

TÜV RHEINLAND ENERGY GMBH



Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals

TÜV Report No.: 936/ 21252753/A1
Cologne, 17.06.2021

www.umwelt-tuv.de



tre-service@de.tuv.com

The department of Environmental Protection of TÜV Rheinland Energy GmbH

is accredited for the following work areas:

- Determination of air quality and emissions of air pollution and emissions of odour substances;
- Inspection of correct installation, function and calibration of continuously operating emission measuring instruments, including data evaluation and remote emission monitoring systems;
- Combustion chamber measurements;
- Performance testing of measuring systems for continuous monitoring of emissions and ambient air, and of electronic data evaluation and remote emission monitoring systems;
- Determination of stack height and air quality projections for hazardous and odour substances;
- Determination of emission and ambient air quality of noise and vibration, determination of sound power levels and execution of sound measurements at wind energy plants

according to EN ISO/IEC 17025.

The accreditation is registered under DAkKS-register number: D-PL-11120-02-00.

Reproduction of extracts from this test report is subject to written consent.

TÜV Rheinland Energy GmbH
D-51105 Cologne, Am Grauen Stein, Tel: +49 221 806-5200, Fax: +49 221 806-1349

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

blank page



Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals

Name of the notified body (§ 29b BImSchG)	TÜV Rheinland Energy GmbH
Reportnumber / Date	936/21252753/A1 17.06.2021
	This report replaces the report-No. : 936/21252753/A from 2021-05-17.
plant operator:	AB Ignitis grupė UAB Vilniaus kogeneracine jėgaine Kodas 303782367 Zveju g.14 LT-09310 Vilnius Lithuania
Audited site:	Jocioniu g. 13 LT-02300 Vilnius Lithuania
Type of measurement:	Emission measurement
Order number: (of the customer)	4200081049
Order date:	24.03.2021
Customer ID:	1033976
Measurement date:	25.03. – 27.03.2021
Scope of report:	38 pages in total Annex starts on page 30
object / according to:	PCDD/PCDF EN 1948:2006-06 WHO-PCB EN 1948:2014-03 Benzo(a)pyrene EN 15549:2008-06 Mercury EN 13211:2005-06 Heavy metals EN 14385:2004-05
Installation arrangement:	Directive 2010/75/EU on industrial emissions

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

Leerseite

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Summary

Type of plant:	Waste incineration plant
Emission source	Chimney
Measurement objects:	PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals and emission boundary conditions
Measurement results:	Three single measurements were carried out for every components on three days. The measurement results are listed in the table below. The individual evaluations are listed in chapter 6.2 and in the appendix.

measurement object	unit	maximum measured value minus expanded measurement uncertainty	maximum measured value plus expanded measurement uncertainty	value guaranteed	operation condition
PCDD/PCDF	ng TEQ/m ³	< 0,015	0,01	0,1	90%/100%/100%
Sum concentration: Cd/Tl	mg/m ³	< 0,01	< 0,01	0,05	90%/100%/100%
Sum concentration: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn	mg/m ³	0,01	0,03	0,5	90%/100%/100%
Sum concentration: As, Cd, Co, Cr, BaP	mg/m ³	< 0,01	< 0,01	-	90%/100%/100%
Hg	mg/m ³	< 0,001	< 0,001	0,05	90%/100%/100%
O ₂ reference value	Vol.-%	-	-	11	90%/100%/100%

All concentration values are in dry norm state.

The table above shows the validated values for all components according to rounding rules. For components with very low emission level the value shows the significant decimal place. Chapter 6 shows the unrounded values.

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

blank page

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Page 5 of 38

TABLE OF CONTENTS	PAGE
1 Objectives	7
2 Description of the plants and the materials handled	8
3 Description of the sampling site	9
4 Methods of measurement	11
5 Operating state of the plant during the measurements	24
6 Summary of the results	25
7 Appendix	29

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

blank page

1 Objectives

1.1	Client:	Steinmüller Babcock Environment GmbH Fabrikstr. 1 51643 Gummersbach
1.2	Plant operator:	AB Ignitis grupė UAB Vilniaus kogeneracine jegaine Kodas 303782367 Zveju g.14 LT-09310 Vilnius Lithuania
	Contact person:	Mr Matas Mizera
	Telephone number:	+370 620 65856
	Work place number:	-
1.3	Location:	Jocioniu g. 13 LT-02300 Vilnius Lithuania
1.4	Plant:	Waste incineration plant according RL 2010/75/EU,
	Plant number:	-
1.5	Date / Duration of the measurements:	25.03. – 27.03.2021
1.6	Reason:	Measurements to verify compliance with the guaranteed emission limits
	Approving authority:	not known
	Licence:	not known
1.7	Task:	Determination of emissions
1.8	Measurement objects:	PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals and emission boundary conditions
1.9	Site inspection before measurement:	Yes
1.10	Measurement plan coordination:	The measurement planning was consulted with the plant builder Steinmüller Babcock Environment GmbH.
1.11	Personnel involved in the measurements:	<u>Mr M. Sc. Jan Rettig. (project manager),</u> Mr Ralf Ritter
1.12	Participation of further institutes:	mas münster analytical solutions, PCDD/PCDF, WHO PCB, BaP
1.13	Technical supervisor:	Mr. Steffen Klötzer
	Telephone number:	0221 806-2382
	E-mail address:	steffen.kloetzer@de.tuv.com
	Technical supervisor:	Mr. Ferdinand Lehmann
	Telephone number:	0221 806-1899
	E-mail address:	ferdinand.lehmann@de.tuv.com

