*2; S; S	EN 14791		0.67	7.8	7.8	mg/m³
43	4.1 / 4.2	C	N.N.; C; S	EN 14791:2006	3 720	40	10	<0.02	g/m³
44	4.1	S	ESP; S	EN 14791:2006	1 855		12.95	12.95	mg/m³

#	Type of instal-lation	Waste gas system with scrubbers		SOx Measurement method	Mean Volume Flow (*) [m³/h]	SOx Mean Mass Flow [g/h]	SOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
45	4.1	S	ESP; S	EN 14791:2006	2 448		19.5	19.5	mg/m³
46	4.1.16	S	FF; S*7	EN 14791	19 400	460	23.7	23.7	mg/m³
47	4.1	S	S; DS; C; S	EN 14791	10 300	1 340	130	0.13	g/m³
48	4.1.8	S	FF; S	EN 14791	15 820	1 427	255.5	255.5	mg/m³
49	4.1.8	S	FF; S	EN 14791	17 810	1 700	272.7	272.7	mg/m³
50	4.1.11	S	S; S; S	EN 14791	10	63	7 151.9	7 151.9	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 21 – SOx data – No scrubbers

Table 43 shows the mean concentration values of SOx and the related mean mass flow from sources where no scrubbers are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 43: SOx emissions from sources without scrubbers

#	Type of installation	Waste gas system without scrubbers		SOx Measurement method	Mean Volume Flow (*) [m³/h]	SOx Mean Mass Flow [g/h]	SOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8 / 8.1	C	TO	EN 14791:2006	45	-	1.1	1.1	mg/m³
2	4.1.8 / 8.1	C	TO	EN 14791:2006	44	-	1.2	1.2	mg/m³
3	4.1.8 / 8.1	C	TO	EN 14791:2006	43	-	1.4	1.4	mg/m³
4	4.1.8 / 8.1	C	TO	EN 14791:2006	48	-	1.42	1.42	mg/m³
5	4.1.8 / 8.1	C	TO	EN 14791:2006	54	-	1.9	1.9	mg/m³
6	4.1.8 / 8.1	C	TO	EN 14791:2006	44	-	2.26	2.26	mg/m³
7	4.1.8 / 8.1	C	TO	EN 14791:2006	48	-	3.26	3.26	mg/m³
8	4.1.8 / 8.1	C	TO	EN 14791:2006	48	-	5.08	5.08	mg/m³
9	4.1.8 / 8.1	C	TO	EN 14791:2006	44	-	5.8	5.8	mg/m³
10	4.1.8 / 8.1	C	TO	EN 14791:2006	47	-	5.94	5.94	mg/m³
11	4.1.13	S	none	VDI 2462 Bl. 2	70	0.03	0.5	0.5	mg/m³
12	4.1.2	C	TO	EN 14791	1 100	0.15	0.2	<0.4	mg/m³
13	4.1.13	S	none	VDI 2462 Bl. 2	72	0.2	3.1	3.1	mg/m³
14	4.1.2	C	TO	EN 14791	1 838	0.45	0.25	<0.5	mg/m³
15	4.1	-	none	EN 14791:2006	370	1	4.1	4.1	mg/m³
16	4.1.2	C	TO	EN 14791	1 460	1.4	1	1	mg/m³

#	Type of instal-lation	Waste gas system with-out scrubbers		SOx Measurement method	Mean Volume Flow (*) [m³/h]	SOx Mean Mass Flow [g/h]	SOx Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
17	4.1.19	S	TO; SCR	EN 14971	7 000	1.5	0.2	<0.4	mg/m³
18	4.1.15	S	CY; FF	EN 14791	19 400	1.5	0.2265	<0.453	mg/m³
19	4.1.19	S	TO; SCR	EN 14971	7 000	1.5	0.25	<0.5	mg/m³
20	4.1.15	S	CY; FF	EN 14791	23 700	1.5	0.305	<0.61	mg/m³
21	4.1.19	S	TO; SCR	EN 14971	7 000	1.75	0.25	<0.5	mg/m³
22	4.1	C	TO	EN 14791:2006	21 730	2	0.1	<0.2	mg/m³
23	4.1.8	S	TO	EN 14791	2 530	4	1.7	1.7	mg/m³
24	4.1.7	S	SR	EN 14791	1 080	4	4.3	4.3	mg/m³
25	4.1	C	TO	EN 14791:2006	2 230	5	3	<0.006	g/m³
26	4.1.12	-	none	EN 14791	6 870	6	1.1	1.1	mg/m³
27	4.1.15	S	CY; FF	EN 14791	21 700	8	1.15	1.15	mg/m³
28	4.1.11	-	none	EN 14791	1 010	9	10.9	10.9	mg/m³
29	4.1.13	S	none	EN 14791	70	40	573	573	mg/m³
30	4.1.8	S	TO	EN 14791	2 140	48	22.3	0.022	g/m³
31	4.1.11	-	none	EN 14791	24 720	52	2.1	2.1	mg/m³
32	4.1.17	S	CY	EN 14791	111 000	61	0.6	0.6	mg/m³
33	4.1.13	-	none	VDI 2462 Bl. 2	65 800	77	1.2	1.2	mg/m³
34	4.1.13	S	none	EN 14791	72	120	1 672.8	1 672.8	mg/m³
35	4.1.16	S	FF; HE	EN 14791	5 100	549	108	108	mg/m³
36	4.1.10	S	FF	EN 14791	29 100	721	24.8	24.8	mg/m³
37	4.1.16	C	TO	EN 14791	1 663	881.8	454	454	mg/m³
38	4.1.16	C	TO	EN 14791	2 630	1 400	460	0.46	g/m³
39	4.1.1	-	none	EN 14791	18 735	3 848	217.5	217.5	mg/m³
40	4.1.21	S	FF	EN 14791	77 400	4 470	57.7	57.7	mg/m³
41	4.1.1	-	none	EN 14791	22 403	4 641	222	222	mg/m³
42	4.1.13	-	none	EN 14791	65 800	26 546	403.4	403.4	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 22 – HCl data – No scrubbers

Table 44 shows the mean concentration values of HCl and the related mean mass flow from sources where no scrubbers are installed. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 44: HCl emissions from sources where no scrubbers are installed

#	Type of instal-lation	Waste gas system not including scrubbers		HCl Measurement method	Mean Volume Flow (*) $[m^3/h]$	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
1	4.1.8 / 8.1	C	TO	EN 1911	44		1.5	1.5	mg/m^3
2	4.1.8 / 8.1	C	TO	EN 1911	49		1.92	1.92	mg/m^3
3	4.1.8 / 8.1	C	TO	EN 1911	46		1.98	1.98	mg/m^3
4	4.1.8 / 8.1	C	TO	EN 1911	51		2.18	2.18	mg/m^3
5	4.1.8 / 8.1	C	TO	EN 1911	40		2.84	2.84	mg/m^3
6	4.1.8 / 8.1	C	TO	EN 1911	45		2.94	2.94	mg/m^3
7	4.1.8 / 8.1	C	TO	EN 1911	50		3.52	3.52	mg/m^3
8	4.1.8 / 8.1	C	TO	EN 1911	47		3.58	3.58	mg/m^3
9	4.1.8 / 8.1	C	TO	EN 1911	47		3.7	3.7	mg/m^3
10	4.1.8 / 8.1	C	TO	EN 1911	47		4.92	4.92	mg/m^3
11	4.1	-	none	EN 1911-1	2.2	0.003	1.3	1.3	mg/m^3
12	4.1	-	none	EN 1911	350	0.015	0.05	<0.1	mg/m^3
13	4.1	-	none	EN 1911	400	0.025	0.05	<0.1	mg/m^3
14	4.1.13	-	none	EN 1911/1-3	35	0.05	0.1	<0.2	mg/m^3
15	4.1.13	-	none	EN 1911/1-3	500	0.05	0.15	<0.3	mg/m^3
16	4.1.2	C	TO	EN 1911	1 838	0.1	0.05	<0.1	mg/m^3
17	4.1.2	C	TO	EN 1911	806	0.1	0.09	<0.18	mg/m^3

#	Type of instal-lation	Waste gas system not including scrubbers		HCl Measurement method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
18	4.1	-	none	EN 1911	760	0.1	0.1	<0.2	mg/m³
19	4.1	-	none	EN 1911/1-3	1 450	0.46	0.32	0.32	mg/m³
20	4.1	-	none	EN 1911	2 327	0.8	0.3	0.3	mg/m³
21	4.1.2	S	TO	EN 1911	718	0.8	1.2	1.2	mg/m³
22	4.1.19	S	TO; SCR	EN 1911	7 000	1.4	0.2	0.2	mg/m³
23	4.1.19	S	TO; SCR	EN 1911	7 000	1.55	0.25	<0.5	mg/m³
24	4.1.18	C	TO	EN 1911:2010	1 026	1.8	1.8	1.8	mg/m³
25	4.1.10	-	none	EN 1911/1-3	2 000	2	0.8	0.8	mg/m³
26	4.1.7	S	COX	EN 1911/1-3	380	2.34	6.17	6.17	mg/m³
27	4.1.19	S	TO; SCR	EN 1911	7 000	2.4	0.4	0.4	mg/m³
28	4.1	C	TO	EN 1911:2010	2 230	2.5	1.7	<3.4	mg/m³
29	4.1	-	none	EN 1911	3 170	3	0.95	<1.9	mg/m³
30	4.1.18	C	TO	EN 1911	594	4.7	7.9	7.9	mg/m³
31	4.1.1	S	TO	EN 1911	209	7	31	31.0	mg/m³
32	4.1.13	-	none	EN 1911	1 810	9	5.2	5.2	mg/m³
33	4.1.17	S	CY	EN 1911 Bl. 1/2	111 000	10	0.1	<0.2	mg/m³
34	4.1.8	S	TO	EN 1911	10 570	10	1	<2	mg/m³
35	4.1.8	S	TO	EN 1911:2010	8 300	26.9	3.3	3.3	mg/m³
36	4.1.8	C	TO	EN 1911	10 860	41.6	3.8	3.8	mg/m³
37	4.1.7	S	COX	EN 1911	233	73	314	314	mg/m³
38	4.1	C	TO	EN 1911	21 730	113	5.2	5.2	mg/m³
39	4.1.16	-	CY; FF; FF	EN 1911	6 180	150	24	24	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 23 – HCl data – Scrubbers

Table 45 shows the mean concentration values of HCl and the related mean mass flow from sources where scrubbers are installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 45: HCl emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.16	S	S; FF	EN 1911	16 600	0.1	0.005	<0.01	mg/m³
2	4.1.10	S	S*2	EN 1911	736	0.05	0.01	<0.02	mg/m³
3	4.1.21	C	C; S	EN 1911	74	0.001	0.015	<0.03	mg/m³
4	4.1.16	S	S; DS	EN 1911	14 000		0.05	<0.1	mg/m³
5	4.1.16	S	S*2	EN 1911	300	0.015	0.05	<0.1	mg/m³
6	4.1.16	S	S; DS	EN 1911	5 000	0.5	0.05	<0.1	mg/m³
7	4.1.16	S	S; DS	EN 1911	9 000	0.5	0.05	<0.1	mg/m³
8	4.1.16	S	S; DS	EN 1911	11 800	0.5	0.05	<0.1	mg/m³
9	4.1.16	S	S*2	EN 1911	800	0.14	0.07	<0.14	mg/m³
10	4.1	S	S*2	EN 1911	284	0.02	0.08	0.08	mg/m³
11	4.1	C	S	EN 1911	3 840	0.5	0.08	<0.16	mg/m³
12	4.1.16	S	S*2	EN 1911	400	0.0335	0.085	<0.17	mg/m³
13	4.1	S	S	EN 1911	90	0.01	0.1	<0.2	mg/m³
14	4.1	S	S	EN 1911	280	0.05	0.1	<0.2	mg/m³
15	4.1	S	S*2	EN 1911	704	0.1	0.1	<0.2	mg/m³
16	4.1	S	C; S	EN 1911	2 643	0.25	0.1	<0.2	mg/m³
17	4.1.16	S	SP; S; S; CY	EN 1911	7 267	1	0.1	0.1	mg/m³
18	4.1.17	S	S; S	EN 1911 Bl. 1/2	11 200	1	0.1	<0.2	mg/m³
19	4.1	C	TO,S*2	EN 1911	34 007	3	0.1	<0.2	mg/m³
20	4.1	S	S	EN 1911	13	0.002	0.15	<0.3	mg/m³
21	4.1.1	S	S	EN 1911	862	0.15	0.15	<0.3	mg/m³
22	4.1.7	C	S; AB; AB	EN 1911	4 710	0.8	0.17	<0.34	mg/m³

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
23	4.1.18	C	S; S; S; S; COX	EN 1911	1 100	0.2	0.2	0.2	mg/m³
24	4.1	S	S*2	EN 1911	3 900	0.6	0.2	0.2	mg/m³
25	4.1.2	C	SCR; Q; S*3; TO	EN 1911	2 985	0.65	0.2	<0.4	mg/m³
26	4.1.16	S	SP; S; S; CY	EN 1911	7 345	2	0.2	0.2	mg/m³
27	4.1.15	S	S*2/FF	EN 1991	11 158	2.05	0.2	<0.4	mg/m³
28	4.1.15	S	S (XN. N.)	EN 1911	24 993	5.5	0.2	<0.4	mg/m³
29	4.1.3	S	S	EN 1911/1-3	<13	0.005	0.225	<0.45	mg/m³
30	4.1.3	S	S	EN 1911/1-3	<13	0.005	0.225	<0.45	mg/m³
31	4.1.16	S	S	EN 1911	1 640	0.42	0.25	0.25	mg/m³
32	4.1	S	S; AC	EN 1911	2 290	0.7	0.3	<0.6	mg/m³
33	4.1	S	S*3	EN 1911	9 253	3	0.3	<0.6	mg/m³
34	4.1.16	S	S; DS	EN 1911	13 000	4	0.3	0.3	mg/m³
35	4.1.16	S	FF; S*5	EN 1911/1-3	19 400	6	0.3	0.3	mg/m³
36	4.1.10 / 8.12.1.1	S	S*2	EN 1911/1-3	3 600	1.5	0.35	<0.7	mg/m³
37	4.1.15	S	S	EN 1911	7 633	2.5	0.35	<0.7	mg/m³
38	4.1.16	S	S*2; S*2; COX; COX	EN 1911	7 900	3	0.35	<0.7	mg/m³
39	4.1.13	S	S	EN 1911	40	0.02	0.4	0.4	mg/m³
40	4.1.13	S	S; S	EN 1911	420	0.2	0.4	0.4	mg/m³
41	4.1	S	S	EN 1911, EN 10304-1	390	0.5	0.4	<0.8	mg/m³
42	4.1.8	S	S; S	EN 1911	1 250	1	0.4	0.4	mg/m³
43	4.1.10	S	S*2; S	EN 1911	1 700	1	0.4	0.4	mg/m³
44	4.1.10 / 8.12.1.1	S	S*2; S	EN 1911/1-3	2 000	1	0.4	<0.8	mg/m³
45	4.1.16	S	S*2; S*2; CAT	EN 1911	17 580	6.5	0.4	<0.8	mg/m³
46	4.1.16	S	S*2; S*2; CAT	EN 1911	18 010	8	0.45	<0.9	mg/m³
47	4.1.16	S	S; DS	EN 1911	6 100		0.5	0.5	mg/m³

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
48	4.1	S	S	EN 1911	47	0.02	0.5	0.5	mg/m³
49	4.1.2	S	S*3; AC*2	EN 1911, EN 10304-1	420	0.5	0.5	0.5	mg/m³
50	4.1.15	S	S	EN 1911, EN 10304-1		0.5	0.5	0.5	mg/m³
51	4.1.1	S	S	EN 1911	3 060	1.6	0.5	0.500	mg/m³
52	4.1.16	S	S	EN 1911/1-3	7 800	4	0.5	0.5	mg/m³
53	4.1.10	S	S	EN 1911-1	3 159	1.9	0.6	0.6	mg/m³
54	4.1.16	S	S; DS	EN 1911	11 400	3	0.6	0.6	mg/m³
55	4.1	C	S; S; S; DS; S	EN 1911	46 670	29	0.6	<1.2	mg/m³
56	4.1	S	S	EN 1911	23 270	15	0.625	<1.25	mg/m³
57	4.1.16	S	FF; S	EN 1911	69	0.05	0.7	0.7	mg/m³
58	4.1.15	S	S	EN 1911, EN 10304-1		0.5	0.7	0.7	mg/m³
59	4.1.10	S	S; S	EN 1911	1 711	1.2	0.7	0.7	mg/m³
60	4.1.10	S	S	EN 1911/1-3	3 300	2	0.7	0.7	mg/m³
61	4.1.10	C	S; S; S	EN 1911	3 517	2.3	0.7	0.7	mg/m³
62	4.1.10	S	S	EN 1911	9 463	6.9	0.7	0.7	mg/m³
63	4.1.16	S	S; DS	EN 1911	11 200	8	0.7	0.7	mg/m³
64	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	15 600	11	0.7	0.7	mg/m³
65	4.1.10	S	S; S	EN 1911	17 200	12.5	0.7	<1.4	mg/m³
66	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	16 126	12	0.73	0.73	mg/m³
67	4.1	S	S	EN 1911	1 280	1	0.78	0.78	mg/m³
68	4.1.15	S	S	EN 1911, EN 10304-1		0.5	0.8	0.8	mg/m³
69	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	17 539	14.67	0.83	0.83	mg/m³
70	4.1	C	S; S; S	EN 1911:2010	18 020	15.6	0.85	<1.7	mg/m³
71	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	EN 1911	5 020	4	0.86	0.86	mg/m³
72	4.1.16	S	S*3	EN 1911	933	0.8	0.9	0.9	mg/m³

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
73	4.1 / 4.2	C	S	EN 1911:2010	2 660	2.5	0.9	<1.8	mg/m³
74	4.1.1	C	TO; Q; S; S	EN 1911	4 278	4	0.9	0.9	mg/m³
75	4.1	C	C; S*2; S; S*3	EN 1911	8 930	8	0.9	<1.8	mg/m³
76	4.1	C	S; S; S	EN 1911:2010	24 850	22.5	0.9	<1.8	mg/m³
77	4.1.1	C	TO; Q; S; BU; SCR	EN 1911	1 180	1.1	0.95	0.95	mg/m³
78	4.1.6	S	TO; S*2	EN 1911/1-3	3 260	3.33	0.967	0.967	mg/m³
79	4.1.8	S	S	EN 1911	14	0.013	1	1	mg/m³
80	4.1.8	S	S; AC	EN 1911	67	0.05	1	<2	mg/m³
81	4.1.7	S	S; AC	EN 1911	459	0.5	1	<2	mg/m³
82	4.1	C	S	EN 1911	3 300	0.5	1	<2	mg/m³
83	4.1	C	S*2; S	EN 1911	3 160	3.5	1	<2	mg/m³
84	4.1 / 4.2	C	N.N.; C; S	EN 1911:2010	3 720	4	1	<2	mg/m³
85	4.1.16	X	SP	EN 1911	10 100	10	1	1	mg/m³
86	4.1.2	C	TO; S; Q	EN 1911/1-3, EN 10304-1	9 269	11	1	1	mg/m³
87	4.1	C	S	EN 1911:2010	23 210	22.5	1	<2	mg/m³
88	4.1 / 4.2	C	S	EN 1911:2010	3 300	3.5	1.05	<2.1	mg/m³
89	4.1 / 4.2	C	C; C; S; S	EN 1911:2010	3 830	4	1.05	<2.1	mg/m³
90	4.1	C	S; S	EN 1911:2010	26 360	27.35	1.05	<2.1	mg/m³
91	4.1.18	C	S*3; S; S; S; S; COX	EN 1911	982	1	1.085	<2.17	mg/m³
92	4.1.18	C	TO; S; S	EN 1911	1 350	1	1.1	1.1	mg/m³
93	4.1.10	C	S*2	EN 1911-1	29 093	31	1.1	1.1	mg/m³
94	4.1.8	S	S	EN 1911:2010	499	0.6	1.2	1.2	mg/m³
95	4.1	C	S	EN 1911	47 950	56.5	1.2	<2.4	mg/m³
96	4.1.15	S	S	EN 1911/1-3	151	0.2	1.3	1.3	mg/m³
97	4.1	S	S	EN 1911	297	0.4	1.3	1.3	mg/m³

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m³/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
98	4.1.16	S	S; DS	EN 1911	11 000	15	1.3	1.3	mg/m³
99	4.1.10	S	S; S	EN 1911	20 600	27	1.3	1.3	mg/m³
100	4.1.13	S	S	EN 1911/1-3	320	0.5	1.6	1.6	mg/m³
101	4.1.16	S	S*2; S*2; CAT	EN 1911	18 200	30	1.7	1.7	mg/m³
102	4.1.10	S	S; others	EN 1911	15 300	30	1.75	1.75	mg/m³
103	4.1.15	S	S	EN 1911/1-3	343	0.61	1.78	1.78	mg/m³
104	4.1	S	S*2	EN 1911, EN 10304-1	7 200	13	1.8	1.8	mg/m³
105	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	16 500	30	1.8	1.8	mg/m³
106	4.1.10	S	S; S	EN 1911	549	1	2	2	mg/m³
107	4.1.10	S	TO, Q, S	EN 1912	3 327	8	2.3	2.3	mg/m³
108	4.1	S	TO; S*2	EN 1911	2 280	6.3	2.4	2.4	mg/m³
109	4.1.16	S	S	EN 1911	3 200	8	2.5	2.5	mg/m³
110	4.1.6	S	S	EN 1911	572	1.4	2.59	2.59	mg/m³
111	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	15 519	40.3	2.6	2.6	mg/m³
112	4.1	S	S*2	EN 1911	15	0.07	2.7	2.7	mg/m³
113	4.1	S	S; S	EN 1911/1-3	33	0.09	2.8	2.8	mg/m³
114	4.1	S	S	EN 1911	888	3	2.8	2.8	mg/m³
115	4.1.2	C	TO; S; Q	EN 1911/1-3, EN ISO 10304-1	9 681	26	3	3	mg/m³
116	4.1.13	S	S	EN 1911/1-3	416	1.42	3.35	3.35	mg/m³
117	4.1.13	S	S	EN 1911/1-3	62	0.2	3.4	3.4	mg/m³
118	4.1.2	C	SCR; Q; S*3; TO	EN 1911	2 805	9.493	3.4	3.4	mg/m³
119	4.1.15	S	S	EN 1911	14 210	50	3.5	3.5	mg/m³
120	4.1.6	S	TO; S*2	EN 1911/1-3	8 933	36	4.03	4.03	mg/m³
121	4.1.19	C	S*2; S; S	EN 1911/1		0.36	4.1	4.1	mg/m³
122	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	16 700	71	4.27	4.27	mg/m³
123	4.1.2	C	TO; S; Q	EN 1911/1-3	9 807	43	4.4	4.4	mg/m³
124	4.1.3	S	S	EN 1911/1-3	<13	0.03	4.7	4.7	mg/m³
125	4.1.3	S	S	EN 1911/1-3	<13	0.03	4.7	4.7	mg/m³
126	4.1	S	S	EN 1911	1 670	9.1	5.45	5.45	mg/m³

#	Type of instal-lation	Waste gas system Including scrubbers		HCl Measure-ment method	Mean Volume Flow (*) [m^3/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
127	4.1.16	S	S; DS	EN 1911	6 000	35	5.9	5.9	mg/m³
128	4.1.1	S	TO; FF; S; S; S; S	EN 1911	544	3.4	6.3	6.30	mg/m³
129	4.1	C	S*2	EN 1911	515	3.7	7.1	7.1	mg/m³
130	4.1.15	S	S; S	EN 1911, EN 10304-1	510	5	10.1	10.1	mg/m³
131	4.1	S	S; DS; C; S	EN 1911	10 300	110	10.8	10.8	mg/m³
132	4.1.18	C	C; S*2; TO	EN 1911	85	0.9	10.96	10.96	mg/m³
133	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	16 400	223	13.6	13.6	mg/m³
134	4.1	S	S; S	EN 1911	4 510	67	14.9	14.9	mg/m³
135	4.1.2	C	S; S	EN 1911, EN 10304-1	210	4	17.6	17.6	mg/m³
136	4.1.6/8	C	TO; Q; S; S; DD	EN 1911/1-3	16 400	390	23.8	23.8	mg/m³
137	4.1.1	S	S	EN 1911	111	2.6	25	25.0	mg/m³
138	4.1.16	C	FF; Q; S; S	EN 1911:2010	2 201	54	29.3	29.3	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 24 – HCl data – Other data

Table 46 shows the mean concentration values of HCl and the related mean mass flow from sources where no information about the waste gas treatment system was provided.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 46: HCl emissions from sources where waste gas treatment is not clear

#	Type of instal-lation	Waste gas system		HCl Measurement method	Mean Volume Flow (*) [m^3/h]	HCl Mean Mass Flow [g/h]	HCl Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	4.1	?	N. N.	EN 1911, EN ISO 10304-1	40	0.5	1.5	1.5	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 25 – HF data – Scrubbers

Table 47 shows the mean concentration values of HF and the related mean mass flow from sources where scrubbers are installed. The values are sorted by increasing concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 47: HF emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system with scrubbers		HF Measurement method	Mean Volume Flow (*) [m³/h]	HF Mean Mass Flow [g/h]	HF Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.2	C	SCR; Q; S*3; TO	VDI 2470 Bl.1	2 985	0.05	0.015	<0.03	mg/m³
2	4.1.21	C	C; S	Based on VDI 2470 Bl.1	74	0.001	0.015	<0.03	mg/m³
3	4.1.13	C	S	VDI 2470 Bl. 1	320	0.02	0.05	<0.1	mg/m³
4	4.1.10	C	S; S; FF; SP; F	Based on VDI 2470 Bl.1	1 810	0.036	0.02	<0.04	mg/m³
5	4.1.16	S	S	VDI 2470	1 640	0.115	0.075	<0.15	mg/m³
6	4.1.2	C	SCR; Q; S*3; TO	VDI 2470 Bl.1	2 805	0.361	0.1	0.1	mg/m³
7	4.1	C	TO,S*2	VDI 2470/1	34 006	0.5	0.015	<0.03	mg/m³
8	4.1	S	S	VDI 2470/1	2 820	0.5	0.15	<0.3	mg/m³
9	4.1.10	S	S	VDI 2470 Bl.1	5 600	0.53	0.1	0.1	mg/m³
10	4.1.16	S	S	VDI 2470	442	0.6	1.4	1.4	mg/m³
11	4.1.10	S	S; S	VDI 2470	17 200	1	0.05	<0.1	mg/m³
12	4.1.15	S	S	VDI 2470/1	7 633	1	0.15	<0.3	mg/m³
13	4.1	S	S; S	VDI 2470/1	670	1	1	1	mg/m³
14	4.1.16	C	FF; Q; S; S	VDI 2470:1975	2 201	1.2	0.53	0.53	mg/m³
15	4.1.16	C	FF; S*6	VDI 2470 Bl. 1	19 400	2	0.1	<0.2	mg/m³
16	4.1.17	S	S; S	VDI 2470 Bl. 1	11 200	2.16	0.1	<0.2	mg/m³
17	4.1.10	S	S	VDI 2470 Bl.1	4 050	2.16	0.53	0.53	mg/m³
18	4.1.15	S	S*2; FF	VDI 2470/1	11 158	2.4	0.21	0.21	mg/m³
19	4.1.15	S	S	VDI2470/1	14 210	4	0.3	0.3	mg/m³
20	4.1	S	S*2; S*2	VDI 2470	35 810	4.1	0.12	<0.24	mg/m³
21	4.1.10	S	S; Misc 1	VDI 2470 Bl.1	14 400	6.08	0.42	0.42	mg/m³

#	Type of instal-lation	Waste gas system with scrubbers		HF Measurement method	Mean Volume Flow (*) [m^3/h]	HF Mean Mass Flow [g/h]	HF Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs)		
							[mg/m^3]	Original Unit	
22	4.1.15	S	S (se-veral)	VDI 2470/1	24 993	7	0.3	0.3	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 26 – HF data – No scrubbers

Table 48 shows the mean concentration values of HF and the related mean mass flow from sources where no scrubbers are installed. The values are sorted by increasing mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 48: HF emissions from sources without scrubbers

#	Type of installation	Waste gas system without scrubbers		HF Measurement method	Mean Volume Flow (*) [m^3/h]	HF Mean Mass Flow [g/h]	HF Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	4.1.1	C	TO	VDI 2470	1 180	0.05	0.055	<0.11	mg/m^3
2	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	164			<0.12	mg/m^3
3	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	160			<0.12	mg/m^3
4	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	160			<0.14	mg/m^3
5	4.7	S	C; AD; FF	VDI 2470 Bl.1	45 900	3.45	0.075	<0.15	mg/m^3
6	4.1.10	S	F; F	VDI 2470 Bl.1	11 000	0.85	0.08	0.08	mg/m^3
7	4.1.13	-	none	VDI 2470 Bl. 1	500	0.05	0.1	<0.2	mg/m^3
8	4.1.13	-	none	VDI 2470 Bl. 1	35	0.05	0.1	<0.2	mg/m^3
9	4.1.17	S	CY	VDI 2470 Bl. 1	111 000	11.13	0.1	<0.2	mg/m^3
10	4.1.10	S	F; F	VDI 2470 Bl.1	11 700	1.93	0.17	0.17	mg/m^3
11	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	164			0.23	mg/m^3
12	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	160			0.38	mg/m^3
13	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	165			0.4	mg/m^3
14	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	159			0.4	mg/m^3
15	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	164			0.64	mg/m^3
16	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	156			0.66	mg/m^3

#	Type of instal-lation	Waste gas system without scrubbers		HF Measurement method	Mean Volume Flow (*) [m³/h]	HF Mean Mass Flow [g/h]	HF Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
17	4.1.8 / 8.1	C	TO	VDI 2470 Bl. 1:1975	161			0.94	mg/m³
18	4.1	-	none	VDI 2470/1	1 490	1.53	1.025	<2.05	mg/m³
19	4.1.18	C	TO	VDI 2470 Bl.1	1 026	2.6	2.6	2.6	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 27 – Chlorine – Scrubbers

Table 49 shows the mean concentration values of chlorine and the related mean mass flow from sources with scrubbers. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 49: Chlorine emissions from sources with scrubbers

#	Type of instal-lation	Waste gas system including scrubbers		Chlorine Measurement method	Mean Volume Flow (*) [m³/h]	Chlorine Mean Mass Flow [g/h]	Chlorine Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.12	S	S*3	VDI 3488 Bl. 1	634	0.005	0.005	<0.01	mg/m³
2	4.1.12	S	S*3	VDI 3488 Bl. 1	1 300	0.005	0.005	<0.01	mg/m³
3	4.1.12	S	S; S; S	VDI 3488-1	4 900	0.25	0.05	<0.1	mg/m³
4	4.1.12	S	S; S; S	VDI 3488-1	3 200	0.15	0.05	<0.1	mg/m³
5	4.1.6	S	S; S	VDI 3488 Bl.1	6.0	0.001	0.06	0.06	mg/m³
6	4.1.18	C	S*3; S; S; S; S; COX	VDI 3488-1	1 250	0.05	0.06	0.06	mg/m³
7	4.1.16	S	FF; S	VDI 3488 Bl.1	69	0.01	0.1	<0.2	mg/m³
8	4.1 / 4.2	C	S	VDI 3488 Bl. 1:1979	3 300	0.4	0.1	<0.2	mg/m³
9	4.1 / 4.2	C	S	VDI 3488 Bl. 1:1979	2 660	0.25	0.1	<0.2	mg/m³
10	4.1	C	S	EN 14791:2006	47 950	5	0.1	<0.2	mg/m³
11	4.1	C	S; S; S	VDI 3488 Bl.1:1979	18 020	3.9	0.21	<0.42	mg/m³
12	4.1	C	S; S; S; DS; S	EN 14791:2006	46 670	10.5	0.225	<0.45	mg/m³
13	4.1.18	C	S; S; S; S; COX	VDI 3488-1	1 100	0.3	0.25	<0.5	mg/m³
14	4.1.7/.12/.14	S	S*3	VDI 3488 Bl. 1	2 107	0.635	0.3	0.3	mg/m³
15	4.1	C	S; S; S	VDI 3488 Bl.1:1979	24 850	11.6	0.37	0.37	mg/m³
16	4.1.18	C	TO; S; S	VDI 3488-1	1 350	0.5	0.4	<0.8	mg/m³
17	4.1	C	S; S	VDI 3488 Bl.1:1979	26 360	11.3	0.43	0.43	mg/m³

#	Type of instal-lation	Waste gas system including scrubbers		Chlorine Measurement method	Mean Volume Flow (*) [m³/h]	Chlorine Mean Mass Flow [g/h]	Chlorine Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
18	4.1.10 / 8.12.1.1	S	S*2; S	VDI 3488 Bl. 1	2 000	1	0.5	0.5	mg/m³
19	4.1.18	C	C; S*2; TO	VDI 3488-1	100	0.05	0.61	0.61	mg/m³
20	4.1.16	S	S	VDI 3488 Bl. 1	3 900	3	0.8	0.8	mg/m³
21	4.1.13	S	S; S	VDI 3488 Bl. 1	1 115	2	0.88	0.88	mg/m³
22	4.1.6	S	TO; S*2	VDI 3488 Bl. 1	3 260	3	0.933	0.933	mg/m³
23	4.1.12	C	S; S; SP; S	VDI 3488/1	4 500	5	1.1	1.1	mg/m³
24	4.1.16	S	S*2; S*2; CAT	VDI 3488 Bl. 1	18 200	22	1.2	1.2	mg/m³
25	4.1.8	S	S	VDI 3488/1	499	0.6	1.2	1.2	mg/m³
26	4.1.16	S	S	VDI 3488 Bl. 1	2 800	4	1.3	1.3	mg/m³
27	4.1.16	S	S*2; S*2; CAT	VDI 3488 Bl. 1	17 580	24	1.4	1.4	mg/m³
28	4.1.1	C	TO; Q; S; S	VDI 3488/1	4 278	7	1.48	1.48	mg/m³
29	4.1.16	S	S*2; S*2; CAT	VDI 3488 Bl. 1	18 010	29	1.6	1.6	mg/m³
30	4.1.16	S	S*2; S*2; COX; COX	VDI 3488 Bl. 1	7 900	17	2.1	2.1	mg/m³
31	4.1.6	S	TO; S*2	VDI 3488 Bl. 1	8 933	22.3	2.47	2.47	mg/m³
32	4.1.18	C	C; S*2; TO	VDI 3488 Bl.1	85	0.5	5.91	5.91	mg/m³
33	4.1.18	C	S*3; S; S; S; S; COX	VDI 3488 Bl.1	982	8.6	8.93	8.93	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 28 – Chlorine – No scrubbers

Table 50 shows the mean concentration values of chlorine and the related mean mass flow from sources without scrubbers. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (TO = thermal oxidation, SCR = selective catalytic oxidation, COX = catalytic oxidation, none = no waste gas treatment). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 50: Chlorine emissions from sources without scrubbers

#	Type of instal-lation	Waste gas system without scrubbers		Chlorine Measurement method	Mean Volume Flow (*) [m³/h]	Chlorine Mean Mass Flow [g/h]	Chlorine Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.12	-	none	VDI 3488-1	723 800	50	0.05	<0.1	mg/m³
2	4.1.19	S	TO; SCR	VDI 3488	7 000	0.4	0.1	0.1	mg/m³
3	4.1.19	S	TO; SCR	VDI 3488	7 000	0.4	0.1	0.1	mg/m³
4	4.1.19	S	TO; SCR	VDI 3488	7 000	0.4	0.1	0.1	mg/m³
5	4.1.4	-	none	VDI 3488 Bl. 1	259 080	62.5	0.239	0.239	mg/m³
6	4.1.4	-	none	VDI 3488 Bl. 1	237 982	58	0.249	0.249	mg/m³
7	4.1.7	S	COX	VDI 3488/1	380	0.12	0.32	0.32	mg/m³
8	4.1.7	S	COX	VDI 3488/1	233	3.83	16.4	16.4	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 29 – Methanol – Thermal oxidation, catalytic oxidation or activated carbon

Table 51 shows the mean concentration values of methanol and the related mean mass flow from sources with thermal oxidation, catalytic oxidation or activated carbon. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 51: Methanol emissions from sources with thermal or catalytic oxidation or activated carbon

#	Type of installation	Waste gas system including thermal or catalytic oxidation or activated carbon		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	S	S; AC	EN 13649, VDI 2457 Bl.1	67	0.005	0.1	<0.2	mg/m³
2	4.1.18	C	S; S; S; S; COX	Own method	1 100	0.15	0.15	<0.3	mg/m³
3	4.1.8	S	SP; COX	EN 13649	10 860	2.335	0.2165	<0.433	mg/m³
4	4.1.8	S	FF; S; COX	EN 13649	10 300	3.5	0.35	<0.7	mg/m³
5	4.1.2	C	TO	Own method	1 838	0.5	0.375	<0.75	mg/m³
6	4.1.2	C	TO	Own method	806	0.35	0.4	<0.8	mg/m³
7	4.1.7/.12/.14 sowie 9.3.1	S	AC; S	VDI 3483 Bl. 1	218	0.1	0.5	<1	mg/m³
8	4.1	C	C; AC	VDI 2457 Bl.1	2.6	0.002	0.7	0.7	mg/m³
9	4.1.18	C	S*3; S; S; S; S; COX	Based on EN 13649:2001, VDI 2457 Bl.1	982	2	1.82	<3.64	mg/m³
10	4.1.18	C	C; S*2; TO	Based on EN 13649:2011, VDI 2457 Bl.1:1997	85	0.2	2.59	<5.18	mg/m³
11	4.1.10	C	TO, Q, S	EN 13649	3 298	6.4	2.9	2.9	mg/m³
12	4.1.2	S	TO	Based on DIN 38407-F5	777	3.4	4.2	4.2	mg/m³
13	4.1	C	C; AC	EN 13649	53	1.8	32.1	32.1	mg/m³
14	4.1.8	C	AC	VDI 3862 Bl.2	983	39.7	40	40	mg/m³

#	Type of instal-lation	Waste gas system including thermal or catalytic oxidation or activated carbon		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
15	4.1.8	S	AC; F; F	VDI 2457/1; EN 13649	20	0.7	89.2	89.2	mg/m³
16	4.1	S	AC	EN 13649, VDI 2457 Bl. 1	4.2	35	7 414	7 414	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 30 – Methanol – Scrubbers or condensers

Table 52 shows the mean concentration values of methanol and the related mean mass flow from sources with scrubbers or condensers. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 52: Methanol emissions from sources with scrubbers or condensers