2 Description of the plants and the materials handled

- 2.1 Type of plant:** Waste incineration plant
- 2.2 Description of the plant**
- The waste incineration plant includes a downstream flue gas cleaning system, described in 2.6.2.
- Brand: Steinmüller Babcock, Gummersbach (boiler, grate)
- Type: Forward moving grate
- Year of manufacture: 2020
- Boiler No.: 8496
- Steam mass flow: 23,2 kg/s
- Max. allow. operating pressure: 83 bar
- Operating pressure at superheater outlet: 76,5 bar
- Superheater outlet temperature: 451 °C
- Max. allow. steam temperature at superheater outlet: 466 °C
- Fuel: Domestic waste
- Max. furnace thermal rating: 70,00 MW
- 2.3 Description of the emission sources**
- Emission source: Stack
- Height above ground: 80 m
- Cross-sectional area of outlet: 3,5 m²
- Building design: steel
- 2.4 Statement of raw materials possible according to the permit:** Domestic waste
- 2.5 Operating times:** Not applicable
- 2.6 Device for collecting and reducing the emissions**
- 2.6.1 Device collecting the emissions**
- Apparatus for emission collection: Closed plant with directed emission source
- Collection element: suction draught ventilator
- 2.6.2 Device reducing the emissions**
- The flue gas cleaning system consists of the following parts:
- Evaporative cooler
 - Reactor
 - Fabric filter
 - Flue gas quench
 - Flue gas tube condenser
 - Combustion air humidifier

3 Description of the sampling site

3.1 Location of the measurement cross-section

Measuring point is located

- Outdoor
- Indoor
- In front of draft fan
- Behind draft fan
- In waste gas duct
- In chimney

Sampling point is located 23,3 m above ground level.

Exhaust gas is Vertical

Access is provided via ladder with climbing protection rail

Inlet section in m: 17,3

Outlet section in m: 62,7

In compliance with the sampling site and the requirements according to EN 15259 as well as EN 14181

Inlet section $\geq 5 D_h$: Yes

Outlet section $\geq 2 D_h$: Yes

Outlet section $\geq 5 D_h$ till the outlet: Yes

Angle between gas flow/ central axis
Waste gas duct $< 15^\circ$: Yes

No negative local flow: Yes

Minimum velocity is available
(differential pressure $> 5 \text{ Pa}$): Yes

Relation max. to min. velocity
 $< 3:1$: Yes

Distance sampling point / sampling site
 $< 3 \times D_{hydr.}$: Yes

Notice :

Regarding to the inflow and outflow ratios the sampling site fulfils the requirements according to gaseous and particulate substances written in EN 15259.

3.2	Dimensions of the measurement cross-section:	Ø 2100 mm	≅ 3,46 m ²
3.3	Number of measurement axes and position of the measurement points in the measurement cross-section		
	Angles:	2	
	Sampling point per angle:	8	
	Distance of sampling points from duct site in cm:	7 / 22 / 41 / 68 / 142 / 169 / 188 / 203	
3.4	Number and dimension of the measurement points:		
	Numbers of measurement ports:	4	
	Location of measurement ports:	in one plane, 90° rotated	
	Measurement of measurement ports		
	Clear diameter:	84 mm	
	Socket length:	340 mm	
3.5	Working platform:	available	
3.6	Weather protection:	not available	

4 Methods of measurement

4.1 Standard reference methods and measurement methods for waste gas conditions

4.1.1	Flow velocity:	Prandtl's pitot tube with a micromanometer
	Manufacturer / T type / measuring range / detection limit:	SI GmbH / LPU 3 / 0 - 500 / 0 - 5000 Pa / 1,5 m/s
	Last check/calibration:	Before measuring 08 / 2020
	Continuous determination:	Net measurement at the beginning of each measuring day. Continuous measuring at a point in the cross-section and recording during the measurements.
4.1.2	Static pressure in the waste gas duct:	Manometer according to 5.1.1
4.1.3	Air pressure at the height of the sampling location	
	Measuring system:	Barometer
	Manufacturer / type / measuring range:	GPB / 300 - 1100 hPa
	Last check/calibration:	Before measuring 04 2020
4.1.4	Waste gas temperature:	Ni-Cr-Ni-thermocouple
	Manufacturer / type:	Thermocouple: MTB/ type K
	Temperature measuring device, manufacturer / type / measuring range:	Measurement data acquisition according to 5.3.8
	Continuous determination and recording:	Continuous measuring at a point in measurement cross-section
4.1.5	Water vapour content in the waste gas (waste gas moisture):	Adsorption at silica gel/ gravimetry
	Manufacturer (balance) / type / measuring range:	Kern / 572-39 / 5-4200 g/
	Last check/calibration:	Before measuring 07 2020
4.1.6	Waste gas density:	Calculated taking into account the waste gas content of oxygen (O ₂), carbon dioxide (CO ₂), carbon monoxide (CO if relevant), atmospheric nitrogen (N ₂ with 0,933 % Ar), waste gas moisture (water vapour content in the waste gas) as well as waste gas temperature and pressure conditions in the duct.