#	Type of instal-lation	Waste gas sys-tem including scrubbers or condensers		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1	C	S	EN 13649	2 452	0.25	0.1	<0.2	mg/m³
2	4.1.15	S	S*2	EN 13649	1 640	0.5	0.165	<0.33	mg/m³
3	4.1	S	S	NIOSH 2000	5.0	0.001	0.2	<0.4	mg/m³
4	4.1.10	S	S; FF; SP; SP; SP; SP; SP; CF; CF	VDI 13649	5 020	2	0.38	0.38	mg/m³
5	4.1	C	C; S*2; S; S*3	Based on EN 13649, VDI 2457 Bl.1	8 930	4	0.4	0.4	mg/m³
6	4.1.15	S	S*2	EN 13649	1 300	1	0.41	0.41	mg/m³
7	4.1	C	C; S	VDI 2457 Bl.1	15	0.0065	0.45	<0.9	mg/m³
8	4.1.15	S	S*2	EN 13649	1 840	1	0.54	0.54	mg/m³
9	4.1	C	S	VDI 2457 Bl.1	44	0.025	0.55	<1.1	mg/m³
10	4.1.19	C	S; F	Based on EN 13649:2011, VDI 2457 Bl.1:1997	5 930	3.98	0.65	0.65	mg/m³
11	4.1.15	S	S*2	EN 13649	885	0.65	0.75	<1.5	mg/m³
12	4.1.15	S	S*2	EN 13649	1 253	0.95	0.75	<1.5	mg/m³
13	4.1.15	S	S*2	EN 13649	1 472	1.1	0.75	<1.5	mg/m³
14	4.1.19	S	S	EN 13649	12	0.01	0.75	<1.5	mg/m³
15	4.1.8	S	FF; S	EN 13649	17 810	26	1.47	1.47	mg/m³
16	4.1.18	S	S	Based on EN 13649:2011, VDI 2457 Bl.1:1997	1 387	2.5	1.7	<3.40	mg/m³
17	4.1.11	C	C	OSHA 91	130	0.5	1.775	1.775	mg/m³

#	Type of instal-lation	Waste gas sys-tem including scrubbers or condensers		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
18	4.1	S	S	EN 13649	16	0.028	1.83	1.83	mg/m³
19	4.1.18	S	S; S	EN 13649, VDI 2457	13	0.05	1.9	<3.8	mg/m³
20	4.1.7, 4.1.12, 4.1.14	S	S; S	VDI 3482 Bl.1	574	1.45	2.5	<5	mg/m³
21	4.1.2	S	S*2	VDI 2457 Bl.1	4.2	0.011	3.1	3.1	mg/m³
22	4.1.8	S	FF; S	EN 13649	15 820	51.3	3.27	3.27	mg/m³
23	4.1 / 4.2	S	C; C; S; S	EN 13649 E:2011, VDI 2457 Bl.1:1997	3 830	14	3.5	3.5	mg/m³
24	4.1	C	S	Based on EN 13649	3 820	26	6.7	6.7	mg/m³
25	4.1 / 4.2	C	S	EN 13649 E:2011, VDI 2457 Bl.1:1997	2 660	18	6.9	6.9	mg/m³
26	4.1	S	S*2	EN 13649	7 200	59	8.2	8.2	mg/m³
27	4.1	C	S	DIN 38407-F5	46 900	610	12.9	12.9	mg/m³
28	4.1.19	S	S	EN 13649	8 060	125	16	16	mg/m³
29	4.1	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	1	20	20	mg/m³
30	4.1.19	S	S	VDI 2457 Bl.1	42	1.34	31.4	31.4	mg/m³
31	8.10	C	S	VDI 2457 Bl.2	25	2.85	75	75	mg/m³
32	4.1	S	S	EN 13649	307	26.2	84.3	84.3	mg/m³
33	4.1.10	S	S	VDI 2457 Bl.1	2.1	0.41	218.8	218.8	mg/m³
34	4.1.8	S	C	EN 13649	10	7.33	762.9	762.9	mg/m³
35	8.11.1.1	S	S	Based on EN 13649:2001, VDI 2457 Bl.1	-	0.05	1126.03	1126.03	mg/m³
36	4.1.1	S	S	Based on 38407-F5	9.4	13.9	1590	1.59	g/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 31 – Methanol – No treatment for organic compounds

Table 53 shows the mean concentration values of methanol and the related mean mass flow from sources without treatment for organic compounds. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 53: Methanol emissions from sources without treatment for organic compounds

#	Type of installation	Waste gas system without treatment for organic compounds		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1	S	F	EN 13649, VDI 2457 Bl.1		0.5	0.05	<0.1	mg/m³
2	4.1	S	F	EN 13649, VDI 2457 Bl.1		0.5	0.05	<0.1	mg/m³
3	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
4	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
5	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
6	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
7	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
8	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.5	0.1	<0.2	mg/m³
9	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 220	5	0.2	<0.4	mg/m³
10	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	13 230	5	0.2	<0.4	mg/m³
11	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 190	5	0.2	<0.4	mg/m³
12	4.1.8	-	none	EN 13649	4 900	1	0.2	0.2	mg/m³
13	4.1.8	-	none	EN 13649	2 710	0.5	0.2	<0.4	mg/m³
14	4.1	S	SP	EN 13649, VDI 2457 Bl.1	4 410	2.6	0.63	0.63	mg/m³
15	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 790	13	0.73	0.73	mg/m³
16	4.1	-	none	DIN 38407-F5	334	0.32	1	1	mg/m³
17	4.3	S	CY	Based on EN 13649:2011, VDI 2457 Bl.1:1997	5 935	8.3	1.402	<2.804	mg/m³
18	4.3	S	CY	Based on EN 13649:2011, VDI 2457 Bl.1:1997	115	0.15	1.5015	<3.003	mg/m³

#	Type of installation	Waste gas system without treatment for organic compounds		Methanol Measurement method	Mean Volume Flow (*) [m³/h]	CH_4O Mean Mass Flow [g/h]	CH_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
19	4.1.19	C	F	Based on EN 13649:2011, VDI 2457 Bl.1:1997	11 230	25.1	2.23	2.23	mg/m³
20	4.1.19	C	F	Based on EN 13649:2011, VDI 2457 Bl.1:1997	14 360	42.7	2.97	2.97	mg/m³
21	4.1.19	C	F	Based on EN 13649:2011, VDI 2457 Bl.1:1997	14 410	67.9	4.7	4.7	mg/m³
22	4.1.18	S	FF	Based on EN 13649:2011, VDI 2457 Bl.1:1997	316	2	5.275	<10.55	mg/m³
23	4.1.8	S	FF	VDI 2457/1; EN 13649	6 918	40	6.3	6.3	mg/m³
24	4.1.8	S	FF	VDI 2457/1; EN 13649	3 692	30	9.6	9.6	mg/m³
25	4.1.8	S	FF	VDI 2457/1; EN 13649	1 612	20	15.8	15.8	mg/m³
26	4.1.8	S	F	VDI 2457/1, VDI 2100-2	15 459	287.54	18.6	18.6	mg/m³
27	8.11.1.1	-	none	Based on EN 13649:2001, VDI 2457 Bl.1		0.05	1 281.4	1 281.4	mg/m³
28	4.1.6	-	none	VDI 2457/1; VDI 2100-2	0.10	7	78 724.6	78 724.6	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 32 – Acetic acid data

Table 54 shows the mean concentration values of acetic acid and the related mean mass flow from sources where scrubbers, thermal oxidation, activated carbon filters or no treatment are installed. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 54: Acetic acid emissions from sources without scrubbers

#	Type of installation	Waste gas system		Acetic acid measurement method	Mean Volume Flow (*) [m³/h]	$C_2H_4O_2$ Mean Mass Flow [g/h]	$C_2H_4O_2$ Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.2	S	S*3; AC*2	VDI 2457 Bl. 4	0.33	0.5	0.2	<0.4	mg/m³
2	4.1	-	none	VDI 2457 Bl.1		0.1	0.25	<0.5	mg/m³
3	4.1	-	none	VDI 2457 Bl.1	6.2	0.1	0.25	<0.5	mg/m³
4	4.1.2	S	S*3; AC*2	VDI 2457 Bl. 4	400	0.5	0.3	<0.6	mg/m³
5	4.1.2	S	DS	VDI 2457 Bl. 4	350	0.5	0.5	0.5	mg/m³
6	4.1.8	S	CY; S	VDI 2457 Bl. 4	166	10	0.5	<0.001	g/m³
7	4.1.8	S	S	Own method	49	0.1	1	0.001	g/m³
8	4.1	-	none	VDI 2457 Bl.1	70	0.8	1	1	mg/m³
9	4.1	C	S	EN 13649:2002, VDI 2457 Bl.1: 1997	640	22.5	1	<2	mg/m³
10	4.1.10	S	S	VDI 2457 Bl.1	420	3.5	1.05	<2.1	mg/m³
11	4.1	-	none	VDI 2457 Bl.1	710	2.6	1.1	1.1	mg/m³
12	4.1.10	S	S	VDI 2457 Bl.1	760	0.0005	1.15	<2.3	mg/m³
13	4.1.19	S	S	VDI 2457 Bl.1	708	0.12	1.2	<2.4	mg/m³
14	4.1.2	C	TO			1	1.5	<0.003	g/m³
15	4.1.10	C	TO	VDI 2457 Bl.1	2 327	11	1.6	<3.2	mg/m³
16	4.1.10	C	S*2	VDI 2457 Bl.1	1 268	55	1.9	1.9	mg/m³
17	4.1	S	S	VDI 2457 Bl.1	3 159	4.85	1.9	<3.8	mg/m³
18	4.1	S	S	VDI 2457 Bl.1	1 720	0.02	1.9	1.9	mg/m³
19	4.1.2	C	TO	N. N.	364	3.5	2	<0.004	g/m³
20	4.1.15	S	S	VDI 2457 Bl.1	210	5	2.4	2.4	mg/m³
21	4.1.10	S	S	VDI 2457 Bl.1	2 585	3.15	2.45	<4.9	mg/m³

#	Type of instal-lation	Waste gas system		Acetic acid measurement method	Mean Volume Flow (*) [m³/h]	$C_2H_4O_2$ Mean Mass Flow [g/h]	$C_2H_4O_2$ Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
22	4.1	S	S*2	VDI 2457 Bl. 4	2 024	18	2.5	2.5	mg/m³
23	4.1.2	S	S	VDI 2457 Bl. 4	1 230	5	3.3	3.3	mg/m³
24	4.1	C	S*2	EN 13649, VDI 2457 Bl.1	15 794	0.25	3.5	3.5	mg/m³
25	4.1	C	S	EN 13649:2011, VDI 2457 Bl.1:1997	6 816	172.5	3.6	<7.2	mg/m³
26	4.1	C	S; S; S; DS; S	EN 13649:2011, VDI 2457 Bl.1:1997	2 230	179	3.842	<7.684	mg/m³
27	4.1	C	S; FF; CART	EN 13649 E:2011, VDI 2457 Bl.1	130	42.35	4.25	<8.5	mg/m³
28	4.1.15	S	S*2	VDI 2457 Bl.1	7 200	22.1	4.8	4.8	mg/m³
29	4.1.8	S	CY; S	VDI 2457 Bl. 4	4 612	60	5	0.005	g/m³
30	4.1	C	S; S; S	EN 13649:2002, VDI 2457 Bl.1:1997	23 210	118.7	6.6	6.6	mg/m³
31	4.1	C	TO	EN 13649:2002, VDI 2457 Bl.1:1997	9 960	11	6.6	<13.2	mg/m³
32	4.1.10	S	S	VDI 2457 Bl.1	29 093	0.04325	6.875	<13.75	mg/m³
33	4.1.8	S	S	VDI 2457 Bl. 4	11 923	128	8	0.008	g/m³
34	4.1.8	S	S	VDI 2457 Bl. 4	2 025	170	9	0.009	g/m³
35	4.1.15	S	S*2	VDI 2457 Bl.1	18 020	4	11.2	11.2	mg/m³
36	4.1.2	C	C; S; S; S	VDI 2457 Bl. 4	16 058	4	20.6	20.6	mg/m³
37	4.1.2	S	S	VDI 2457 Bl. 4	370	434	21.9	21.9	mg/m³
38	4.1.2	S	FF	VDI 2457 Bl. 4	19 272	717	30	0.03	g/m³
39	4.1	S	S	VDI 2457 Bl.1	47 950	73.3	36.2	36.2	mg/m³
40	4.1.2	S	S	EN 13649	46 670	182	82.2	82.2	mg/m³
41	4.1	S	FF	EN 13649, VDI 2457 Bl.1	2 210	14	105	105	mg/m³
42	4.1	S	FF	EN 13649, VDI 2457 Bl.1	834	129	344.2	344.2	mg/m³
43	4.1.15	S	S	VDI 2457 Bl.1	19 840	277	413	413	mg/m³
44	4.1.2	-	none	VDI 2457 Bl. 4	23 880	1.875	415	0.415	g/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 33 – Formaldehyde data – Activated carbon, thermal oxidation or catalytic oxidation

Table 55 shows the mean concentration values of formaldehyde and the related mean mass flow from sources with activated carbon filters, thermal oxidation or catalytic oxidation. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (AC = activated carbon, TO = thermal oxidation, S = scrubber, COX = catalytic oxidation, FF = fabric filter, SP = sinter plate filter). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 55: Formaldehyde emissions from sources with activated carbon, thermal oxidation or catalytic oxidation

#	Type of instal-lation	Waste gas system		Formaldehyde measurement method	Mean Volume Flow (*) [m³/h]	CH_2O Mean Mass Flow [g/h]	CH_2O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
1	4.1.2	C	TO	VDI 3862 Bl. 6	1 838	0.05	0.075	<0.15	mg/m³
2	4.1.2	C	TO	VDI 3862 Bl. 6	806	0.15	0.07	<0.14	mg/m³
3	4.1.8	C	AC	VDI 3862 Bl.2	14 800	0.45	0.45	0.45	mg/m³
4	4.1	S	S; S; AC	VDI 3862 Bl.2:2000	983	1.3	0.467	0.467	mg/m³
5	4.1	C	TO	VDI 3862 Bl.2:2000	3 260	1.5	0.8	<1.6	mg/m³
6	4.1.2	S	TO	VDI 3862 Bl. 4	2 230	5	0.15	<0.3	mg/m³
7	4.1.8	C	TO	VDI 3862 Bl. 2	10 300	13	3.58	3.58	mg/m³
8	4.1.8	S	FF; S; COX	VDI 3862 Bl. 2	10 860	20	1.9	1.9	mg/m³
9	4.1.8	S	SP; COX	VDI 3862 Bl. 2	3 740	28.3	2.6	2.6	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 34 – Formaldehyde data – Scrubbers, condensers, fabric filters or no treatment

Table 56 shows the mean concentration values of formaldehyde and the related mean mass flow from sources with scrubbers, condensers, fabric filters or no treatment. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (S = scrubber, FF = fabric filter, C = condenser, none = no treatment). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 56: Formaldehyde emissions from sources with scrubbers, condensers, mechanical filters or no treatment

#	Type of instal-lation	Waste gas system including scrub-bers, condensers, fabric filters or none		Formaldehyde Measurement method	Mean Volume Flow (*) [m³/h]	CH_2O Mean Mass Flow [g/h]	CH_2O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
1	4.1.10	S	S	VDI 3862 Bl.2	0.92	0.0002	0.2	0.2	mg/m³
2	4.1.8	S	S	VDI 3862 Bl. 2	3 540	0.005	0.002	<0.004	mg/m³
3	4.1.2	S	S; S*2	VDI 3862 Bl. 2	3 440	0.02	0.005	<0.01	mg/m³
4	4.1	S	S	VDI 3862 Bl.2	306	0.03	0.1	<0.2	mg/m³
5	4.1.8	-	none	VDI 3862 Bl.2	1 117	0.05	0.05	<0.1	mg/m³
6	4.1.8	S	FF	VDI 3862 Bl.2	1 020	0.05	0.05	<0.1	mg/m³
7	4.1.8	S	FF	VDI 3862 Bl.2	2 680	0.075	0.027	0.027	mg/m³
8	4.1.2	S	S	VDI 3862 Bl. 4	31	0.39	11.3	11.3	mg/m³
9	4.1.8	S	C	VDI 3862 Bl. 2	10	0.5	1.6	1.6	mg/m³
10	4.1.8	S	S	VDI 3862	6 660	1	0.1	0.1	mg/m³
11	4.1.2	S	S*2	VDI 3862 Bl. 2	5 260	1	0.2	0.2	mg/m³
12	4.1.8	S	S	VDI 3862 Bl.2	3 570	1	0.3	<0.6	mg/m³
13	4.1.8	S	C	VDI 3862 Bl. 2	10	1	55.3	55.3	mg/m³
14	4.1.8	S	C	VDI 3862 Bl. 2	10	1	103.4	103.4	mg/m³
15	4.1.2	S	S; S*2	VDI 3862 Bl. 2	3 850	1.3	0.33	0.33	mg/m³
16	4.1	-	none	VDI 3862 Bl.2:2000	19 170	1.5	0.1	<0.2	mg/m³
17	4.1 / 4.2	C	S	VDI 3862 Bl. 2:2000	2 660	1.5	0.5	<1	mg/m³
18	4.1	-	none	VDI 3862 Bl.2:2000	19 400	2	0.1	<0.2	mg/m³

#	Type of instal-lation	Waste gas system including scrub-bers, condensers, fabric filters or none		Formaldehyde Measurement method	Mean Volume Flow (*) [m³/h]	CH_2O Mean Mass Flow [g/h]	CH_2O Mean Concentra-tion (if one or more values are < LOD: 50 % of origi-nal value is used in graphs) [mg/m3]	Original Unit	
19	4.1	-	none	VDI 3862 Bl.2:2000	25 980	2	0.1	<0.2	mg/m³
20	4.1.8	-	none	VDI 3862 Bl.2	19 501	2.835	0.146	0.146	mg/m³
21	4.1 / 4.2	C	S	VDI 3862 Bl. 2:2000	1 210	12	10	10	mg/m³
22	4.1.8	S	S	VDI 3862 Bl. 2	3 540	27	7.6	7.6	mg/m³
23	4.1.8	S	FF; S	VDI 3862 Bl. 2	17 810	49	2.77	2.77	mg/m³
24	4.1.2	S	S*2	VDI 3862 Bl. 2	5 200	59	12.1	12.1	mg/m³
25	4.1.8	S	FF; S	VDI 3862 Bl. 2	15 820	110	6.97	6.97	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 35 – Ethylene oxide data – Scrubbers, activated carbon or catalytic oxidation

Table 57 shows the mean concentration values of ethylene oxide and the related mean mass flow from sources with scrubbers, activated carbon or catalytic oxidation. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (S = scrubber, FF = fabric filter, C = condenser, none = no treatment). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 57: Ethylene oxide emissions from sources with scrubbers, activated carbon or catalytic oxidation