4.2 Automated measurement methods for gaseous measured objects

4.2.1 Measured object:	Oxygen (O ₂)
4.2.1.1 Measuring system / guideline:	Paramagnetism / EN 14789
4.2.1.2 Analyzer:	TÜV measuring system
Manufacturer / type:	Horiba / PG 250 SRM
4.2.1.3 Measuring range set:	0 – 25 Vol.-%
4.2.1.4 Declaration of suitability:	Yes

4.2.1 Measured object	Carbon dioxide (CO ₂)
4.2.1.1 Measuring system / guideline:	NDIR / analogue EN 15058
4.2.1.2 Analyzer:	TÜV measuring system
Manufacturer / type:	Horiba / PG 250 SRM
4.2.1.3 Measuring range set:	0 - 20 Vol.-%
4.2.1.4 Declaration of suitability:	Yes

4.2.1.5 Sampling system	O₂, CO₂	
Sampling probe/ suction tube:	Heated to °C	180
Particle filter:	Heated by waste gas	
Sample gas line before gas treatment:	Heated to °C	180
Sample gas line before gas treatment:	Length, in m	3
Sample gas line after gas treatment:	Unheated	
Sample gas line after gas treatment:	Length, in m	30
Material of gas-bearing parts:	Quartz filter, stainless steel, PTFE	
Measuring gas processing:	Sample gas cooler	
Manufacturer / type:	M. & C. / PSS-5	
Temperature, controlled to dew point temperature:	3 °C ± 1 K	

4.2.1.6 Check of the instrument characteristic with the following test gases

Zero gas:	N ₂	N ₂		
Test gas:	O ₂ , dehumidified external air	CO ₂ in N ₂		
Concentration:	Vol.-%	20.94	14.98	Vol.-%
Uncertainty:	%	-	2	
Cylinder number:		-	16834	
Manufacturer:		-	Nippon Gases	
Production date:		-	31.07.2020	
Guarantee of stability:	Months	-	60	
Certified:		No	ja	
Check of the certificate by:		-	TÜV Rheinland	
Check of the certificate on:		-	18.09.2020	

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Page 13 of 38

4.2.1.7 90% - Response time of the entire measuring system in s (feeding of test gases via the probe): < 90 s < 60 s

4.2.1.8 Recording of measured values

With a data acquisition system (data processor), manufacturer / type: Yokogawa / DX2048-3-4-2

Data collection programme (software): Yokogawa / Excel

4.3 Discontinuous standard reference measurement method

4.3.1 Gaseous and vaporous emissions

Not applicable

4.3.2 Particulate emissions

4.3.2.1 Measured object:

dust ingredients and adsorbed chemical bonds (metals, semi-metals and their compounds) including not filterable fractions

4.3.2.2. Measuring system / guideline:

sampling dust and not filterable fractions for determination of the total emission according to DIN EN 14385, mai 2004 and DIN EN 13211, june 2001 (Correction June 2005)

Analytical procedures:

ICP-MS / ICP-OES and AAS for Hg

4.3.2.3 Measuring setup:

Retention system for particulate materials

Filter unit

Flat filter head device

Arrangement:

Instack, heated by waste gas

Material:

Titan

Sampling Probe / Tube

Titan / Quartz, heated to 150 °C

Filter:

Quarzfaser Whatman, 1851

Filter diameter

50 mm

Separation efficiency

> 99 %

Absorption system not filterable substances:

Absorption devices:

100-ml-wash-bottles with filter (double for Hg and triple for the other metals)

Sorbent (metals but Hg)

HNO₃,5% + H₂O₂, 1,5% in H₂O, each 35 ml

Sorbent (Hg)

Lösung aus 22 g KMnO₄, 2 ml HCl (1 mol/l) in 1 l 10% H₂SO₄, each 35 ml

Distance probe / absorber:

1,7 m

Duration until analysis

13 days

4.3.2.4 Treatment of the filter and the deposits

Samples treatment (Hg)

Addition of 10% aqueous (NH₃OH)Cl-solution

Transport and storage (filter):

Polystyrene containers

Transport and storage (solutions):

in PP-beaker with PE-lid, cooled

Rinse of filter unit

After each series of measurements with sorbent

Treatment of Rinsing solution:

Collecting in PP beakers with PE lids, for metal analysis

Drying temperature/time

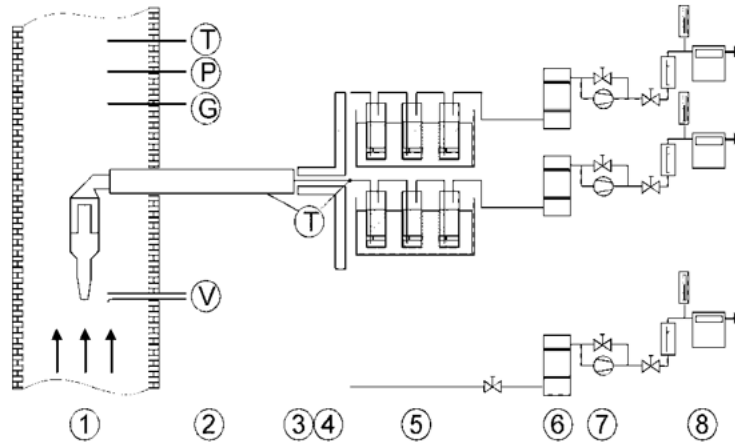
before exposure:

180 °C / >. 1 h

after exposure:

without drying

Design of the sampling



- | | |
|---|---------------------------|
| 1 Sampling probe with filter | T Temperature measurement |
| 2 Sampling tube, heated | P Pressure measurement |
| 3 Temperature measurement with controller | G Gas analysis |
| 4 Adapter, insulated, heated | V Speed measurement |
| 5 Absorption system | |
| 6 Condensate separator | |
| 7 Pump system with bypass control | |
| 8 Gas meter | |

4.3.2.5 Preparation and evaluation of the measuring filters and the absorption solutions

Filter

Preparation of the sample material and analysis procedure:

microwave digestion , aliquote of the eluat to analysis (parameters in table)

Addition of 5 ml 65% HNO₃, 1 ml 40% H₂F₂, 1 ml 30% H₂O₂ and 1 ml distilled water, microwave digestion at 215-240 °C, at full digestion, filled up to 50 ml (parameters in table)

Absorption solutions

Preparation of the sample material:

Aliquote of the solution directly to the analysis

Hg-absorption solution:

Aliquote (7ml) with 28µl Br⁻/BrO₃⁻-solution, 5ml directly to the analysis

Analyzers

Metals:

Agilent ICP-MS Typ 7800 / Perkin Elmer ICP_OES Typ Optima 7300 DV

Hg, particulate:

Perkin Elmer, Hydrid-AAS FIMS FIAS 400

Hg, not filterable:

MWS DMA-80L

Standards:

Standards solutions by Baker, Merck, Johnson Matthey, Alfa Products

Calibration procedure: standard addition (Hg)
Standard calibration procedure,
additional standard addition (metals)

Element	Comment	Guideline
Hg, particulate		EN 13211
Hg, gaseous	Reducing agent SnCl ₂	EN 13211
As		EN 14385
Cd		EN 14385
Co		EN 14385
Cr		EN 14385
Cu		EN 14385
Mn		EN 14385
Ni		EN 14385
Pb		EN 14385
Sb		EN 14385
Sn	in style of	EN 14385
Tl		EN 14385
V		EN 14385

4.3.2.6 Process parameters

Determination limit

Hg	0,02 µg/Filter:	0,00003 mg/l Absorption solution
Cd	0,05 µg/Filter:	0,001 mg/l Absorption solution
other elements	0,5 µg/Filter:	0,01 mg/l Absorption solution

4.3.2.7 Quality assurance measures

- leak test
- marked wash bottles for the absorption of Hg and the other elements
- Cleaning of the used washing bottles and distributors in a dishwasher as well as by intensive treatment with concentrated acid solutions and highly pure water.
- Replacement of the inner pipe or cleaning by treatment with acid solutions and high-purity water

Determination of blank value

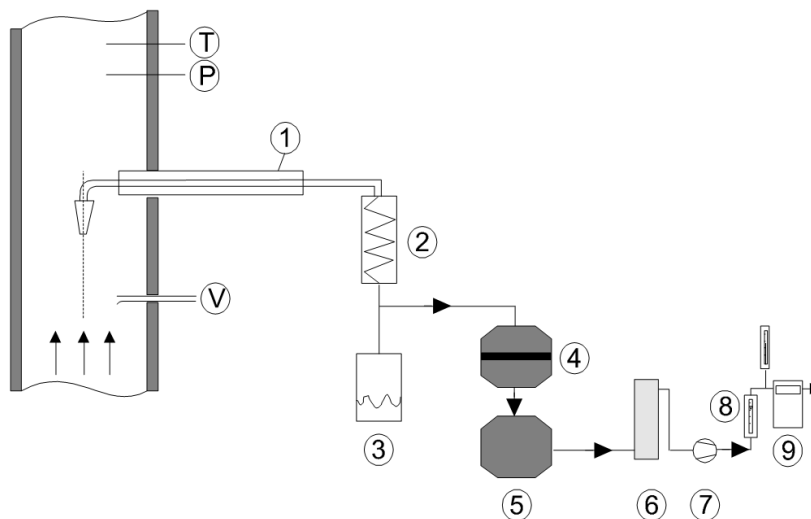
Field blank value

Date of sampling (Hg):	25.03.2021	14:00	Solution
Date of sampling (other metals and Hg particulate):	25.03.2021	14:00	Filter
		14:30	Solution

4.3.3 Special highly toxic exhaust gas ingredients

4.3.3.1 Measured object:	PCDD/PCDF, PCB (WHO); BaP
4.3.3.2 Measuring system / guideline::	Chilled probe method according to DIN EN 1948-1, June 2006
Analytical procedures:	DIN EN 1948-2, June 2006 (PCDD/PCDF) DIN EN 1948-3, June 2006 (PCDD/PCDF) DIN EN 1948-4, March 2014 (PCB) VDI 3874, December 2006 (B(a)P)
4.3.3.3 Measuring setup:	
Sampling Probe / Tube	Glass, Ø = compare appendix 1 / Glass, Ø = 10 mm gekühlt
Filter unit:	Flat filter, fiberglass filter GF 10 HY, Whatman® Schleicher & Schüll Ø = 47 mm v < 0,3 m/s
Condensate separation:	Water cooled heat exchanger Lenght: 250 mm, Ø = 100 mm
Cooling medium:	Cooled water
Adsorption device /Sorbent:	Glass cartridge, Length: 100 mm, Ø = 45 mm/XAD-2, 120 ml, v < 0,3 m/s
Design of the sampling device:	see illustration
Material of all parts coming into contact with the sample:	Glass

Image: Design of the used sampling apparatus



1	Water cooled tube	7	Suction pump
2	Water cooled Heat exchanger	8	Flow meter
3	Condensate collecting vessel	9	Gas meter with thermocouple
4	Quartz filter / flat filter	T	Temperature measurement
5	XAD-2 cartridge	P	Pressure measurement
6	Drying tower	V	Speed measurement

Design of the used sampling apparatus

Light protection: Filter- and XAD-catridge and collecting vessel consist of amber glass.

Cleaning of the sampling vessels: Sampling vessels for condensate and rinsing solution are used anew in each case, the cleaning of the other parts is described in 4.3.3.4.