#	Type of instal-lation	Waste gas System Including scrubbers, activated carbon, catalytic oxidation		Ethylene Oxide measurement method	Mean Volume Flow (*) [m³/h]	C_2H_4O Mean Mass Flow [g/h]	C_2H_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m3]	Original Unit	
1	4.1.2	S	S*4; S*4	EN 13649, VDI 2100 Bl. 2	110	0.002	0.015	<0.03	mg/m³
2	4.1.8	S	S	EN 13649 E:2011, VDI 2457 Bl.1:1997	300	0.005	0.02	<0.04	mg/m³
3	4.1.8	S	S	EN 13649 E:2011, VDI 2457 Bl.1:1997	280	0.005	0.02	<0.04	mg/m³
4	4.1	S	S	Based on EN 13649 E:2011, VDI 2457 Bl.1:1997, NIOSH 1614	18	0.3	0.023	<0.046	mg/m³
5	4.1.8	S	DS	EN 13649 E:2011, VDI 2457 Bl.1:1997	1 690	0.04	0.025	<0.05	mg/m³
6	4.1	S	S; **AC**	NIOSH 1614 Adsorp-tion on activated car-bon, impregnated with hydrogen bromide	2 290	0.125	0.05	<0.1	mg/m³
7	4.1.2	C	S*2	EN 13649	250	0.015	0.06	0.06	mg/m³
8	4.1.2	C	**COX**	EN 13649	8 130	0.6	0.07	0.07	mg/m³
9	4.1.2	S	S; S	EN 13649	2 291	0.24	0.1	0.1	mg/m³
10	4.1.2	S	S; S	EN 13649	2 100	0.39	0.18	0.18	mg/m³
11	4.1	S	S; S	Based on EN 13649:2002	786		0.3	0.3	mg/m³
12	4.1.11	S	S; DS	VDI 2457 Bl.1:1997, EN 13649:2002	2.5	0.00174	0.7	0.7	mg/m³
13	4.1.8	S	S	Own method	166	0.24	1.4	1.4	mg/m³
14	4.1.8	S	S*2; S; S	Own method	229	0.33	1.6	1.6	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 36 – Ethylene oxide data – No treatment of organic compounds

Table 58 shows the mean concentration values of ethylene oxide and the related mean mass flow from sources where no treatment for organic compounds is installed. The values are sorted by increasing mean mass flow values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (S = scrubber, FF = fabric filter, C = condenser, none = no treatment). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 58: Ethylene oxide emissions from sources without treatment of organic compounds

#	Type of instal-lation	Waste gas system		Ethylene oxide measurement method	Mean Volume Flow (*) [m³/h]	C_2H_4O Mean Mass Flow [g/h]	C_2H_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	-	none	EN 13649 E:2011, VDI 2457 Bl.1:1997	3 300	0.08	0.025	<0.05	mg/m³
2	4.1	S	SP	EN 13649, VDI 2457 Bl.1	4 410	0.15	0.035	<0.07	mg/m³
3	4.1.8	-	none	EN 13649 E:2011, VDI 2457 Bl.1:1997	11 620	0.2	0.02	<0.04	mg/m³
4	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
5	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
6	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
7	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
8	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
9	4.1.8	S	CY	EN 13649 E:2011, VDI 2457 Bl.1:1997	18 280	0.3	0.015	<0.03	mg/m³
10	4.1.8	S	CY	EN 13649 E:2011, VDI 2457 Bl.1:1997	18 590	0.3	0.015	<0.03	mg/m³
11	4.1.8	S	CY	EN 13649 E:2011, VDI 2457 Bl.1:1997	12 980	0.35	0.05	<0.1	mg/m³
12	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.365	0.05	<0.1	mg/m³
13	4.1.8	-	none	EN 13649 E:2011, VDI 2457 Bl.1:1997	16 640	0.405	0.025	<0.05	mg/m³
14	4.1.8	S	F	EN 13649,	16 790	0.5	0.035	<0.07	mg/m³

#	Type of instal-lation	Waste gas system		Ethylene oxide measurement method	Mean Volume Flow (*) [m^3/h]	C_2H_4O Mean Mass Flow [g/h]	C_2H_4O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
				VDI 2457 Bl.1					
15	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 220	0.5	0.035	<0.07	mg/m^3
16	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	13 230	0.65	0.0415	<0.083	mg/m^3
17	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 190	2.63	0.167	0.167	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 37 – PCDD/F data – Activated carbon or catalysts

Table 59 shows the mean concentration values of PCDD/F and the related mean mass flow from sources where activated carbon or catalyst treatment is installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 59: PCDD/F emissions from sources with activated carbon or catalysts

#	Type of instal-lation	Waste gas system with activated carbon or catalyst treatment		PCDD/F Measurement method	Mean Volume Flow (*) [m³/h]	PCDD/F Mean Mass Flow [µg/h]	PCDD/F Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [ng/m³]	Original Unit	
1	4.1.16	S	S*2; S*2; COX; COX	EN 1948-1-3	7 900	< 0.1 g/h	0.0005	<0.001	ng/m³
2		S	FF; AC	EN 1948-1, VDI 2066 Bl.1, EN 1948-2 / -3	9 410	0.00700	0.0007	0.0007	ng/m³
3		S	FF; AC	EN 1948-1, VDI 2066 Bl.1, EN 1948-2 / -3	9 390	0.01200	0.0013	0.0013	ng/m³
4		S	FF; AC	EN 1948-1-3, VDI 2066 Bl.1,	8 880	0.02000	0.0020	0.002	ng/m³
5	4.1.2	C	SCR; Q; S*3; TO	VDI 3499 Bl.3, EN 1948-1	2 985	0.00500	0.0020	0.002	ng/m³
6	4.1.2	C	SCR; Q; S*3; TO	VDI 3499 Bl.3, EN 1948-1	2 805	0.01000	0.0030	0.003	ng/m³
7	4.1.16	S	S*2; S*2; CAT	EN 1948-1-3	17 580	< 0.1 g/h	0.0040	0.004	ng/m³
8	4.1.19	S	TO; SCR	EN 1948-1	7 000	0.03000	0.0040	0.004	ng/m³
9	4.1.16	S	S*2; S*2; CAT	EN 1948-1-3	18 200	< 0.1 g/h	0.0050	0.005	ng/m³
10	4.1.19	S	TO; SCR	EN 1948-1	7 000	0.04000	0.0050	0.005	ng/m³
11	4.1.16	S	S*2; S*2; CAT	EN 1948-1-3	18 010	< 0.1 g/h	0.0070	0.007	ng/m³

#	Type of instal-lation	Waste gas system with activated carbon or catalyst treatment		PCDD/F Measurement method	Mean Volume Flow (*) [m³/h]	PCDD/F Mean Mass Flow [µg/h]	PCDD/F Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [ng/m³]	Original Unit	
12	4.1.19	S	TO; SCR	EN 1948-1	7 000	0.05000	0.0080	0.008	ng/m³
13		S	FF; AC	EN 1948-1-3, VDI 2066 Bl.1,	8 530	0.10400	0.0120	0.012	ng/m³
14	4.1.13	S	Q; ZY; S*3; S*2; FF	EN 1948-1	19 700	0.35200	0.0180	0.018	ng/m³
15	4.1.18	C	S; S; S; S; COX	EN 1948-1, EN 1948-2, EN 1948-3	1 100	0.04000	0.0360	0.036	ng/m³
16	4.1.18	C	S*3; S; S; S; S; COX	EN 1948-1	960	0.03700	0.0400	0.04	ng/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 38 – PCDD/F data – No activated carbon or catalysts

Table 60 shows the mean concentration values of PCDD/F and the related mean mass flow from sources where no activated carbon nor catalyst treatment is installed. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 60: PCDD/F emissions from sources without activated carbon or catalysts

#	Type of instal-lation	Waste gas system without activated carbon or catalyst treatment		PCDD/F Measure-ment method	Mean Volume Flow (*) [m³/h]	PCDD/F Mean Mass Flow [µg/h]	PCDD/F Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [ng/m³]	Original Unit	
1	4.1.1, 4.1.2, 4.1.3, 4.1.6,4.1.11;4.1.13,4.1.15	S	TO	EN 1948	480	0.00025	0.00025	<0.0005	ng/m³
2	4.1	C	TO,S*2	VDI 3499/3; EN 1948-1	34 011	0.03000	0.0010	0.001	ng/m³
3	4.1.18	C	C; S*2; TO	EN 1948-1	85	0.00020	0.0020	0.002	ng/m³
4	4.1.10	S	TO, Q, S	EN 1948	3 170	0.03170	0.0100	0.01	ng/m³
5	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	15 913	0.17000	0.0110	0.011	ng/m³
6	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	16 700	0.21000	0.0130	0.013	ng/m³
7	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	16 267	0.27000	0.0160	0.016	ng/m³
8	4.1.2	C	TO; S; Q	EN 1948 1-3.1997	9 807	0.18000	0.0181	0.0181	ng/m³
9	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	16 133	0.31200	0.0188	0.0188	ng/m³
10	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	16 400	0.31200	0.0190	0.019	ng/m³
11	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	15 100	0.34000	0.0230	0.023	ng/m³
12	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1;	16 433	0.57700	0.0351	0.0351	ng/m³

#	Type of instal-lation	Waste gas system without activated carbon or catalyst treatment		PCDD/F Measure-ment method	Mean Volume Flow (*) [m³/h]	PCDD/F Mean Mass Flow [µg/h]	PCDD/F Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [ng/m³]	Original Unit	
				VDI 3874					
13	4.1.6	S	TO; S*2	EN 1948-1	8 933	0.45767	0.0510	0.051	ng/m³
14	4.1.6/8	C	TO; Q; S; S; DD	EN 1948-1; VDI 3874	16 400	0.86400	0.0530	0.053	ng/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 39 – Toluene data

Table 61 shows the mean concentration values of toluene and the related mean mass flow. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 61: Toluene emissions and related waste gas treatment

#	Type of instal-lation	Waste gas system		Toluene Measurement method	Mean Volume Flow (*) [m³/h]	Toluene Mean Mass Flow [g/h]	Toluene Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original	Unit
1	4.1	S	S; AC	EN 13649, VDI 2457 Bl. 1	2 290	0.029	0.014	<0.028	mg/m³
2	4.1	S	AC	EN 13649, VDI 2457 Bl. 1	5.3	0.0001	0.015	<0.03	mg/m³
3	4.1.8	-	none	EN 13649	19 501	0.3216	0.016	0.016	mg/m³
4	4.2.2	S	S	EN 13649	2 128	0.05	0.05	<0.1	mg/m³
5	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	2 470	0.25	0.1	0.1	mg/m³
6	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	1 060	0.1	0.1	0.1	mg/m³
7	4.1	C	TO	EN 13649:2002, VDI 2457 Bl.1:1997	2 230	0.5	0.19	<0.38	mg/m³
8	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	2 090	0.5	0.2	0.2	mg/m³
9	4.1.10	C	TO	VDI 2457 Bl.1	6 816	1.5	0.2	<0.4	mg/m³
10	4.1.4	S	S	EN 13649	31	0.01	0.31	0.31	mg/m³
11	4.1	-	none	EN 13649, VDI 2457 Bl. 1	334	0.2	0.5	0.5	mg/m³
12	4.1	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.02	0.5	0.5	mg/m³
13	4.1	-	none	EN 13649, VDI 2457 Bl.1	3 170	1.5	0.5	<1	mg/m³
14	4.1 / 4.2	C	N.N.; C; S	EN 13649:2011, VDI 2457 Bl.1:1997	3 720	1.8	0.55	0.55	mg/m³

#	Type of instal-lation	Waste gas system		Toluene Measurement method	Mean Volume Flow (*) [m³/h]	Toluene Mean Mass Flow [g/h]	Toluene Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
15	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	739	0.65	0.9	0.9	mg/m³
16	4.1.8	C	C	EN 13649	15 783	14	0.9	0.9	mg/m³
17	4.1.4	S	AC	EN 13649	177	0.161	3.5	3.5	mg/m³
18	4.1.8	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.1	3.6	3.6	mg/m³
19	4.1.7	C	S; S	EN 13649, VDI 2457 Bl. 1	11	5	5	<10	mg/m³
20	4.1.7	S	S; C	EN 13649, VDI 2457 Bl. 1	72	0.4	5.5	5.5	mg/m³
21	4.1.4	S	AC	EN 13649	15	0.137	9.86	9.86	mg/m³
22	4.1	S	S*2	EN 13649	7 200	110	15.3	15.3	mg/m³
23	4.1.7	-	none	EN 13649	n.n.		42.67	42.67	mg/m³
24	4.1.7	S	C	EN 13649, VDI 2457 Bl. 1	23	2	91	91	mg/m³
25	4.1.18	S	FF	EN 13649:2001, VDI 2457 Bl.1	264	74	282.5	282.5	mg/m³
26	4.1.7	C	S; S	EN 13649, VDI 2457 Bl. 1	11	32.35	2 838	2 838	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 40 – Propylene oxide data

Table 62 shows the mean concentration values of propylene oxide and the related mean mass flow. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (S = scrubber, FF = fabric filter, F = “filter”, “DS” = droplet separator). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the results originally indicated with “<“.

Table 62: Propylene oxide emissions and related waste gas treatment

#	Type of instal-lation	Waste gas system		Propylene oxide measurement method	Mean Volume Flow (*) [m³/h]	C_3H_6O Mean Mass Flow [g/h]	C_3H_6O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	-	none	EN 13649:2011, VDI 2457 Bl.1:1997	10 990	0.2	0.02	<0.04	mg/m³
2	4.1.8	S	S	EN 13649:2011, VDI 2457 Bl.1:1997	310	0.005	0.02	<0.04	mg/m³
3	4.1.8	S	S	EN 13649:2011, VDI 2457 Bl.1:1997	280	0.005	0.02	<0.04	mg/m³
4	4.1.8	S	DS	EN 13649:2011, VDI 2457 Bl.1:1997	1 700	0.05	0.03	<0.06	mg/m³
5	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
6	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
7	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
8	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
9	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
10	4.1.8	-	none	EN 13649, VDI 2457 Bl.1	7 290	0.25	0.035	<0.07	mg/m³
11	4.1.8	-	none	EN 13649:2011, VDI 2457 Bl.1:1997	16 560	0.605	0.035	<0.07	mg/m³
12	4.1.8	-	none	EN 13649:2011, VDI 2457 Bl.1:1997	3 270	0.115	0.035	<0.07	mg/m³
13	4.1	C	S	Based on EN 13649:2002, VDI 2457 Bl.1:1997	4 010	0.175	0.045	<0.09	mg/m³

#	Type of instal-lation	Waste gas system		Propylene oxide measurement method	Mean Volume Flow (*) [m³/h]	C_3H_6O Mean Mass Flow [g/h]	C_3H_6O Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
14	4.1.8	S	F	VDI 2457/1, VDI 2100-2	15 459	1.5459	0.05	<0.1	mg/m³
15	4.1.8	S	F	VDI 2457/1, VDI 2100-2	1 874	0.1874	0.05	<0.1	mg/m³
16	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 790	1.5	0.075	<0.15	mg/m³
17	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 220	1	0.075	<0.15	mg/m³
18	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	13 230	1	0.075	<0.15	mg/m³
19	4.1.8	S	F	EN 13649, VDI 2457 Bl.1	16 190	1	0.075	<0.15	mg/m³
20	4.1.8	S	FF	VDI 2457/1; EN 13649	3 692	0.365	0.1	<0.2	mg/m³
21	4.1.8	S	FF	VDI 2457/1; EN 13649	1 612	0.16	0.1	<0.2	mg/m³
22	4.1.8	S	FF	VDI 2457/1; EN 13649	6 918	0.69	0.1	<0.2	mg/m³
23	4.1.2	S	S*4; S*4	EN 13649, VDI 2100 Bl. 2	110	0.015	0.125	<0.25	mg/m³
24	4.1	C	C; S*2; S; S*3	Based on EN 13649, VDI 2457 Bl.1	8 930	2	0.215	<0.43	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 41 – Benzene data

Table 63 shows the mean concentration values of benzene and the related mean mass flow. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 63: Benzene emissions and related waste gas treatment

#	Type of instal-lation	Waste gas system		Benzene Measurement method	Mean Volume Flow (*) [m³/h]	Benzene Mean Mass Flow [g/h]	Benzene Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.1	-	none	EN 13649	22 403	0.1	0.005	0.005	mg/m³
2	1.2	C	TO, SCR	EN 13649	10 000	0.05	0.005	<0.01	mg/m³
3	1.2	C	TO, SCR	EN 13649	8 617	0.03	0.005	<0.01	mg/m³
4	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	2 090	0.015	0.0075	<0.015	mg/m³
5	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	2 470	0.02	0.0075	<0.015	mg/m³
6	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	739	0.005	0.0075	<0.015	mg/m³
7	4.1.8	?	N. N.	EN 13649, VDI 2457 Bl. 1	1 060	0.015	0.015	<0.03	mg/m³
8	4.1	S	AC	EN 13649, VDI 2457 Bl. 1	5.3	0.0001	0.015	<0.03	mg/m³
9	4.1.16	S	FF; S*2	EN 13649	19 400	0.5	0.015	<0.03	mg/m³
10	4.1	C	Q; S*2	EN 13649, VDI 2457 Bl. 1	30	0.001	0.03	<0.06	mg/m³
11	4.1.1	-	none	EN 13649	18 735	0.8	0.045	<0.09	mg/m³
12	4.1.2	S	S; TO	EN 13649	146 901	7.35	0.05	<0.1	mg/m³
13	4.1.2	S	S; TO	EN 13649	162 235	6.5	0.05	<0.1	mg/m³
14	4.1	-	none	EN 13649, VDI 2457 Bl. 1	334	0.3	0.1	0.1	mg/m³
15	4.1	C	TO	EN 13649:2001, VDI 2457 Bl.1	16 424	6	0.4	0.4	mg/m³

#	Type of instal-lation	Waste gas system		Benzene Measurement method	Mean Volume Flow (*) [m^3/h]	Benzene Mean Mass Flow [g/h]	Benzene Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
16	4.1	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.025	0.7	0.7	mg/m^3
17	4.1.8	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.28	7.95	7.95	mg/m^3
18	4.1.8	S	AC; F; F	EN 13649	20	1.7	203.1	203.1	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 42 –Toluene diisocyanate

Table 64 shows the mean concentration values of toluene diisocyanate ($C_9H_6N_2O_2$) and the related mean mass flow. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (- = none) and the type of treatment (none = no waste gas treatment). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 64: Toluene diisocyanate emissions and related waste gas treatment

#	Type of instal-lation	Waste gas system		Toluene Diisocyanate measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	37 490	0.05	0.001	<0.002	mg/m³
2	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	13 100	0.01	0.001	<0.002	mg/m³
3	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	19 220	0.015	0.001	<0.002	mg/m³
4	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	7 280	0.005	0.001	<0.002	mg/m³
5	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	17 690	0.015	0.001	<0.002	mg/m³
6	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	18 478	0.14	0.0075	<0.015	mg/m³
7	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	15 328	0.1	0.01	<0.02	mg/m³
8	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	8 114	0.1	0.02	0.02	mg/m³
9	4.1.8	-	none	BGIA 7120	87 860	2	0.025	<0.05	mg/m³
10	4.1.8	-	none	BGIA 7120	97 660	2.5	0.025	<0.05	mg/m³
11	4.1.8	-	none	BGIA 7120	5 600	0.5	0.025	<0.05	mg/m³
12	4.1.8	-	none	BGIA 7120	7 070	0.5	0.025	<0.05	mg/m³
13	4.1.8	-	none	BGIA 7120	7 070	0.5	0.025	<0.05	mg/m³
14	4.1.8	-	none	BGIA 7120	87 860	3	0.035	<0.07	mg/m³
15	4.1.8	-	none	BGIA 7120	97 660	4	0.04	<0.08	mg/m³
16	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	65 866	9	0.1	0.1	mg/m³

#	Type of instal-lation	Waste gas system		Toluene Diisocyanate measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
17	4.1.8 / 5.11	-	none	Based on VDI 2457 Bl. 1	49 230	10	0.211	0.211	mg/m³
18	4.1.8	-	none	BGIA 7120	5 600	0.5	0.25	<0.5	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 43 – Non-CMR halogenated organic compounds data – Scrubbers

Table 65 shows the mean concentration values of non-CMR halogenated organic compounds and the related mean mass flow from sources with scrubbers. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 65: Non-CMR halogenated organic compound emissions with scrubbers