Before sampling / extraction / analysis the following ¹³C-marked dioxins / furans were added to check the individual steps of the process (sampling, processing and analysis).

	sampling ¹⁾	extraction	analysis
PCDD			
¹³ C ₁₂ -1,2,3,4-TetraCDD			X
¹³ C ₁₂ -2,3,7,8-TetraCDD		X	
¹³ C ₁₂ -1,2,3,7,8-PentaCDD		X	
¹³ C ₁₂ -1,2,3,4,7,8-HexaCDD		X	
¹³ C ₁₂ -1,2,3,6,7,8- HexaCDD		X	
¹³ C ₁₂ -1,2,3,7,8,9- HexaCDD			X
¹³ C ₁₂ -1,2,3,4,6,7,8-HeptaCDD		X	
¹³ C ₁₂ -1,2,3,4,6,7,8,9-OctaCDD		X	
PCDF			
¹³ C ₁₂ -2,3,7,8-TetraCDF		X	
¹³ C ₁₂ -1,2,3,7,8- PentaCDF	X		
¹³ C ₁₂ -2,3,4,7,8- PentaCDF		X	
¹³ C ₁₂ -1,2,3,4,7,8- HexaCDF		X	
¹³ C ₁₂ -1,2,3,6,7,8- HexaCDF		X	
¹³ C ₁₂ -1,2,3,7,8,9- HexaCDF	X		
¹³ C ₁₂ -2,3,4,6,7,8- HexaCDF		X	
¹³ C ₁₂ -1,2,3,4,6,7,8-HeptaCDF		X	
¹³ C ₁₂ -1,2,3,4,7,8,9-HeptaCDF	X		
¹³ C ₁₂ -1,2,3,4,6,7,8,9-OctaCDF		X	

¹⁾ Doping in the quartz filter

Distance between end of probe and cooler inlet or sorbent: 1,7 m plus 0,3 m

4.3.3.4 Sampling and post-treatment:

Leak test: The probe is closed with the pump switched on and the apparatus is checked for gas flow.

max. allowed gas flow in m³/h: < 0,02

Post-treatment

New glass parts or glass parts cleaned in the laboratory are used for each series of measurements. After each individual measurement, the probe, the sampling tube, the connecting parts and the cooler are rinsed with acetone and toluene. The resulting rinsing solution is collected in a collection bottle and sent to the laboratory for analysis. In the case of visible deposits, the probe and the cut sampling tube are also sent to the laboratory in a glass bottle for analysis.

The dust filter and XAD cartridge are removed, sealed and stored in a darkened place protected from high heat until analysis.

Exchange of an doped part:	No
Sample storage:	Darkened and cool
Sample transfer (Period between sampling and shipment):	max. 7 days

4.3.3.5 Analytical determination: PCDD/PCDF, PCB (WHO); BaP

Involvement of an external laboratory: mas münster analytical solutions gmbh, Münster

Analytical Method: EN 1948, part 2 and 3, June 2006

Reconditioning of the sample material:

The accumulated samples (flat filter/quartz filter, condensate, XAD-2 cartridge and rinsing solution, were processed and analysed externally according to the following instructions:

Quartz filter / Flat filter:

Extraction of the filters with toluene after wetting with 1 ml HCl and drying, extraction together with XAD-2 (min. 20 hours)

Condensate:

Liquid/liquid extraction (at least 3 times) with toluene, in case of solid content previous filtration and separate Soxhlet extraction of the dried filter residue with toluene/acetone

Rinsing solution:

addition of toluene, concentration, recovery with toluene, drying over sodium sulfate

XAD-2

Drying, extraction in Soxhlet with toluene/acetone (min. 20 hours)

The partial extracts were combined and analyzed as described below.

Method of analysis

The total extract was purified several times by column chromatography and concentrated to 20 µl (with n-nonane as keeper) before GC/MS analysis.

Analyzers: Trace GC Ultra / DFS or MAT 95 XP, Thermo Scientific

HRGC-Conditions:

Injection type: PTV in cold feed mode

Injection volume, solvent: 1 µl, n-Nonan

GC-column: RTX-2330, 60 m, 0,25 mm ID, 0,1 µm film, DB-5 MS, 60 m, 0,25 mm ID, 0,25 µm film

Carrier gas: Helium, 0,9 ml/min (RTX-2330)
Helium, 0,9 ml/min (DB-5 MS)

Temperature program:	RTX-2330 120 °C, 4 min isothermal with 30 °C/min to 210 °C with 2 °C/ min to 240 °C, with 30 °C/min to 260 °C, 25 min isothermal DB-5 MS 120 °C, 4,45 min isothermal, with 40 °C/min to 210 °C, 0,5 min isothermal, with 2,5 °C/min to 270 °C, with 20 °C/min to 320 °C, 7,8 min isothermal
Temperature of the transfer line:	260 °C
HRMS- Conditions:	
Source temperature:	250 °C
Resolution / EI:	approx. 10.000 / 40 eV
Reference substance:	PFTBA, FC 43
MID mode, up to 3 masses per homologue group	
Setting time windows	

4.3.3.6 Process parameters

Detection limit (2378-TetraCDD): PCCD/F 0,001 ng/sample \triangleq 0,0002 ng/m³ in 5 m³

4.3.3.7 Quality assurance measures

Compliance with isokinetic conditions ,
determination of the tightness of the sampling device,
cleaning of the glass parts used

Field blank value:

Date of sampling: 25.03.2021 16:00 Solution

Data on mass, concentration and comparison of results: Annex A1

The **field blank value** is sampled for each measurement series. An analysis is performed if the analysis values determined in the current series exceed WHO-TEQ2005 0,02 ng \triangleq 0,004 ng/m or if analysis abnormalities are detected.

All dioxin analyses carried out are kept in a summary list and checked for the specified criteria. The quartz-filter and XAD-Datriges are checked in batches by the analysis laboratory (mas gmbh).

The last field blank determination was 21.03.2021 with 0,006337 ng WHO-TEQ2005 (including detection limit).

4.3.3.5 Analytical determination: PCB (WHO)

Before sampling / extraction / analysis the following ¹³C-marked PCB were added to check the individual steps of the process (sampling, processing and analysis).

	sampling ¹⁾	extraction	analysis
¹³ C ₁₂ -2,3,4,4'-TeCB (60)	X		
¹³ C ₁₂ -3,3',4,5,5'-PeCB (127)	X		
¹³ C ₁₂ -2,3,3',4,5,5'-HxCB (159)	X		
¹³ C ₁₂ -3,3',4,4'-TeCB (77)		X	
¹³ C ₁₂ -3,4,4',5-TeCB (81)		X	
¹³ C ₁₂ -2,3,3',4,4'-PeCB (105)		X	
¹³ C ₁₂ -2,3,4,4',5-PeCB (114)		X	
¹³ C ₁₂ -2,3',4,4',5-PeCB (118)		X	
¹³ C ₁₂ -2',3,4,4',5-PeCB (123)		X	
¹³ C ₁₂ -3,3,4,4',5-PeCB (126)		X	
¹³ C ₁₂ -2,3,3',4,4',5-HxCB (156)		X	
¹³ C ₁₂ -2,3,3',4,4',5'-HxCB (157)		X	
¹³ C ₁₂ -2,3',4,4',5,5'-HxCB (167)		X	
¹³ C ₁₂ -3,3',4,4',5,5'-HxCB (169)		X	
¹³ C ₁₂ -2,3,3',4,4',5,5'-HpCB (189)		X	
¹³ C ₁₂ -2,3',4',5-TeCB (70)			X
¹³ C ₁₂ -2,3,3',5,5'-PeCB (111)			X
¹³ C ₁₂ -2,2',3,3',4,4',5-HpCB (170)			X

¹⁾ Doping in the quartz filter

Involvement of an external laboratory:	mas münster analytical solutions gmbh, Münster
Analytical Method:	DIN EN 1948, part 4, march 2014
Standard (preparation and analysis):	¹³ C-marked PCB
Reconditioning of the sample material:	same as 4.3.3.5 dioxine
Method of analysis:	GC-analysis with mass detector (GC/MS)
Analyzers:	Trace GC Ultra / DFS or MAT 95 XP, Thermo Scientific
Injection type:	PTV in cold feed mode
Injection volume, solvent:	1 µl, n-Nonan
GC-column:	DB-5 MS
Carrier gas:	Helium, 0,9 ml / min
Temperature program:	120 °C, 4 min isothermal, with 15 °C/min to 185 °C, with 1,5 °C/min to 205 °C, with 2,3 °C/min to 245 °C, with 6 °C/min to 290 °C, 13,44 min isothermal
Temperature of the transfer line:	260 °C
HRMS- Conditions:	
Source temperature:	250 °C
Resolution / EI:	approx. 10.000 / 40 eV
Reference substance:	PFTBA, FC 43
MID mode, up to 3 masses per homologue group	

Setting time windows

4.3.3.6 Process parameters

detection limit (sum WHO-PCB): 2,33 ng / Probe \triangleq 0,0041 ng TEQ or
0,0008 ng TEQ / m³ in 5 m³ sample volume

4.3.3.7 Quality assurance measures

Compliance with isokinetic conditions ,
determination of the tightness of the sampling device,
cleaning of the glass parts used
Field blank value (sampling in 4.3.3.7 PCDD/PCDF)

The **field blank value** is sampled for each measurement series.

An analysis shall be performed if the current analytical value for the sum of WHO PCBs in TEQ exceeds 0,01 ng. or if analysis abnormalities are detected.

oder The last field blank determination was 26.02.2021 mit < 0,01 ng \triangleq < 0,0041 ng TEQ.

All PCB-analyses carried out are kept in a summary list and checked for the specified criteria. The quartz-filter and XAD-Datriges are checked in batches by the analysis laboratory (mas gmbh).

The TEQ values have been calculated using the WHO-TEF 2005.

4.3.3.5 Analytical determination:

Benzo(a)pyrene (BaP)

Method of analysis: Measurement of polycyclic aromatic hydrocarbons (PAH), GC/MS-procedure according to VDI 3874, december 2006

Reconditioning of the sample material: same as 4.3.3.5 dioxine

10 % of the dioxin extraction solution is analysed as described below.

Preparation: SiOH-short columns (Baker-Bond SPE) and – if required - liquid-liquid distribution in the system dimethylformamide/water

Method of analysis GC-analysis with mass detector (GC/MS)

Analyzers: Trace GC Ultra / DSQ MS, Thermo Scientific

Column / carrier gas: 60 m DB-5 MS / Helium 0,9 ml/min

Temperature of transfer-line: 320 °C

MS-conditions: MID mode: 2 masses per substance, setting time windows

Standards (preparation and analysis): D12-Benzo(a)pyrene

Standard (Recovery): D12-Perylen

4.3.3.6 Process parameters

detection limit: 0,02 μ g \triangleq 0,004 μ g/m³ in 5 m³ sample volume

4.3.3.7 Quality assurance measures

Compliance with isokinetic conditions ,
determination of the tightness of the sampling device,
cleaning of the glass parts used
Field blank value (sampling in 4.3.3.7 PCDD/PCDF)

The **field blank value** is sampled for each measurement series. An analysis is performed if the analysis values determined in the current series exceed 0,02 ng \triangleq 0,004 ng/m or if analysis abnormalities are detected.

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Page 23 of 38

All BaP-analyses carried out are kept in a summary list and checked for the specified criteria. The quartz-filter and XAD-Datriges are checked in batches by the analysis laboratory (mas gmbh).

The last field blank determination was 03.03.2020 with <0,02 µg BaP (<detection limit).

5 Operating state of the plant during the measurements

The operating data of the production plant can be obtained by the recording of measuring values of the operating measuring system in control station.

5.1 Production plant

The operating data of the plant during the measurements are indicated hereinafter.

Date	Steam mass flow kg/s	Operation condition %
25.03.2021:	20,9	90
26.03.2021:	23,4	100
27.03.2021:	23,3	100

6 Summary of the results

6.1 Evaluation of the operating conditions during the measurements

During the measurements, the plant was operated in the intended mode at a capacity of 90 - 100 %, based on the steam quantity (see Section 5.1).