#	Type of installation	Parameter	Waste gas system with scrubbers		Other organic compounds measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.18	CH3Cl	S	S	EN 13649:2001, VDI 2457 Bl.1	1 387	0.4	0.03	<0.06	mg/m³
2	4.1.2	CH3Cl	S	S; S*2	EN 13649	3 490	0.35	0.1	<0.2	mg/m³
3	4.1.11	CH3Cl	C	RU	VDI 2457 Bl.1:1997, interne SAA D-V-40	10	0.00525	0.115	<0.23	mg/m³
4	4.1.3	C2H3ClO2	S	S	EN 1911-1bis3	<13	0.005	0.175	<0.35	mg/m³
5	4.1.3	C2H3ClO2	S	S	EN 1911/1-3	<13	0.005	0.175	<0.35	mg/m³
6	4.1.10	C6H5ClO2S	C	S	VDI 2457 Bl.1	3 153	0.7	0.25	<0.5	mg/m³
7	4.1.8	C3H3ClO	S	S; S	Absorption in 0.1 n NaOH	2 210	0.5	0.3	<0.6	mg/m³
8	4.1.8	C2H3ClO2	S	S	VDI 2457 Bl. 4	19 272	10	0.5	<1	mg/m³
9	4.1.8	C2H3ClO2	S	CY; S	VDI 2457 Bl. 4	11 582	5	0.5	<1	mg/m³
10	4.1.8	C2H3ClO2	S	CY; S	VDI 2457 Bl. 4	11 923	5	0.5	<1	mg/m³

#	Type of instal-lation	Parameter	Waste gas system with scrubbers		Other or-ganic com-pounds measure-ment method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of origi-nal value is used in graphs) [mg/m³]	Original Unit	
11	4.1.8	C3H5ClO2	S	S	EN 1911 Bl. 1-3, VDI 3480	583	0.435	0.75	<1.5	mg/m³
12	4.1	CH2Cl2	C	C; S*2 ; S*3	EN 13649 E:2011, VDI 2457 Bl.1:1997	9 160	11.9	1.3	<2.6	mg/m³
13	4.1	C4H9Cl	C	S	EN 13649:2002, VDI 2457 Bl.1:1997	240	0.5	3	<6	mg/m³
14	4.1.21	C6H4Cl2; Xylole	C	C; S	EN 13649	74	0.5	4.65	<9.3	mg/m³
15	4.1.10	C6H4Cl2	C	S; S; S	EN 13649	3 517	19.8	5.6	5.6	mg/m³
16	4.1.8	C2H3ClO2	S	S	VDI 2457 Bl. 4	16 058	94	5.8	5.8	mg/m³
16	4.1.8	C2H3ClO2	S	S	VDI 2457 Bl. 4	15 794	94	5.8	5.8	mg/m³
17	4.1.8	C2H3ClO2	S	CY; S	VDI 2457 Bl. 4	3 517	93	5.9	5.9	mg/m³
18	4.1.10	C6H4Cl2	C	S; S; S	EN 13649	240	40.2	11.4	11.4	mg/m³
19	4.1	C3H7Cl	C	S	EN 13649:2002, VDI 2457 Bl.1:1997	2 717	3.5	15.5	<31	mg/m³
20	4.1.10	C6H4Cl2	C	S; S; S	EN 13649	35	45.6	16.7	16.7	mg/m³
21	4.1	CH2Cl2	C	S; S; S	EN 13649, VDI 2457 Bl. 1	1 387	3.7	104	104	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 44 – Non-CMR halogenated organic compounds data – Thermal oxidation or catalytic oxidation

Table 66 shows the mean concentration values of non-CMR halogenated organic compounds and the related mean mass flow from sources with thermal oxidation or catalytic oxidation. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 66: Non-CMR halogenated organic compound emissions with thermal or catalytic oxidation

#	Type of instal-lation	Parame-ter	Waste gas system with thermal oxidation or catalytic oxidations		Non-CMR halogenated organic compounds measure-ment method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.7	C2H5Cl	S	COX	EN 13649	183	0.0205	0.115	<0.23	mg/m³
2	4.1.4	C6H4Cl2	C	AC; S*3	EN 13649	2 333	0.6	0.3	0.3	mg/m³
3	4.1	CH2Cl2	C	C; C; AC	EN 13649	49	0.02	0.4	0.4	mg/m³
4	4.1.18	CH3Cl	C	S; S; S; S; COX	LE-SOP-060, L-SOP-016	1 100	0.4	0.4	0.4	mg/m³
5	4.1.18	CH3Cl	C	C; S*2; TO	EN 13649:2001, VDI 2457 Bl.1	85	0.05	0.585	<1.17	mg/m³
6	4.1.18	CH3Cl	C	S*3; S; S; S; S; COX	EN 13649:2001, VDI 2457 Bl.1	982	0.9	0.925	<1.85	mg/m³
7	4.1	CH2Cl2	C	C; AC	EN 13649	27	0.197	7.02	7.02	mg/m³
8	4.1.2	CHCl3	S	TO	i.A. DIN 38407-F5	718	82	114.5	114.5	mg/m³
9	4.1	CH2Cl2	C	C; AC	EN 13649	22	3.4	160	160	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 45 – Non-CMR halogenated organic compounds data – Mechanical filter or no treatment

Table 67 shows the mean concentration values of non-CMR halogenated organic compounds and the related mean mass flow from sources with mechanical treatment or without waste gas treatment system. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 67: Non-CMR halogenated organic compound emissions without treatment for organics

#	Type of instal-lation	Parame-ter	Waste gas system		Non-CMR halogenated organic compounds measure-ment method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	CH3Cl	S	F	VDI 2457/1; EN 13649	3 692	0.37	0.05	<0.1	mg/m³
2	4.1.8	CH3Cl	S	F	VDI 2457/1; EN 13649	1 612	0.16	0.05	<0.1	mg/m³
3	4.1.8	CH3Cl	S	F	VDI 2457/1; EN 13649	6 918	0.35	0.05	<0.1	mg/m³
4	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
5	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
6	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
7	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
8	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
9	4.1.8	CH3Cl	-	none	EN 13649, VDI 2457 Bl.1	7 290	1.5	0.2	<0.4	mg/m³
10	4.1.8	CH3Cl	S	F	VDI 2457/1, VDI 2100-2	15 459	6.18	0.2	<0.4	mg/m³
11	4.1.8	CH3Cl	S	F	VDI 2457/1, VDI 2100-2	1 874	0.75	0.2	<0.4	mg/m³
12	4.1.8	CH3Cl	S	F	EN 13649, VDI 2457 Bl.1	16 790	5	0.5	<1	mg/m³

#	Type of instal-lation	Parame-ter	Waste gas system		Non-CMR halogenated organic compounds measure-ment method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of origi-nal value is used in graphs) [mg/m³]	Original Unit	
13	4.1.8	CH3Cl	S	F	EN 13649, VDI 2457 Bl.1	16 220	5	0.5	<1	mg/m³
14	4.1.8	CH3Cl	S	F	EN 13649, VDI 2457 Bl.1	13 230	5	0.5	<1	mg/m³
15	4.1.8	CH3Cl	S	F	EN 13649, VDI 2457 Bl.1	16 190	5	0.5	<1	mg/m³
16	4.1.18	CH3Cl	S	FF	EN 13649:2001, VDI 2457 Bl.1	316	0.2	0.6	<1.2	mg/m³
17	4.1.18	C6H5Cl	-	none	EN 13649	810	12.7	15.6	15.6	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 46 – More harmful organic compound data – Scrubber, condensers or droplet separator

Table 68 shows the mean concentration values of more harmful organic compounds and the related mean mass flow from sources where scrubbers, condensers or droplet separators are installed. For details of sum parameters "OC Class I" and "OC Class II" see Annex 1. All individual organic compounds are categorized in OC Class I. The values are sorted by increasing mean concentration.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 68: More harmful organic compound emissions from sources with scrubbers, condensers or droplet separators

#	Type of installation	Parameter (for substances of OC Class I and OC Class II see Annex 1)	Waste gas system with scrubbers, condensers or droplet separators		More harmful organic compounds measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original	Unit
1	4.1.2	C4H2O3	S	S; S*2	VDI 2457 Bl. 4	3 440	0.02	0.005	<0.01	mg/m³
2	4.1.2	C4H2O3	S	S*2	VDI 2457 Bl. 4	5 200	0.015	0.005	<0.01	mg/m³
3	4.1.11	C4H2O3	S	S	Own method	15	0.005	0.01	<0.02	mg/m³
4	4.1.8	C2H4O2	S	S	EN 13649	7 780	0.1	0.015	<0.03	mg/m³
5	4.1.8	C2H4O2	S	S	EN 13649	10 700	0.15	0.015	<0.03	mg/m³
6	4.1.8	C2H4O2	S	S	EN 13649	1 760	0	0.015	<0.03	mg/m³
7	4.1.8	C5H8O2	S	S	EN 13649	7 780	0.1	0.015	<0.03	mg/m³
8	4.1.8	C5H8O2	S	S	EN 13649	10 700	0.15	0.015	<0.03	mg/m³
9	4.1.8	C5H8O2	S	S	EN 13649	1 760	0	0.015	<0.03	mg/m³
10	4.1.2	OC Class I	S	S; S*2	EN 13649	3 490	0.0675	0.02	<0.04	mg/m³
11	4.1.2	C4H6O3	S	S; S*2	VDI 2457 Bl. 4	3 500	0.1	0.02	0.02	mg/m³
12	4.1	C4H8O2	C	S; S	Based on EN 13649, VDI 2457 Bl.1	9 030	0.15	0.02	<0.04	mg/m³
13	4.1.2	C3H4O2	S	S; S*2	VDI 2457 Bl. 4	3 490	0.3	0.1	<0.2	mg/m³
14	4.1.2	OC Class I	S	DS	EN 13649	710	0.5	0.15	<0.3	mg/m³
15	4.1.2	OC Class I	S	S	EN 13649	1 230	0.5	0.15	<0.3	mg/m³
16	4.1.2	OC Class I&II	S	S	VDI 2457; EN 13649	130	0	0.15	<0.3	mg/m³

#	Type of instal-lation	Parameter (for sub-stances of OC Class I and OC Class II see Annex 1)	Waste gas system with scrub-bers, condensers or droplet separators		More harmful organic compounds measure-ment method	Mean Volume Flow (*) [m^3/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
17	4.1.15	OC Class I&II	S	S (sev-eral)	VDI 3481/3	24 993	4.5	0.2	<0.4	mg/m^3
18	4.1.8	OC Class I&II	S	S	EN 13649	7 780	0	0.21	0.21	mg/m^3
19	4.1.11	C4H2O3	S	DS	Own method	3 620	1.4	0.4	0.4	mg/m^3
20	4.1	CH2O2	C	S; S; S	EN 13649:2002, VDI 2457 Bl.1:1997	24 850	13.05	0.5	<1	mg/m^3
21	4.1	CH2O2	C	S; S; S	EN 13649:2002, VDI 2457 Bl.1:1997	18 020	8.65	0.5	<1	mg/m^3
22	4.1	CH2O2	C	S; S	EN 13649:2002, VDI 2457 Bl.1:1997	26 360	13.95	0.55	<1.1	mg/m^3
23	4.1.8	OC Class I&II	S	S	EN 13649	10 700	20	1.61	1.61	mg/m^3
24	4.1.2	OC Class I	C	C; S; S; S	EN 13649	210	0.5	1.7	1.7	mg/m^3
25	4.1.8	OC Class I	S	FF; S		17 810	49.3	2.7665	<5.533	mg/m^3
26	4.1	CH2O2	C	S	EN 13649:2011, VDI 2457 Bl.1:1997	47 950	148	3.1	<6.2	mg/m^3
27	4.1.8	OC Class I	S	FF; S		15 820	92	5.83	<11.66	mg/m^3
28	4.1	C4H6O3	S	S*2	EN 13649	7 200	46	6.3	6.3	mg/m^3
29	4.1.8	OC Class I&II	S	S	EN 13649	1 760	90	50.53	50.53	mg/m^3
30	4.1	C8H18OSi2	C	S; S; S	EN 13649, VDI 2457 Bl. 1	35	3.48	106	106	mg/m^3
31	4.1.8	OC Class I	S	C		10	7.33	764.3	764.3	mg/m^3

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 47 – More harmful organic compound data – Thermal oxidation, catalytic oxidation or no treatment for organic compounds

Table 69 shows the mean concentration values of more harmful organic compounds classified as “OC Class I” and “OC Class II” and the related mean mass flow from sources where thermal or catalytic oxidation systems are installed or without specific treatment for organic compounds. For details of sum parameters “OC Class I” and “OC Class II” see Annex 1. All individual organic compounds listed in the talbe are categorized as OC Class I. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 69: More harmful organic compound emissions from sources with thermal oxidation, catalytic oxidation or no treatment for organic compounds

#	Type of installation	Parameter (for substances of OC Class I and OC Class II see Annex 1)	Waste gas system with thermal or catalytic oxid. or no treatment		More harmful organic compounds measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	C_7H_8O	-	none	EN 13649	19 501	0.3246	0.016	0.016	mg/m³
2	4.1.8	$C_3H_4O_2$	-	none	VDI 3862 Bl. 2	715	0.016	0.023	0.023	mg/m³
3	4.1.8	$C_5H_8O_2$	-	none	EN 13649	2 710	0.2	0.06	0.06	mg/m³
4	4.1	CH_2O_2	-	none	VDI 2457/4	1 490	0.175	0.12	<0.24	mg/m³
5	4.1.2	OC Class I	C	TO	EN 13649	1 720	0.26	0.15	0.15	mg/m³
6	4.1.2	OC Class I	C	TO	EN 13649	708	0.29	0.34	0.34	mg/m³
7	4.1.10	OC Class I&II	C	TO	VDI 2457 Bl.1	6 816	1.5	0.45	<0.9	mg/m³
8	4.1.8	C_2H_4	-	none	VDI 2457 Bl. 5		5	0.5	<1	mg/m³
9	4.1.8	C_2H_4	-	none	VDI 2457 Bl. 5		5	0.5	<1	mg/m³
10	4.1.2	C_2H_4	C	COX	EN 13649	8 130	5.1	0.625	<1.25	mg/m³
11	4.1	$C_4H_6O_3$	C	TO	EN 13649, VDI 2457 Bl.1	2 230	1.5	0.85	<1.7	mg/m³
12	4.1.8	OC Class I	S	FF; S; COX	N. N.	10 300	13.5	1.3	<2.6	mg/m³
13	4.1.8	OC Class I	S	SP; COX	N. N.	10 860	16.5	1.5165	<3.033	mg/m³
14	4.1	$C_8H_{18}OSi_2$	-	none	EN 13649, VDI 2457 Bl. 1	334	0.52	1.6	1.6	mg/m³

#	Type of instal-lation	Parameter (for sub-stances of OC Class I and OC Class II see Annex 1)	Waste gas system with ther-mal or catalytic oxid. or no treat-ment		More harmful organic compounds measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
15	4.1.2	CH2O2	S	FF	EN 13650	2 210	6	2.6	2.6	mg/m³
16	4.1.2	OC Class I	-	none	VDI 2457 Bl. 1, EN 13649		8	3 270	3.27	g/m³
17	4.1.2	OC Class I	-	none	VDI 2457 Bl. 1, EN 13649	1.5	11	7 200	7.2	g/m³
18	4.1.2	OC Class I	-	none	VDI 2457 Bl. 1, EN 13649	1.2	22	17 700	17.7	g/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 48 – Metals PM Class I data (mercury)

Table 70 shows the mean concentration values of mercury categorized in PM Class I, the related mean mass flow and waste gas treatment. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 70: PM Class I (mercury) emissions and related waste gas treatment

#	Type of installation	Waste gas system		Metals PM Class I (Mercury) Measurement method	Mean Volume Flow (*) [m³/h]	Hg Mean Mass Flow [g/h]	Hg Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [µg/m³]	Original Unit	
1	4.1 h / 8.1 a	C	TO	EN 13211:2011, EN 1483 (12): 1997	-	-	0.135	<0.27	µg/m³
2	4.1 h / 8.1 a	C	TO	EN 13211:2011, EN 1483 (12): 1997	-	-	0.68	0.68	µg/m³
3	4.1.7 / 4.1.12 / 4.1.14; 9.3.1	S	AC; S	EN 13211	218	0.0002	0.935	0.935	µg/m³
4	4.1.7, 4.1.12, 4.1.14	S	S; S	EN 13211	574	0.00118	2.1	2.1	µg/m³
5	4.1.15	S	S	EN 13211:2001	25	0.0001	3	0.003	mg/m³
6	4.1.4	-	none	EN 13211	259 080	1.91	7.6	0.0076	mg/m³
7	4.1.12	-	none	EN 13211	723 800	6	8	0.008	mg/m³
8	4.1.4	-	none	EN 13211	237 982	3.33	13.8	0.0138	mg/m³
9	4.1.12	-	none	EN 13211	300	0.01	36	0.036	mg/m³
10	4.1.15	S	S*2	EN 13211:2001	863	0.0643	75	0.075	mg/m³
11	4.1.15	S	S	EN 13211:2001	99	0.0075	76	0.076	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 49 – Metals PM Class II data (Co, Ni, Pb, Se, Te)

Table 71 shows the mean concentration values of heavy metals categorized in PM Class II (cobalt, lead, nickel, selenium, telluric), the related mean mass flow and waste gas treatment system. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with "<".