The operating conditions during the measurements corresponded to the condition of the highest emissions.

6.2 Measurement results

The measurement results and the guaranteed values are summarised in tables 6.1 to 6.4. Table 6.5 to 6.18 shows the single results.

Table 6.1: Results of the emission measurements (heavy metals, Sum concentration: Cd/Tl)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,001	< 0,001	0,001	< 0,17	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,001	< 0,001	0,001	< 0,22	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,001	< 0,001	0,001	< 0,21	100%
minimum						< 0,001	< 0,001			
maximum						< 0,001	< 0,001			
average						< 0,001	< 0,001			
value guaranteed							0,05			

Table 6.2: Results of the emission measurements (Hg)

Standard DIN EN 13211:2001-06/2005-06										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	19:15	8,7	< 0,00018	< 0,00018	0,00	< 0,016	90%
	26.03.2021	2	13:07	13:37	8,8	< 0,00018	< 0,00018	0,00	< 0,022	100%
	27.03.2021	3	12:16	12:46	8,7	< 0,000027	< 0,000027	0,00	< 0,0031	100%
minimum						< 0,00003	< 0,00003			
maximum						< 0,0002	< 0,0002			
average						< 0,0001	< 0,0001			
value guaranteed							0,05			

Table 6.3: Results of the emission measurements (heavy metals, Sum concentration: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,016	< 0,016	0,010	< 1,5	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,016	< 0,016	0,010	< 2,0	100%
	27.03.2021	3	12:16	14:22	8,7	0,021	0,021	0,010	2,6	100%
minimum						<0,02	< 0,016			
maximum						0,02	0,021			
average						0,01	0,018			
value guaranteed							0,5			

Table 6.4: Results of the emission measurements (PCDD/PCDF)

Standard EN 1948:2006-06										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} ng TEQ/m ³	mass flow µg TEQ/h	operation condition
			from	to		ng TEQ/m ³	11 Vol.-% O ₂ ng TEQ/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	16:55	23:01	8,6	0,005	0,005	0,001	0,46	90%
	26.03.2021	2	11:17	17:23	8,8	0,006	0,006	0,001	0,79	100%
	27.03.2021	3	10:26	16:32	8,7	0,008	0,008	0,002	0,98	100%
minimum						0,005	0,005			
maximum						0,008	0,008			
average						0,007	0,007			
value guaranteed							0,1			

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

Table 6.5: Results of the emission measurements (Cd)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,00016	< 0,00016	0,00013	< 0,015	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,00017	< 0,00017	0,00013	< 0,020	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,00016	< 0,00016	0,00012	< 0,019	100%
minimum						< 0,00016	< 0,00016			
maximum						< 0,00017	< 0,00017			
average						< 0,00016	< 0,00016			

Table 6.6: Results of the emission measurements (Tl)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0017	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0017	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0016	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.7: Results of the emission measurements (Sb)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0012	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0013	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0012	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.8: Results of the emission measurements (As)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0016	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0016	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0016	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.9: Results of the emission measurements (Pb)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0014	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0015	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0014	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Table 6.10: Results of the emission measurements (Cr)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0014	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0014	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0014	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.11: Results of the emission measurements (Co)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0015	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0016	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0015	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.12: Results of the emission measurements (Cu)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0017	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0017	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0017	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.13: Results of the emission measurements (Mn)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0013	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0013	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	0,0071	0,0071	0,0020	0,83	100%
minimum						< 0,0016	< 0,0016			
maximum						0,0071	0,0071			
average						0,0035	0,0035			

Table 6.14: Results of the emission measurements (Ni)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0014	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0014	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0014	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No.: 936/ 21252753/A1

Table 6.15: Results of the emission measurements (V)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0017	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0017	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0017	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.16: Results of the emission measurements (Sn)

Standard EN 14385:2004-05										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,0016	< 0,0016	0,0017	< 0,15	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,0017	< 0,0017	0,0017	< 0,20	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,0016	< 0,0016	0,0016	< 0,19	100%
minimum						< 0,0016	< 0,0016			
maximum						< 0,0017	< 0,0017			
average						< 0,0016	< 0,0016			

Table 6.17: Results of the emission measurements (Benzo(a)pyren)

Standard EN 15549:2008-06										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} µg/m ³	mass flow mg/h	operation condition
			from	to		µg/m ³	11 Vol.-% O ₂ µg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	16:55	23:01	8,6	< 0,002	< 0,002	0,002	< 0,28	90%
	26.03.2021	2	11:17	17:23	8,8	< 0,003	< 0,003	0,002	< 0,40	100%
	27.03.2021	3	10:26	16:32	8,7	< 0,003	< 0,003	0,002	< 0,40	100%
minimum						< 0,002	< 0,002			
maximum						< 0,003	< 0,003			
average						< 0,003	< 0,003			

Table 6.18: Results of the emission measurements (heavy metals, Sum concentration: AS, Cd, Co, Cr, BaP)

Standard EN 14385:2004-05 / EN 15549:2008-06										
Stationary pollution source name and number	date	measurement No.	time		O ₂ Vol.-%	concentration		expected measurement uncertainty U _{0,95} mg/m ³	mass flow g/h	operation condition
			from	to		mg/m ³	11 Vol.-% O ₂ mg/Nm ³			
Waste incineration boiler stack/ Stationary Pollution source number 001	25.03.2021	1	18:45	20:51	8,5	< 0,005	< 0,005	0,004	< 0,47	90%
	26.03.2021	2	13:07	15:13	8,8	< 0,005	< 0,005	0,004	< 0,63	100%
	27.03.2021	3	12:16	14:22	8,7	< 0,005	< 0,005	0,004	< 0,60	100%
minimum						<0,005	< 0,005			
maximum						<0,005	< 0,005			
average						<0,005	< 0,005			