Table 71: Heavy metal PM Class II (Co, Ni, Pb, Se, Te) emissions and related waste gas treatment

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class II measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.21	Nickel	S	FF	Atomic ab-sorption VDI 2268 Bl. 1-4	12 200	-	0.000005	<0.00001	mg/m³
2	4.1.16	Nickel	S	S	VDI 2066/1; EN 14385	4 733	0.00015	0.00003	<0.06	µg/m³
3	4.1.16	Nickel	S	FF	VDI 2066 Bl. 1	10 933	0.015	0.00015	<0.0003	mg/m³
4	4.1.16	PM Class II	S	FF	EN 13284-1, EN 14358	1 730	0.0005	0.0002	<0.0004	mg/m³
5	4.1.16	PM Class II	S	FF	EN 13284-1, EN 14358	1 730	0.0005	0.0002	<0.0004	mg/m³
6	4.1.16	Nickel	S	S	VDI 2066/1; EN 14385	4 933	0.001	0.0002	0.2	µg/m³
7	4.1.16	PM Class II	S	S*2	EN 13284-1, EN 14358	9 450	0.002	0.00025	<0.0005	mg/m³
8	4.1.16	PM Class II	S	S*2	EN 13284-1, EN 14359	12 100	0.003	0.00025	<0.0005	mg/m³
9	4.1.16	PM Class II	S	S*2	EN 13284-1, EN 14358	9 450	0.002	0.00025	<0.0005	mg/m³
10	4.1.16	PM Class II	S	S*2	EN 13284-1, EN 14359	12 100	0.003	0.00025	<0.0005	mg/m³
11	4.1.16	PM Class II	S	FF	EN 13284-1, EN 14358	5 510	0.0015	0.0003	<0.0006	mg/m³
12	4.1.16	PM Class II	S	FF	EN 13284-1, EN 14358	5 510	0.0015	0.0003	<0.0006	mg/m³
13	4.1.10	Lead	S	S	EN 13284-1, EN 14358	2 600	0.0015	0.0005	<0.001	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class II measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
14	4.1	Lead	S	S; FF; CART	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	9 960	0.01	0.001	<0.002	mg/m³
15	4.1	Nickel	S	FF	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	1 480	0.0019	0.0013	0.0013	mg/m³
16	4.1.16	Nickel	S	S	VDI 2066/1; EN 284-1; EN 14385	4 700	0.007	0.0014	1.4	µg/m³
17	4.1 / 4.2	Nickel	S	S	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl. 1-4	1 480	2.5	0.0015	<0.003	mg/m³
18	4.1.16	Lead	S	none	VDI 2268/1-4	300 654	0.48	0.0016	0.0016	mg/m³
19	4.1.16	Nickel	S	S	VDI 2066/1; EN 284-1; EN 14385	4 500	0.008	0.0019	1.9	µg/m³
20	4.1.16	Cobalt	S	FF	EN 14385; EN 13284	700	0.0015	0.002	<0.004	mg/m³
21	4.1.16	Nickel	S	FF	EN 14385; EN 13284-1	3 530	0.005	0.002	<0.004	mg/m³
22	4.1	Cobalt	S	FF	EN 14385; EN 13284	1 293	0.0005	0.0025	<0.005	mg/m³
23	4.1	Nickel	S	FF	EN 14385; EN 13284	1 293	0.0005	0.0025	<0.005	mg/m³
24	4.1.16	Lead	S	none	VDI 2268/1-4	382 312	1.38	0.00361	0.00361	mg/m³
25	4.1	Nickel	S	F; HE; S	VDI 3858 Bl. 1; EN 14385; VDI 3868 Bl. 1	71	0.00036	0.0036	0.0036	mg/m³
26	4.1.16	Nickel	S	none	VDI 2066/1; EN 284-1; EN 14385	3 833	0.016	0.0043	4.3	µg/m³
27	4.1.16	Nickel	S	FF; HE	EN 14385; EN 13284-1	5 100	0.03	0.005	0.005	mg/m³
28	4.1	Nickel	S	FF	VDI 3858 Bl. 1; EN 14385; VDI 3868 Bl. 1	2 500	0.0166	0.00733	0.0073	mg/m³
29	4.1	Co, Ni, Cr, Cu, Mn	S	none	EN 14385,	21 300	0.227	0.01	0.01	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class II measurement method	Mean Volume Flow (*) [m^3/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
					DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4					
30	4.1.16	Cobalt	S	FF	EN 14385; EN 13284-1	3 530	0.02	0.01	0.01	mg/m^3
31	4.1	Nickel	S	none	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	21 300	0.19	0.01	0.01	mg/m^3
32	4.1	Ni, Co	S	none	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	21 300	0.19	0.01	0.01	mg/m^3
33	4.1	Pb, Co, Ni, Se, Te	S	F; S	VDI 2066 Bl.1, VDI 3868 Bl.1, EN 13284		0.00678	0.015	0.015	mg/m^3
34	4.1	Nickel	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.27	0.02	0.02	mg/m^3
35	4.1	Nickel	S	S	VDI 2066/1, EN 13284-1, EN 14385	2 820	0.1	0.02	0.02	mg/m^3
36	4.1	Co, Ni, Cr, Cu, Mn	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.38	0.031	0.031	mg/m^3
37	4.1	Nickel	S	F; HE; S	VDI 3858 Bl. 1; EN 14385; VDI 3868 Bl. 1	121	0.0035	0.032	0.032	mg/m^3
38	4.1	Nickel	S	FF	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	1 370	0.063	0.047	0.047	mg/m^3
39		Lead	S	CART	EN 14385:2004	2 227		0.05	<0.1	mg/m^3
40	4.1.2	Lead	S	FF	EN 14385	4 890	0.27	0.056	0.056	mg/m^3
41	4.1.16	Cobalt	S	FF; HE	EN 14385; EN 13284-1	5 100	0.36	0.07	0.07	mg/m^3

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class II measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
42	4.1.16	Nickel	S	FF; FF	VDI 3858 Bl. 1; EN 14385; VDI 3868 Bl. 1	1 590	0.13	0.0833	0.0833	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 50 – Metals PM Class III data (Cr, Co, Mn, Sb, Sn, V)

Table 72 shows the mean concentration values of heavy metals categorized in PM Class III (antimony, chromium, copper, manganese, vanadium, tin) and the related mean mass flow. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. Values below the detection limit are presented in the graphs with 50 % of the measurement results originally indicated with “<“.

Table 72: Heavy metal PM Class III (Cr, Co, Mn, Sb, Sn, V) emissions and related waste gas treatment

#	Type of installation	Parameter	Waste gas system		Metals PM Class III measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.7	Antimony	C	S; AB;AB	VDI 3868 Bl.1, VDI 2268 Bl.1-4, DIN 38406-E 29	4 710	0.0005	0.0001	<0.0002	mg/m³
2	4.1.21	Copper	C	FF	VDI 3868 Bl.1, VDI 2268 Bl.1-4, DIN 38406-E 29	4 220	0.0005	0.0001	<0.0002	mg/m³
3	4.1.15	Manganese	S	CY; FF	VDI 2066	2 466	0.245	0.0001	<0.0002	mg/m³
4	4.1.21	Tin	C	FF	VDI 3868 Bl.1, VDI 2268 Bl.1-4, DIN 38406-E 29	4 220	0.0005	0.0001	<0.0002	mg/m³
5	4.1	Manganese	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.002	0.00015	<0.0003	mg/m³
6	4.1	Manganese	-	none	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	21 300	0.005	0.0002	<0.0004	mg/m³
7	4.1.21	Copper	C	FF	VDI 3868 Bl.1, VDI 2268 Bl.1-4, DIN 38406-E 29	1 170	0.0006	0.00025	<0.0005	mg/m³
8	4.1.2	Copper	S	FF	DIN 13284-1, VDI 2066 Bl. 1	2 900	0.001	0.0003	0.0003	mg/m³
9	4.1.16	PM Class III	S	FF	EN 13284-1, EN 14359	1 730	0.0005	0.0005	<0.001	mg/m³
10	4.1	Chromium	-	none	EN 14385,	21 300	0.013	0.0007	0.0007	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class III measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original	Unit
					DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4					
11	4.1.16	PM Class III	S	FF	EN 13284-1, EN 14359	5 510	0.0035	0.0007	<0.0014	mg/m³
12	4.1	Copper	S	none	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	21 300	0.023	0.001	0.001	mg/m³
13	4.1.16	Copper	S	FF; HE	EN 14385; EN 13284-1	5 100	0.01	0.0015	<0.003	mg/m³
14	4.1 / 4.2	Copper	S	S	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl. 1-4	1 480	2.5	0.0015	<0.003	mg/m³
15	4.1.16	PM Class III	S	S*2	EN 13284-1, EN 14359	9 450	0.014	0.0015	<0.003	mg/m³
16	4.1	Tin	S	TO; C	EN 14385, VDI 3868, VDI 2268	40	0.00005	0.0015	0.0015	mg/m³
17	4.1	Chro-mium	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.02	0.0017	0.0017	mg/m³
18	4.1	Cr, Cu, Mn	-	none	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	21 300	0.043	0.0017	0.0017	mg/m³
19	4.1.10	Tin		S; FF; SP; SP; SP; SP; SP; CF; CF	EN 14385	5 020	0.01	0.002	0.002	mg/m³
20	4.1.16	Chro-mium	S	FF	EN 14385; EN 13284-1	3 530	0.005	0.002	<0.004	mg/m³
21	4.1.16	Copper	S	FF	EN 14385; EN 13284-1	3 530	0.005	0.002	<0.004	mg/m³
22	4.1	Chro-mium	S	FF	EN 14385; EN 13284	1 293	0.0005	0.0025	<0.005	mg/m³
23	4.1.2	Cu, Mn	S	FF	EN 13284-1,	4 133	0.013	0.003	0.003	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class III measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
					EN 14385, EN 13211, EN 1484					
24	4.1.15	Man-ganese	S	FF	VDI 2268/1-4, VDI 3868/1	700	0.0021	0.003	0.003	mg/m³
25	4.1	Chro-mium IV	S	FF	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	4 180	0.0135 5	0.0032 5	<0.0065	mg/m³
26	4.1.16	Chro-mium	S	FF; HE	EN 14385; EN 13284-1	5 100	0.02	0.005	0.005	mg/m³
27	4.1.2	Chro-mium	S	S	VDI 3868 Bl. 1	19 840	0.1	0.005	<0.01	mg/m³
28	4.1.2	Man-ganese	S	FF	DIN 13284-1, VDI 2066 Bl. 2	2 900	0.013	0.0051	0.0051	mg/m³
29	4.1	Chro-mium IV	S	FF	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	4 330	0.025	0.0055	<0.011	mg/m³
30	4.1	Copper	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.087	0.006	0.006	mg/m³
31	4.1.15	Man-ganese	S	FF	VDI 2066, VDI 2268/1-4, VDI 3868/1	2 061	0.013	0.006	0.006	mg/m³
32	4.1	Chro-mium IV	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	202	0.0015	0.007	<0.014	mg/m³
33	4.1	Chro-mium IV	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	354	0.0025	0.0075	<0.015	mg/m³
34	4.1	Cr, Cu, Mn	S	S; S	EN 14385, DIN 38406-E 29, VDI 3868 Bl. 1, VDI 2268 Bl. 1-4	12 500	0.107	0.008	0.008	mg/m³
35	4.1	PM Class III	S	S	VDI 2268 Bl. 1+4	7 260	0.06	0.01	0.01	mg/m³
36	4.1	Copper	S	FF	EN 14385,	4 180	0.04295	0.01025	<0.0205	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class III measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
					DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4					
37	4.1	Chro-mium IV	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	788	0.0085	0.0105	<0.021	mg/m³
38	4.1.15	Copper	S	S*2	VDI 2066 Bl.1	4 612	0.06	0.012	0.012	mg/m³
39	4.1	Man-ganese	S	FF	VDI 2066/1; EN 14385	1 225	0.0185	0.015	<0.03	mg/m³
40	4.1.7	Tin	S	S; AC	NIOSH Methode 5504, EN 14385, VDI 3868	459	0.01	0.015	<0.03	mg/m³
41	4.1	Chro-mium	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	202	0.004	0.02	0.02	mg/m³
42	4.1.15	Chro-mium IV	S	S	VDI 2066, VDI 2268/1-4, VDI 3868/1	170	0.003	0.02	0.02	mg/m³
43	4.1	Man-ganese	S	S	EN 13284-1, EN 14385	2 820	0.1	0.03	0.03	mg/m³
44		Tin		CART	EN 14385:2004	2 227		0.05	<0.1	mg/m³
45	4.1.21	Chro-mium	S	FF	VDI 2268 Bl. 1-4	51 600	3.1	0.06	0.060	mg/m³
46	4.1	Chro-mium	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	354	0.02	0.08	0.08	mg/m³
47	4.1	Chro-mium	S	FF	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	4 330	0.27	0.08	0.08	mg/m³
48	4.1	Chro-mium	S	FF	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	4 180	0.3719	0.087	0.087	mg/m³
49	4.1	Chro-mium	-	none	EN 14385, DIN 38406-E29, VDI 3868 Bl. 1, VDI 2268 Bl.1-4	788	0.23	0.3	0.3	mg/m³

#	Type of instal-lation	Para-meter	Waste gas system		Metals PM Class III measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
50	4.1.15	Man-ganese	S	S	VDI 2066, VDI 2268/1-4, VDI 3868/1	1 160	0.67	0.58	0.58	mg/m³
51	4.1	Copper	S	S; S	EN 13284-1, EN 14385	670	0.4	0.6	0.6	mg/m³
52	4.1.16	Copper	S	FF; S	VDI 2066 Bl.1, EN 13284-1, EN 14385	69	0.165	2.35	<4.7	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 51 – Other metal data

Table 73 shows the mean concentration values of other metal data, not discussed before, the related mean mass flow and the waste gas treatment system. The values are sorted by substance name and for each substance with increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. For sorting, values below the detection limit are presented with 50 % of the measurement results originally indicated with "<".

Table 73: Other metal emissions and waste gas treatment

#	Type of installation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.7	Aluminium	none	EN 14385	-		1	1	mg/m³
2	4.1.19	Arsenic	S*2; S*2; AC	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	770	0.001	0.001	<0.002	mg/m³
3	4.1	Arsenic, Copper	F; S	VDI 2066 Bl.1, VDI 3868 Bl.1, EN 13284	-	0.001945	0.0041	<0.0082	mg/m³
4	4.1.21	Niobe	FF	VDI 2268 Bl. 1-4	12 200		0.000005	< 1.00E-05	mg/m³
5		Potassium	S	EN 13284-1	4 401	0.775	0.4	<0.8	mg/m³
6		Potassium	S	VDI 2066 Bl. 2	135	0.128	1	1	mg/m³
7		Potassium	none	VDI 2066 Bl.1	12 215	0.0145	1.2025	1.2025	mg/m³
8	4.1.15	Potassium	CY; S	VDI 2066 Bl. 2	27 849	435	15.6	15.6	mg/m³
9	4.1.7	Siliceous	S; S	EN 13649, VDI 2457 Bl. 1	11	0.5	0.5	<1	mg/m³
10	4.1.7	Siliceous	S; C	EN 13649, VDI 2457 Bl. 1	72	0.1	1.9	1.9	mg/m³
11	4.1.7	Siliceous	C	EN 13649, VDI 2457 Bl. 1	23	3	134	134	mg/m³
12	4.1.7	Siliceous	S; S	EN 13649, VDI 2457 Bl. 1	11	4.5	395	395	mg/m³
13	4.1.16	Zinc	none	VDI 2268/1-4	382 312	361	0.95	0.95	mg/m³
14	4.1.16	Zinc	none	VDI 2268/1-4	300 654	394	1.31	1.31	mg/m³

#	Type of installation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
15	4.1.15	Zinc	S	Vdi 2066/1; EN 13284/1; EN 14385	7 633	11	1.5	1.5	mg/m³
16	4.1.7	Zinc	none	EN 14385	-		10	10	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 52 – Other organic CMR substances data

Table 74 shows the mean concentration values of other organic CMR substances, not discussed before, the related mean mass flow and the waste gas treatment system. The values are sorted by substance name and for each substance by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third and fourth column show the character of waste gas treatment system (S = stand alone, C = Centralized, - = none) and the type (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. For sorting, values below the detection limit are presented with 50 % of the measurement results originally indicated with “<“.

Table 74: Other CMR substances emissions and waste gas treatment

#	Type of instal-lation	Parameter	Waste gas system	Organic CMR substance measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³] Original Unit		
1	4.1	2-Ethyl hexane acid	S*2	EN 13649	7 200	0.1	0.015	<0.03	mg/m³
2	4.1.2	Acetaldehyde	COX	VDI 3862 Bl. 3	8 130	0.1	0.01	0.01	mg/m³
3	4.1.8	Acetaldehyde	S	VDI 3862 Bl.2	166	0.14	0.8	0.8	mg/m³
4	4.1.10	Acetaldehyde	S	VDI 3862 Bl.2	0.92	0.016	1.8	1.8	mg/m³
5	4.1.8	Acetaldehyde	CY*2; FF; S	VDI 3862 Bl. 2	4 840	15	3.2	3.2	mg/m³
6	4.1.8	Acetaldehyde	C	VDI 3862 Bl. 2	10	1	101	101	mg/m³
7	4.1 g	Acetalde-hyde, Cro-tonaldeyhde, Methanol	S	VDI 2457 Bl.1	11	1.0957	96	96	mg/m³
8	4.1 g	Acetalde-hyde,Cro-tonaldeyhde, Methanol	none	VDI 2457 Bl.1	<0.32	0.3206 5	2034	2034	mg/m³
9	4.1.7	Allylglycid ether (AGE)	C; S	EN 13649	16	0.0009 7	0.062	0.062	mg/m³
10	4.1.7	Allylglycid ether (AGE)	C; S	EN 13649	17	0.051	1.43	1.43	mg/m³
11	4.1.2	Allylglyc-idylether	TO	EN 13649	512	0.02	0.004	<0.008	mg/m³
12	4.1.2	Allylglyc-idylether	TO	EN 13649	1 788	0.075	0.04	<0.08	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Organic CMR substance measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of origi-nal value is used in graphs) [mg/m³]	Original Unit	
13	4.1.2	Aminoethyl-ethanola-mine	S; S*2	EN 13649	3 500	0.15	0.05	<0.1	mg/m³
14		Benzene, Dichloroe-thene	FF; AC	EN 13649	9 410	0.25	0.03	<0.06	mg/m³
15	4.7	Benzo(a)pyren	C; AD; FF	EN 1948-1; VDI 2066 Bl. 1	45 900	0.045	0.001	<0.002	mg/m³
16	4.1.2	Bisphenol A	S	VDI 2457/4	130	0	0	0	mg/m³
17	4.1.2	Bisphenol A	S	VDI 2457; EN 13649	130	0	0.1	<0.2	mg/m³
18	4.1.8	Bisphenol A	S	EN 13649	6 660	2	0.3	0.3	mg/m³
19	4.1.2	Cancerogenic substances	C; S; S; S	EN 13649	210	0.0095	0.05	<0.1	mg/m³
20	4.1.2	Cancerogenic substances	DS	EN 13649	710	0.101	0.15	<0.3	mg/m³
21	4.1.2	Cancerogenic substances	S	EN 13649	1 230	0.1	0.15	<0.3	mg/m³
22	4.1.13	Cancerogenic substances	S; S	EN 13649	1 115	535			
23	4.1.19	Carboplatin in dust	F	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	13 330	0.007	0.0005	<0.001	mg/m³
24	4.1.19	Carboplatin in dust	F	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	13 970	0.007	0.0005	<0.001	mg/m³
25	4.1.19	Carboplatin in dust	F	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	14 410	0.0065	0.0005	<0.001	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Organic CMR substance measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
26	4.1.19	Carboplatin in dust	F	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	14 360	0.006	0.0005	<0.001	mg/m³
27	4.1.19	Carboplatin in dust	S; F	EN 14385:2004, VDI 3868:1994, VDI 2268 Bl.1-4	5 930	0.003	0.0005	<0.001	mg/m³
28	4.1.2	Dimethyl-sulfate	S; S*2	EN 13649	3 440	0.075	0.0225	<0.045	mg/m³
29	4.1.11	Dimethyl-sulfate	C	VDI 2457 Bl.1:1997	70	0.05	0.5	<1	mg/m³
30	4.1.11	Dimethyl-sulfate	none	VDI 2457 Bl.1:1997	1.0	0.0005	0.5	<1	mg/m³
31	4.1.8	Furfurylalde-hyde	S	VDI 3862 Bl. 2	3 540	0.005	0.002	<0.004	mg/m³
32	4.1 / 4.2	Glyoxal	S	VDI 3862 Bl. 2:2000	2 660	1.5	0.6	<1.2	mg/m³
33	4.1.8	Glyoxal	S	VDI 3862 Bl.2	166	0.1	0.7	<1.4	mg/m³
34	4.1	n-Hexan	S; AC	EN 13649, VDI 2457 Bl. 1	2 290	0.065	0.035	<0.07	mg/m³
35	4.1	n-Hexan	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.004	0.1	0.1	mg/m³
36	4.3	Hexane	CY	EN 13649:2001, VDI 2457 Bl.1	3 995	0.25	0.565	<1.13	mg/m³
37	4.1.7	Hexane	none	EN 13649:2002	1 255	3.73	2.97	2.97	mg/m³
38	4.1	Hydrazine	S; S; S; DS; S	BIA 7635 // ZH1/120.20	46 670	1	0.0165	<0.033	mg/m³
39	4.1	Hydrazine	S	BIA 7635 ZH 1/120.20	3 300	0.1	0.0275	<0.055	mg/m³
40	4.1	Hydrazine	S; S; S	BIA 7635 // ZH1/120.20	24 850	1.15	0.045	<0.09	mg/m³
41	4.1	Hydrazine	S	BIA 7635 // ZH1/120.20	10 690	0.55	0.05	<0.1	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Organic CMR substance measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of origi-nal value is used in graphs) [mg/m³] Original Unit		
42	4.1	Hydrazine	S; FF; CART	BIA 7635 // ZH1/120.20	7 640	0.2	0.05	<0.1	mg/m³
43	4.1	Hydrazine	S; S; S	BIA 7635 // ZH1/120.20	18 020	0.9	0.05	<0.1	mg/m³
44	4.1.8	Methanol, Formalde-hyde	AC	VDI 3862 Bl.2, VDI 2457 Bl.1	473	21.7	64.4	64.4	mg/m³
45	4.1.8	Phenol, Kre-sol, Formal-dehyd	S	EN 13649, VDI 3862 Bl.2	4 700	8.5	1.81	1.81	mg/m³
46	4.1.8	Phenol, Kre-sol, Formal-dehyde	none	EN 13649, VDI 3862 Bl.2	34	6.1	177.3	177.3	mg/m³
47	4.1.8	Phenol, o,m,p-Kresol, Dimethylphe-nole, Formal-dehyde	S	EN 13649	5 383	5.2	1	1	mg/m³
48	4.1.8	Phenol, o,m,p-Kresol, Dimethylphe-nole, Formal-dehyde	none	EN 13649	42	1.51	34.7	34.7	mg/m³
49	4.1	Tetrahydro-furan (THF)	S; AC	EN 13649, VDI 2457 Bl. 1	2 290	0.19	0.082	0.082	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 53 – Hydrogen cyanide (HCN) and non-CMR amino compounds

Table 75 shows the mean concentration values of hydrogen cyanide and amino compounds, the related mean mass flow and the waste gas treatment system. The values are sorted by increasing mean concentration values. Note that toluene diisocyanate ($C_9H_6N_2O_2$) is discussed in chapter 17 (p. 142), and related data is listed in Annex 42.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. For sorting, values below the detection limit are presented with 50 % of the measurement results originally indicated with "<".

Table 75: Hydrogen cyanide and amino compound emissions and waste gas treatment system

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
1	4.1.8	Acrylamide (C3H5NO)	none	VDI 3862 Bl. 2	715	0.25	0.0005	<0.001	mg/m³
2	4.1	Acrylonitrile (C3H3N)	TO	EN 13649	19 820	0.2	0.01	<0.02	mg/m³
3	4.1	Acrylonitrile (C3H3N)	TO	EN 13649	18 700	2	0.1	<0.2	mg/m³
4	4.1.2	Acrylonitrile (C3H3N)	TO	EN 13649	512	0.003	0.005	<0.01	mg/m³
5	4.1.2	Acrylonitrile (C3H3N)	TO	EN 13649	1 788	0.01	0.005	<0.01	mg/m³
6	4.1.8	Acrylonitrile (C3H3N)	AC	EN 13649	6 520	0.5	0.05	<0.1	mg/m³
7	4.1.8	Acrylonitrile (C3H3N)	S	EN 13649	24 400	1	0.05	<0.1	mg/m³
8	4.1.8	Acrylonitrile (C3H3N)	S	EN 13649	21 400	23	1.1	1.1	mg/m³
9	4.1.8	Acrylonitrile (C3H3N)	S	EN 13649	23 300	96	4.1	4.1	mg/m³
10	4.1.8	Acrylonitrile (C3H3N)	S	EN 13649	22 900	120	4.8	4.8	mg/m³
11	4.1.8	Acrylonitrile (C3H3N)	CY	EN 13649	37 460	236	6.3	6.3	mg/m³
12	4.1.8	Acrylonitrile (C3H3N)	CY	EN 13649	45 391	522	11.5	11.5	mg/m³
13	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	37 490	3.5	0.0995	<0.199	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
14	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	49 230	5	0.102	<0.204	mg/m³
15	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	19 220	2	0.1045	<0.209	mg/m³
16	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	13 100	1.5	0.1085	<0.217	mg/m³
17	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	7 280	0.65	0.1085	<0.217	mg/m³
18	4.1.8 /5.11	Amines	none	VDI 3481 Bl. 2	17 690	2	0.1165	<0.233	mg/m³
19	4.1.8	Amines	none	VDI 3496 Bl.1:1982	87 860	22	0.25	<0.5	mg/m³
20	4.1.8	Amines	none	VDI 3496 Bl.1:1982	97 660	24.5	0.25	<0.5	mg/m³
21	4.1.8	Amines	none	VDI 3496 Bl.1:1982	5 600	1.5	0.25	<0.5	mg/m³
22	4.1.8	Amines	none	VDI 3496 Bl.1:1982	7 070	2	0.25	<0.5	mg/m³
23	4.1.8 /5.11	Amines	none	Based on VDI 2457 Bl. 1	65 866	150	2.5	<5	mg/m³
24	4.1.8 /5.11	Amines	none	Based on VDI 2457 Bl. 1	15 328	50	3	<6	mg/m³
25	4.1.8 /5.11	Amines	none	Based on VDI 2457 Bl. 1	18 478	50	3	<6	mg/m³
26	4.1.8 /5.11	Amines	none	Based on VDI 2457 Bl. 1	8 114	25	3	<6	mg/m³
27	4.1.8 /5.11	Amines	none	Based on VDI 2457 Bl. 1	49 619	200	3.9	<7.8	mg/m³
28	4.1.11	2-(2-Amino ethyl amino) ethanol (C4H12N2O , AEEA)	C	VDI 2457 Bl.1:1997	130	0.5	3	<6	mg/m³
29	4.1.11	1-Amino propane-2-ol (C3H9NO, MIPA)	C	VDI 2457 Bl.1:1997	70	0.05	0.5	<1	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
30	4.1.10	Aniline (C6H7N)	S	VDI 2457 Bl.1	2 692	8.6	3.2	3.2	mg/m³
31	4.1	Aniline/ Ethylene di-amine (C6H7N/C2 H8N2)	S; S; S	EN 13649, VDI 2457 Bl. 1	35	0.01	0.15	<0.3	mg/m³
32	4.1.17	e-Caprolac-tam (C6H11NO)	N. N.	VDI 2457 Bl. 1, VDI 3481 Bl. 2+6	173 064	346	2	<4	mg/m³
33	4.1.17	e-Caprolac-tam (C6H11NO)	CY; S	VDI 2066 Bl. 1	190 600	539	2.8	2.8	mg/m³
34	4.1.11	Diethanola-mine (C4H11NO2)	C	VDI 2457 Bl.1:1997	130	0.5	3	<6	mg/m³
35	4.1.8	Diethylene-triamine (C4H13N3)	S	EN 13649	6 660	9	1.3	1.3	mg/m³
36	4.1.11	Diethylene-triamine (C4H13N3)	C	VDI 2457 Bl.1:1997	100	0.5	3	<6	mg/m³
37	4.1.4	3,4-Dihy-droxy-5-ni-tro benzal-dehyde (C7H5NO5, DHNB)	C; AC	VDI 2457 Bl.1	6	0.0000 5	0.015	<0.03	mg/m³
38	4.1.10	Dimethyl acetoamide (C4H9NO)	TO	VDI 2457 Bl.1	6 816	1.5	0.25	<0.5	mg/m³
39	4.1.8	Bis-(N,N-Di-methyl ami-noethyl)-ether (C8H20N2O)	none	VDI 3496 Bl.1:1982	87 860	39.5	0.45	<0.9	mg/m³
40	4.1.8	Bis-(N,N-Di-methyl amino ethyl)-ether (C8H20N2O)	none	VDI 3496 Bl.1:1982	97 660	44	0.45	<0.9	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
41	4.1.8	Bis-(N,N-Dimethyl amino ethyl)-ether ($C_8H_{20}N_2O$)	none	VDI 3496 Bl.1:1982	7 070	3	0.45	<0.9	mg/m³
42	4.1.8	Bis-(N,N-Dimethyl amino ethyl)-ether ($C_8H_{20}N_2O$)	none	VDI 3496 Bl.1:1982	5 600	3	0.5	<1	mg/m³
43	4.1.11	Dimethyl amino propyl amine ($C_5H_{14}N_2$, DMAPA)	C	VDI 2457 Bl.1:1997	130	0.5	3	<6	mg/m³
44	4.1.8	N,N-Dimethyl benzylamine ($C_9H_{13}N$)	none	VDI 3496 Bl.1:1982	97 660	371	3.8	3.8	mg/m³
45	4.1.8	N,N-Dimethyl benzylamine ($C_9H_{13}N$)	none	VDI 3496 Bl.1:1982	7 070	170	24.1	24.1	mg/m³
46	4.1.8	N,N-Dimethyl benzylamine ($C_9H_{13}N$)	none	VDI 3496 Bl.1:1982	5 600	138	24.6	24.6	mg/m³
47	4.1.8	N,N-Dimethyl benzylamine ($C_9H_{13}N$)	none	VDI 3496 Bl.1:1982	87 860	5 626	64	64	mg/m³
48	4.1	N,N-Dimethyl formamide (C_3H_7NO)	S	EN 13649	4 210	0.5	0.165	<0.33	mg/m³
49	4.1.19	Dimethyl formamide (C_3H_7NO)	S	VDI 2457 Bl.1	42	0.01	0.25	<0.5	mg/m³
50	4.1.8	Dimethyl formamide (C_3H_7NO)	S	EN 13649	24 400	9	0.365	<0.73	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
51	4.1.8	Dimethyl formamide (C3H7NO)	S	Based on EN 13649	23 300	15	0.6	0.6	mg/m³
52	4.1.8	Dimethyl formamide (C3H7NO)	S	Based on EN 13649	22 900	19	0.8	0.8	mg/m³
53	4.1.8	Dimethyl formamide (C3H7NO)	S	EN 13649	21 400	20	0.9	0.9	mg/m³
54	4.1.8	Dimethyl formamide (C3H7NO)	none	EN 13649			3	3	mg/m³
55	4.1.8	Diphenyl methane-4,4'-diisocy-anate (C15H10N2 O2, MDI)	none	Absorption on filter with pi-perazine reac-tant	7 000		0.001	0.001	mg/m³
56	4.1.8	Diphenyl methane-4,4'-diisocy-anate (MDI)	S	Absorption on filter with pi-perazine reac-tant	2 020	0.01	0.0049	0.0049	mg/m³
57	4.1.4	Ethylene di-amine (C2H8N2)	none	Based on EN 13649	1 260	0.5	0.3	<0.6	mg/m³
58	4.1.4	Ethylene di-amine (C2H8N2)	DS; C	Based on EN 13649	0.10	0.5	0.35	<0.7	mg/m³
59	4.1.4	Ethylene di-amine (C2H8N2)	CY; CY	Based on EN 13649	1 330	0.5	0.35	<0.7	mg/m³
60	4.1	Ethylene di-amine (C2H8N2)	S*2	EN 13649, VDI 2457 Bl.1	73	0.015	0.2	<0.4	mg/m³
61	4.1.2	2-Ethyl hex-ylamine (C8H19N)	S; S*2	EN 13649	3 440	0.75	0.225	<0.45	mg/m³
62	4.1.10	Formamide (CH3NO)	S	VDI 2457 Bl.1	0.9	0.0003 5	0.4	<0.8	mg/m³
63	4.1	Hydrogen cyanide (HCN)	S	VDI 2470-1	307	0.01	0.05	<0.1	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
64	4.1.2	Hydrogen cyanide (HCN)	S	VDI 2457 Bl. 4	1 230	0.17	0.1	0.1	mg/m³
65	4.1.10	Hydrogen cyanide (HCN)	Misc 1	VDI 2470 Bl.1, DIN 38405	15 300	4.41	0.29	0.29	mg/m³
66	4.1.16	Hydrogen cyanide (HCN)	FF; TO	VDI 2457 Bl. 1	3 020	1	0.4	0.4	mg/m³
67	4.1.10	Hydrogen cyanide (HCN)	S; FF; SP; SP; SP; SP; SP; CF; CF	VDI 2470 Bl.1, DIN 38405	5 060	3.1	0.61	0.61	mg/m³
68	4.1.19	Hydrogen cyanide (HCN)	TO; S	DIN 38405-D13	1 342	3	2.3	2.3	mg/m³
69	4.1.16	Hydrogen cyanide (HCN)	FF; TO; S	VDI 2457 Bl. 1	3 850	14	3.6	3.6	mg/m³
70	4.1.19	Hydrogen cyanide (HCN)	TO; S	DIN 38405-D13	1 160	5	4.1	4.1	mg/m³
71	4.1.8	1,3-Bis(1-Isocyanato-1-methyl-ethyl) benzene (C14H16N2O2, TMXDI (Tetra methyl xylene diisocyanate)	AC	Absorption on filter with piperazine reactant	198	0.65	3.29	3.29	mg/m³
72	4.1	Isophorone diisocyanate (C12H18N2O2)	S*2	EN 13649	7 200	0.005	0.0005	<0.001	mg/m³
73	4.1.10	p-Kresidine (C8H11NO)	S	VDI 2457 Bl.1	0.6	0.00005	0.05	<0.1	mg/m³
74	4.1.10	p-Kresidine (C8H11NO)	S	VDI 2457 Bl.1	6.2	0.0003	0.1	<0.2	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
75	4.1.11	Monoeth-anolamine (C2H7NO)	C	VDI 2457 Bl.1:1997	130	1	5.5	<11	mg/m³
76	4.1.2	Monoeth-anolamine (C2H7NO)	S; S*2	EN 13649	3 500	0.7	0.2	<0.4	mg/m³
77	4.1.2	Monoeth-anolamine (C2H7NO)	S*2	VDI 2457 Bl. 4	5 200	1.05	0.2	<0.4	mg/m³
78	4.1	Monoeth-anole amine (C2H7NO, MEA)	S	VDI 2457/1	2 820	0.2	0.05	<0.1	mg/m³
79	4.1	Morpholine (C4H9NO)	none	EN 13649:2002, VDI 2457 Bl.1:1997	25 980	4.5	0.15	<0.3	mg/m³
80	4.1.18	Morpholine (C4H9NO)	none	EN 13649	810	0.2	0.2	0.2	mg/m³
81	4.1	Morpholine (C4H9NO)	none	EN 13649:2002, VDI 2457 Bl.1:1997	19 400	3.5	0.2	<0.4	mg/m³
82	4.1	Morpholine (C4H9NO)	none	EN 13649:2002, VDI 2457 Bl.1:1997	19 170	3.5	0.2	<0.4	mg/m³
83	4.1	Morpholine (C4H9NO)	S; S; AC	EN 13649:2002, VDI 2457 Bl.1:1997	3 260	0.5	0.2	<0.4	mg/m³
84	4.1.10	o-Phe-nylene dia-mine (C6H8N2)	S	VDI 2457 Bl.1	240	0.05	0.1	<0.2	mg/m³
85	4.1.11	Polyethox-ylated tal-low amine (POEA)	DS	EN 13649 E:2011, VDI 2457 Bl.1:1997	3 860	0.05	0.015	<0.03	mg/m³

#	Type of instal-lation	Parameter	Waste gas system	Measurement method	Mean Volume Flow (*) [m³/h]	Mean Mass Flow [g/h]	Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
86	4.1	Triethylamine (C6H15N)	S*2	EN 13649	7 200	0.15	0.025	<0.05	mg/m³
87	4.1	Triethylamine (C6H15N)	C; S	EN 13649	12	0.005	0.15	<0.3	mg/m³
88	4.1	Triethylamine (C6H15N)	C; S	EN 13649	96	0.015	0.15	<0.3	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 54 – Carbon monoxide data

Table 76 shows the mean concentration values of carbon monoxide, the related mean mass flow and the waste gas treatment system. The values are sorted by increasing mean concentration values.

The second column indicates the process category number (compare Annex 2), the third column presents the parameter. The fourth column shows the type of treatment (see section 2.5, page 76 for explanation of abbreviations). The fifth column informs about the measurement method. The sixth column shows the mean volume flow and the seventh column indicates the mean mass flow. The eighth and ninth column show the mean concentration value as it is used in graphs and the related original value. For sorting, values below the detection limit are presented with 50 % of the measurement results originally indicated with "<".

Table 76: Carbon monoxide emissions and related waste gas treatment

#	Type of installation	Waste gas system	Carbon monoxide Measurement method	Mean Volume Flow (*) [m^3/h]	CO Mean Mass Flow [g/h]	CO Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m^3]	Original Unit	
1	4.1.18	C; S*2; TO	EN 15058	100	0.0007	0.007	0.007	mg/m^3
2	4.10 / 4.1.8	TO	EN 15058	18 500	3	0.19	0.00019	g/m^3
3	4.1.18	S; S; S; S; COX	EN 15058	1 100	-	0.2	<0.0004	g/m^3
4	4.1.12	none	EN 15058	1 085	0.68	0.6	0.6	mg/m^3
5	4.1.18	S*3; S; S; S; S; COX	EN 15058	1 250	0.8	0.6	0.0006	g/m^3
6	4.1.1	none	EN 15058	22 403	-	0.65	<1.3	mg/m^3
7	4.1.2	TO; S; Q	EN 15058	9 681	-	0.65	<1.3	mg/m^3
8	4.1.8	COX	EN 15058	18 500	-	0.65	<1.3	mg/m^3
9	4.1.6/8	TO; Q; S; S; DD	VDI 3482/4-5	16 400	-	0.65	<1.3	mg/m^3
10	4.1.6/8	TO; Q; S; S; DD	VDI 3482/4-5	16 400	-	0.65	<1.3	mg/m^3
11	4.1.8	S; TO	EN 15058	945	-	0.75	<1.5	mg/m^3
12	4.1	TO	EN 15058	18 700	15	0.8	0.8	mg/m^3
13	4.1.2	TO	EN 15058	777	1	0.95	0.95	mg/m^3
14	4.1.2	TO; S; Q	EN 15058	9 269	16	1	1	mg/m^3
15	4.1.8	Flare	EN 15058	3 000	-	1	<2	mg/m^3
16	4.1.8	Flare	EN 15058	3 416	-	1	<2	mg/m^3
17	4.1.8	TO	EN 15058	3 263	-	1	1	mg/m^3
18	4.1	S; DS	EN 15058	11 800	-	1	<2	mg/m^3
19	4.1.18	S*3; S; S; S; S; COX	EN 15058	982	0.9	1	0.001	g/m^3
20	4.1.1	TO	EN 15058	209	0.2	1.2	1.20	mg/m^3

#	Type of installation	Waste gas system	Carbon monoxide Measurement method	Mean Volume Flow (*) [m³/h]	CO Mean Mass Flow [g/h]	CO Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
21	4.1.2	TO	EN 15058	718	-	1.2	<2.4	mg/m³
22	4.1.2	TO	EN 15058	1 460	4	1.25	<2.5	mg/m³
23	4.1.2	TO	EN 15058	806	-	1.25	<2.5	mg/m³
24	4.1.2	TO	EN 15058	1 888	-	1.25	<2.5	mg/m³
25	4.1.18	TO; S; S	EN 15058, VDI 2459-6	1 350	-	1.25	<2.5	mg/m³
26	4.1	TO	EN 15058	19 820	26	1.3	1.3	mg/m³
27	4.1.2, 4.1.7	TO	EN 15058	3 955	-	1.5	<3	mg/m³
28	4.1.7	COX	EN 15058	380	-	1.5	<3	mg/m³
29	4.1.8	TO	EN 15058	2 530	4	1.6	1.6	mg/m³
30	1.2	TO, SCR	EN 15058	9 559	7	1.8	1.8	mg/m³
31	4.1.6/8	TO; Q; S; S; DD	EN 15058	16 126	29	1.8	1.8	mg/m³
32	4.1.17	CY; S	EN 15058	190 600	365	1.9	1.9	mg/m³
33	4.1	none	EN 15058	11 500	-	1.9	<3.8	mg/m³
34	4.1.8	TO	EN 15058	10 860	-	2.5	<0.005	g/m³
35	4.1.1, 4.1.2, 4.1.3, 4.1.6,4.1.11;4.1.13,4.1.15	TO	EN 25058	480	2.67	2.5	<0.005	g/m³
36		TO	EN 15058	15 750	29	2.5	0.0025	g/m³
37	4.1.12	none	EN 15058	6 870	-	2.5	<5	mg/m³
38	4.1.16	TO	EN 15058	4 533	-	2.5	<5	mg/m³
39	4.1.16	S; TO	EN 15058	3 700	-	2.5	<5	mg/m³
40	10.3.1	SNCR; Q; S; S	Based on EN 15058:2006	5 542	-	2.5	<0.005	g/m³
41	4.1.17	N. N.	EN 15058	173 064	447	2.6	2.6	mg/m³
42	4.1.17	CY; S	EN 15058	185 400	506	2.7	2.7	mg/m³
43	4.1.19	TO; DENOX; S; Q; S	EN 15058	4 552	-	2.7	2.7	mg/m³
44	4.1.18	TO	EN 15058	594	1.78	3	3	mg/m³
45	4.1.18	TO	EN 15058	1 026	3.1	3	3	mg/m³
46	4.1.2	TO; S; Q	EN 15058	9 807	34	3.5	3.5	mg/m³

#	Type of installa-tion	Waste gas system	Carbon monoxide Measurement method	Mean Volume Flow (*) [m³/h]	CO Mean Mass Flow [g/h]	CO Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
47	4.1.6/8	TO; Q; S; S; DD	EN 15058	17 539	62.3	3.57	3.57	mg/m³
48	4.1.2	TO	EN 15058	14 800	52.5	3.7	3.7	mg/m³
49	4.1.1	TO; Q; S; BU; SCR	EN 15058, VDI 2459-6	1 180	5	3.9	3.9	mg/m³
50	4.1.8	TO	EN 15058	2 140	8	3.9	3.9	mg/m³
51	4.1.2	SCR; Q; S*3; TO	EN 15058	2 805	10	4	0.004	g/m³
52	4.1.2	SCR; Q; S*3; TO	EN 15058	2 985	11	4	0.004	g/m³
53	4.1.8	SP; COX	EN 15058	10 860	47	4	0.004	g/m³
54	4.1.8	TO	EN 15058, VDI 2459 Bl.6	32 100	168	4.2	4.2	mg/m³
55	4.1.6/8	TO; Q; S; S; DD	EN 15058	16 700	79.3	4.73	4.73	mg/m³
56	4.1.16	F	EN 15058	604	1.5	5	0.005	g/m³
57	4.1.16	F	EN 15058	620	1.8	5	0.005	g/m³
58	4.1.18	C; S*2; TO	EN 15058	85	0.4	5	0.005	g/m³
59	4.1.7	COX	EN 15058	233	1.3	5.1	5.1	mg/m³
60	4.1	TO	EN 15058	800	4	5.3	5.3	mg/m³
61	4.1.1	none	EN 15058	18 735	96	5.4	5.4	mg/m³
62	10.3.1	SNCR; Q; S; S	Based on EN 15058:2006	5 657	-	5.5	0.0055	g/m³
63	4.1.8	TO	EN 15058	650	5	6	6	mg/m³
64	4.1.16	SP	VDI 2459	10 100	60	6	6	mg/m³
65	10.3.1	SNCR; Q; S; S	Based on EN 15058:2006	5 867	-	6	0.006	g/m³
66	4.1.6/8	TO; Q; S; S; DD	EN 15058	15 519	98.7	6.37	6.37	mg/m³
67	4.1	TO	Based on EN 15058:2006	60	-	6.5	0.0065	g/m³
68	4.1.16	none	EN 15058	600	-	6.85	<13.7	mg/m³
69	4.1.8	CY; TO; S	EN 15058	331	-	6.9	6.9	mg/m³
70	4.1	none	EN 15058	882	2	7	7	mg/m³
71	4.1	none	EN 15058	332	5	7	7	mg/m³
72	4.1.16	FF; TO	EN 15058	3 020	22	7.1	7.1	mg/m³
73	4.1.16	none	EN 15058	633	-	7.25	<14.5	mg/m³

#	Type of installation	Waste gas system	Carbon monoxide Measurement method	Mean Volume Flow (*) [m³/h]	CO Mean Mass Flow [g/h]	CO Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
74	1.2	TO, SCR	EN 15058	8 617	27	7.5	7.5	mg/m³
75	4.1.12	none	EN 15058	2 200	16	9	0.009	g/m³
76	4.1.16	none	EN 15058	800	-	9.95	<19.9	mg/m³
77	4.1.11	none	EN 15058	3 870	29	10.6	10.6	mg/m³
78	4.1	TO; S*2	EN 15058	2 280	26.7	11.3	0.0113	g/m³
79	4.1.8	TO	EN 15058:2006	8 300	95	11.7	11.7	mg/m³
80	4.1.15	none	EN 15058	764	7	11.8	11.8	mg/m³
81	4.1.8	none	EN 15058	-	-	11.9	11.9	mg/m³
82	4.1.19	TO; SCR	N. N.	7 000	85	12.4	12.4	mg/m³
83	4.1.16	FF	EN 15058	10 933	136.7	12.5	12.5	mg/m³
84	4.1.8	COX	EN 15058	2 885	37	12.8	12.8	mg/m³
85	4.1.1	TO; FF; S; S; S; S	EN 15058	544	7.2	13	13.0	mg/m³
86	4.1.2	none	EN 15058	560	4	13	13	mg/m³
87	4.1.7	SR	EN 15058	1 080	13	13	0.013	g/m³
88	4.1.19	TO	EN 15058	6 660	86.8	13	13.03	mg/m³
89	4.1.19	TO; SCR	N. N.	7 000	90	13.1	13.1	mg/m³
90	4.1.15	S*2; FF	EN 15058	11 158	183	13.4	13.4	mg/m³
91	4.1.19	TO; SCR	N. N.	7 000	95	14.4	14.4	mg/m³
92	4.1	S; S; S; DS; S	EN 15058:2006	46 670	699	14.8	14.8	mg/m³
93	4.1	TO	EN 15058:2006	2 230	23	15.7	15.7	mg/m³
94	4.1.8	TO	EN 15058	10 570	170	16.3	0.0163	g/m³
95	4.1.2	TO	EN 15058	1 200	20	17	0.017	g/m³
96	4.1.16	TO	EN 15058	1 663	33.8	17.4	17.4	mg/m³
97	4.1.8	TO	EN 15058	896	-	17.9	17.9	mg/m³
98	4.1	none	EN 15058:2006	380	7	19.5	19.5	mg/m³
99	4.1.8	F	EN 15058:2006	26 010	165	20	20	mg/m³
100	4.1.2	S; TO	EN 15058	162 235	3 380	20.8	20.8	mg/m³
101	4.1.6	none	EN 15058	30 300	646	21.9	21.9	mg/m³
102	4.1.8	FF; S; COX	EN 15058	10 300	226	22	0.022	g/m³
103	4.1	none	EN 15058:2006	370	7	23.4	23.4	mg/m³
104	4.1.8	TO	EN 15058	1 509	-	24.2	24.2	mg/m³
105	4.1	TO	EN 15058	16 424	400	26.1	26.1	mg/m³
106	4.1.16	none	EN 15058	567	6	28.4	28.4	mg/m³

#	Type of installa-tion	Waste gas system	Carbon monoxide Measurement method	Mean Volume Flow (*) [m³/h]	CO Mean Mass Flow [g/h]	CO Mean Concentration (if one or more values are < LOD: 50 % of original value is used in graphs) [mg/m³]	Original Unit	
107	4.1.16	none	EN 15058	567	5	28.7	28.7	mg/m³
108	4.1.16	none	DIN 14792	367	6	30	30	mg/m³
109	4.1.2	S; TO	EN 15058	146 839	4 744.9	32.3	32.3	mg/m³
110	4.1	F	EN 15058	16 250	127	33	33	mg/m³
111	4.1.8	FF; S	EN 15058	17 810	213	34.2	34.2	mg/m³
112	4.1.7	none	EN 15058	152	3	35	35	mg/m³
113	4.1.16	none	EN 15058	567	7	35.8	35.8	mg/m³
114	4.1.16	FF; TO; S	EN 15058	3 850	150	39	39	mg/m³
115	4.1.8	TO	EN 15058	3 740	140	40	0.04	g/m³
116	4.1.8	C; COX	EN 15058	36	2	47	0.047	g/m³
117	4.1.19	TO; S	VDI 2459 Part 6	1 340	67	49.9	49.9	mg/m³
118	4.1.19	TO; S	VDI 2459 Part 6	1 160	63	54.3	54.3	mg/m³
119	4.1.8	FF; S	EN 15058	15 820	308	55.2	55.2	mg/m³
120	4.1.8	TO	EN 15058	1 030	34	57.4	57.4	mg/m³
121	4.1	TO	EN 15058:2006	21 730	1 283	58.5	58.5	mg/m³

(*) In case of several measurements the mean of the volume flow was calculated.

Annex 55 – Chemical industry installations in Germany

Table 77 shows the number of chemical industry installations covered by the EU Industrial Emissions Directive (IED 2010) in the 16 federal states of Germany or the regions responsible for inspection. The lists indicates a total of 2015 chemical industry installations with activities according to IED Annex 1 no. 4 respectively no. 4.1 and 4.6 of the 4. BImSchV (2013).

As download links may change when updated, Table 78 provides the websites with inspection plans for chemical industry installations under the Industrial Emissions Directive in Germany.

Table 77: Number of chemical industry installations covered by the IED in Germany

#	No. Plants	Federal State / Region	IED Inspection Plan (intensive rearing installations and disposal sites are reported on separate lists in some cases)
1	**154**	**Baden-Wuerttemberg**	https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/3_Umwelt/Schutz_nat%C3%BCrlicher_Lebensgrundlagen/Luft/IE-Richtlinie/Anhang1_Anlagenverzeichnis_Ueberwachungsplan-alle_RPen.pdf
2	**208**	**Bavaria**	See regions
a	8	Lower Bavaria	http://www.regierung.niederbayern.bayern.de/media/aufgabenbereiche/5u/ierichtlinie/ie-rl_immissionsschutz_anhang1.pdf
b	136	Upper Bavaria	http://www.regierung.oberbayern.bayern.de/imperia/md/content/regob/internet/dokumente/bereich5/technischerumweltschutz/ie-rl/160829_anhang_1_zum_%C3%9Cberwachungsplan.pdf
c	10	Lower Franconia	https://www.regierung.unterfranken.bayern.de/assets/6/1/anhang_1_%C3%9Cberwachungsplan.pdf
d	4	Middle Franconia	http://www.regierung.mittelfranken.bayern.de/aufg_abt/abt8/EU_Rili/Anhang1_zumUeberwachungsplanRMF.pdf
e	3	Upper Franconia	http://www.regierung.oberfranken.bayern.de/imperia/md/content/regofr/umwelt/umweltinformationen/anlagenueberwachung/1_1_im_uebwplan_anhang1.pdf
f	3	Upper Palatinate	http://www.regierung.oberpfalz.bayern.de/leistungen/umwelt/info/eu_industrieemissionen/immissionsschutz/zusammenstellung_ieanlagen.pdf
g	44	Swabia	http://www.regierung.schwaben.bayern.de/Aufgaben/Bereich_5/Technischer_Umweltschutz/IE-Richtlinie/Plan-I-Anh1.pdf
3	**4**	**Berlin**	http://www.stadtentwicklung.berlin.de/umwelt/industrie_gewerbe/download/ueberwachungsplan.pdf
4	**41**	**Brandenburg**	http://www.lfu.brandenburg.de/cms/detail.php/bb1.c.363209.de
5	**1**	**Bremen**	http://www.bauumwelt.bremen.de/sixcms/media.php/13/%DCberwachungsplanBremen2015_2015-11-16.pdf
6	**35**	**Hamburg**	http://www.hamburg.de/contentblob/4355242/96b4c4258cbf59e19b0e95ba1b3220c9/data/anlagenliste.pdf
7	**194**	**Hesse**	https://umweltministerium.hessen.de/sites/default/files/media/ueberwachungsprogramm_hessen_stand_dezember_2015.pdf

#	No. Plants	Federal State / Region	IED Inspection Plan (intensive rearing installations and disposal sites are reported on separate lists in some cases)
8	**191**	**Lower Saxony**	http://www.umwelt.niedersachsen.de/download/86771
9	**15**	**Mecklenburg-Western Pomerania**	http://www.regierung-mv.de/serviceassistent/download?id=1579800
10	**497**	**North Rhine-Westphalia**	See regions
a	23	Arnsberg	http://www.bezreg-arnsberg.nrw.de/themen/u/umweltinspektionen_5/do_ueberwachungsprogramme/bimschg_anlagen_ied-anlagen.pdf
b	13	Detmold	http://www.bezreg-detmold.nrw.de/200_Aufgaben/050_Umwelt_und_Naturschutz/009_Medienuebergreifende_Umweltinspektionen/009_Dokumente/Ueberwachungsprogramm_IE_05-01-2016_bf.pdf
c	132	Düsseldorf	http://www.brd.nrw.de/umweltschutz/umweltinspektionen/service/Ueberwachungsplan-und-programm.pdf
d	59	Münster	http://www.bezreg-muenster.de/zentralablage/dokumente/umwelt_und_natur/umweltinspektionsberichte/Ueberwachungsprogramm-BR-MS-29_5_15.pdf
e	135	Köln	http://www.bezreg-koeln.nrw.de/brk_internet/umweltueberwachungsberichte/umweltueberwachungsprogramm.pdf
11	**267**	**Rhineland-Palatinate**	https://mueef.rlp.de/fileadmin/mwkel/Abteilung_5/Bodenschutz/Rundschreiben/2013_2_IED_Ueberwachungsplan_Rheinland-Pfalz.pdf
12	**1**	**Saarland**	http://www.saarland.de/dokumente/thema_immissionsschutz/Liste_der_IED_Anlagen_des_Saarlandes_12_05_2016.pdf
13	**81**	**Saxony**	https://www.umwelt.sachsen.de/umwelt/download/Anlagenliste2016.pdf
14	**272**	**Saxony-Anhalt**	http://mule.sachsen-anhalt.de/fileadmin/Bibliothek/Politik_und_Verwaltung/MLU/MLU/a-Themen/Luft_Laerm_Verkehr/Immissionsschutz/Industrieemissionsanlagen/Anlage_1a_IE_Anlagen_nach_BImSchG_sowie_Industrieklaeranlagen.pdf
15	**29**	**Schleswig-Holstein**	http://www.schleswig-holstein.de/DE/Fachinhalte/I/immissionsschutz/Downloads/Ueberwachungsplan.pdf?__blob=publicationFile&v=1
16	**25**	**Thuringia**	http://www.thueringen.de/mam/th8/tmlfun/umwelt/immissionsschutz/uberwachungsplan_2016__anhang__1.pdf
	2015	**Total**	

(Ökopol 2016)

Table 78: Websites with inspection plans for IED chemical industry installations in Germany

#	Federal State / Region	IED Inspection Plan
1	**Baden-Wuerttemberg**	http://www4.lubw.baden-wuerttemberg.de/servlet/is/225638/
2	**Bavaria**	See regions
a	Lower Bavaria	http://www.regierung.niederbayern.bayern.de/aufgabenbereiche/5u/ierichtlinie/immissionsschutz/
b	Upper Bavaria	https://www.regierung.oberbayern.bayern.de/aufgaben/umwelt/tumwelt/09631/
c	Lower Franconia	https://www.regierung.unterfranken.bayern.de/aufgaben/6/1/01119/index.html
d	Middle Franconia	https://www.regierung.mittelfranken.bayern.de/aufg_abt/abt8/abt84010_EU-Rili_Ueberwachungsplan_Industrie.htm
e	Upper Franconia	https://www.regierung.oberfranken.bayern.de/umwelt/umweltinformationen/anlagenueberwachung/ueberwachungsplaene.php
f	Upper Palatinate	http://www.regierung.oberpfalz.bayern.de/leistungen/umwelt/index.htm
g	Swabia	https://www.regierung.schwaben.bayern.de/Aufgaben/Bereich_5/Technischer_Umweltschutz/IE-Richtlinie/IE-R_Immissionsschutz_Ueberwachung.php?PFAD=/index.php:/index2.php:Bereich_5.php
3	**Berlin**	http://www.stadtentwicklung.berlin.de/umwelt/industrie_gewerbe/de/gendat.shtml
4	**Brandenburg**	http://www.lfu.brandenburg.de/cms/detail.php/bb1.c.363209.de
5	**Bremen**	http://www.bauumwelt.bremen.de/sixcms/detail.php?gsid=bremen213.c.30419.de
6	**Hamburg**	http://www.hamburg.de/betriebe-umwelt/4355206/ueberwachung-ied/
7	**Hesse**	https://umweltministerium.hessen.de/umwelt-natur/anlagensicherheit-und-ueberwachung/ueberwachung-von-anlagen-nach-der-industrieemissions
8	**Lower Saxony**	http://www.umwelt.niedersachsen.de/themen/anlagenbezogene_luftreinhaltung/industrieemissionen/industrieemissionen-121074.html
9	**Mecklenburg-Western Pomerania**	http://www.regierung-mv.de/Landesregierung/wm/Wirtschaft/Immissionsschutz/%C3%9Cberwachungsplan-Industrieemissionen/
10	**North Rhine-Westphalia**	See regions
a	Arnsberg	http://www.bezreg-arnsberg.nrw.de/themen/u/umweltinspektionen_5/do_ueberwachungsprogramme/index.php
b	Detmold	http://www.bezreg-detmold.nrw.de/200_Aufgaben/050_Umwelt_und_Naturschutz/009_Medienuebergreifende_Umweltinspektionen/index.php

#	Federal State / Region	IED Inspection Plan
c	Düsseldorf	http://www.brd.nrw.de/umweltschutz/umweltinspektionen/Ueberwachung-splan-Ueberwachungsprogramm.html
d	Münster	http://www.bezreg-muenster.de/de/umwelt_und_natur/um-weltinspektionsberichte/ueberwachungsplan/index.html
e	Köln	http://www.bezreg-koeln.nrw.de/brk_internet/umweltueberwachungsber-ichte/index.html
11	**Rhineland-Palatinate**	https://mueef.rlp.de/de/themen/umweltschutz-umwelt-und-gesundheit/in-dustrieanlagen/industrieemissionen/
12	**Saarland**	http://www.saarland.de/109666.htm
13	**Saxony**	https://www.umwelt.sachsen.de/umwelt/luft/42031.htm
14	**Saxony-Anhalt**	http://mule.sachsen-anhalt.de/themen/immissionsschutz/ied/ueberwa-chungsplan-des-landes-sachsen-anhalt-fuer-industrieemissions-anlagen/
15	**Schleswig-Holstein**	https://www.schleswig-holstein.de/DE/Fachinhalte/I/immis-sionsschutz/Downloads/Anlage1.pdf?__blob=publicationFile&v=3
16	**Thuringia**	http://www.thueringen.de/th8/tmuen/umwelt/immissionsschutz/industrie/

(Ökopol 2016)