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

6.3 Uncertainty of measurement

Table 6.19: Uncertainty of measurement

measurement object y	unit	mean measured value y_{mean} referred to reference value	maximum measured value y_{max} referred to reference value	expanded measurement uncertainty ($U_{p,95}$)	$y_{\text{max}} - U_p$	$y_{\text{max}} + U_p$	value guaranteed	determination method
PCDD/PCDF	ng TEQ/m ³	0,007	0,008	0,002	< 0,015	0,01	0,1	indirect
Sum concentration Cd/Tl	mg/m ³	<0,001	<0,001	0,001	< 0,01	< 0,01	0,05	indirect
Sum concentration: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V,	mg/m ³	0,018	0,021	0,010	0,01	0,03	0,5	indirect
Hg	mg/m ³	< 0,0001	< 0,0002	0,0001	< 0,001	< 0,001	0,05	indirect
O ₂ reference value	Vol.-%	-	-	-	-	-	11	-

All concentration values are in dry norm state.

6.4 Plausibility check

The plant utilisation can be understood from the steam quantity of 20,9 kg/s – 23,4 kg/s (100 % load \pm 23,2 kg/s normal full load).

The individual results and measurement protocols can be found in the appendix.

Taking into account the measurement accuracy of the applied measurement methods and the found operation mode of the plant, the results are plausible.

The measurement results are typical for a fully functioning exhaust gas cleaning system and all guaranteed limit values were complied with.

Environmental protection / Air pollution control Dept. (936)

Editor:

Representative of the person responsible :




M.Sc. Jan Rettig

Dipl.-Ing. Ferdinand Lehmann

Cologne, 17.06.2021

936/21252753/A1

7 Appendix

A1 Individual evaluations of the measurements

Annex A1: Individual evaluations of the measurements
Table 1: Determination of the volume flows

Plant	Measuring point	Waste incineration plant		
		Chimney		
Date		25.3.2021	26.3.2021	27.3.2021
Measurement	no.	1	2	3
Start of measurement	time	16:00	10:00	09:20
Measuring time	min	16	16	16
Main volume flow (mean values)				
Temperature	°C	34	33	33
Temperature absolute	K	307	306	306
Air pressure	hPa	1007	1005	1005
Static pressure difference	hPa	-0,3	-0,4	-0,4
absolute pressure in the line	hPa	1007	1005	1005
Oxygen concentration	Vol.-%	6,1	7,7	7,3
Reference oxygen concentration	Vol.-%	11,0	11,0	11,0
Carbon dioxide concentration	Vol.-%	12,0	11,3	11,7
Humidity (ww)	Vol.-%	5,4	5,6	5,2
Density (t,p,h)	kg/m ³	1,168	1,167	1,171
Average gas velocity	m/s	8,84	11,68	11,25
Ratio v _{max} :v _{min}		1,2 : 1	1,4 : 1	1,5 : 1
Line area	m ²	3,46	3,46	3,46
Unnormalized flow q _{V,w} (t,p,h)	m ³ /h (t,p,h)	110.270	145.600	140.270
expanded uncertainty	m ³ /h	11.641	10.004	10.301
relative expanded uncertainty	%	10,6	6,9	7,3
Volume flow, standardised, humid (norm h)	m ³ /h (n,h)	97.430	128.800	124.080
Volume flow, standardised q _{V,0d} (norm dry)	m ³ /h (n,dr)	92.170	121.590	117.630
Volume flow, standardised in relation to 11 Vol.-% Reference oxygen concentration	m ³ /h (n,dr,O ₂)	137.330	161.710	161.150

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Table 2: Determination of PCDD/PCDF emissions

Plant	Waste incineration plant			
	Chimney			
Measuring point	no. time	25.3.2021	26.3.2021	27.3.2021
Date		1	2	3
Measurement		16:55	11:17	10:26
Start of measurement		23:01	17:23	16:32
Measuring time				
Main volume flow (mean values)				
Volume flow measurement	Nr.	1	2	3
Volume flow, standardised (norm dry)	m³/h	92.170	121.590	117.630
SAMPLING				
Duration of suction	min	360	360	360
Temperature at the gas meter	°C	18	16	15
Temperatur des Adsorbens	°C	7	7	7
Mean oxygen content	Vol.-%	8,6	8,8	8,7
Probe diameter	mm	7	6	6
Maximum suction rate	m³/h	1,3		
Partial gas volume (t,p,dr)	m³	6,980	6,321	6,112
Correction factor of the gas meter		1,026	1,026	1,026
Related to standard condition, dry (norm dr)	m³	6,678	6,078	5,897
Isokinetic ratio	%	109	102	102
Recovery rate, 13C12-12378-Penta-CDF	%	93,0	95,0	93,0
Recovery rate, 13C12-123789-Hexa-CDF	%	107,0	114,0	106,0
Recovery rate, 13C12-1234789-HeptaCDF	%	118,0	120,0	120,0
Recovery rate,12C12-PCB 60	%	107,0	120,0	100,0
Recovery rate,13C12-PCB 127	%	92,0	99,0	81,0
Recovery rate,13C12-PCB 159	%	98,0	112,0	105,0
MASS CONCENTRATION- AND FLOW				
PCDD/PCDF-mass (TEQ) in the partial flow	ng TEQ	0,03369	0,03970	0,04943
PCDD/PCDF-mass (TEQ), field blank value	ng TEQ	< 0,00634		
as concentration at partial gas volume (norm dr)	ng TEQ/m³	< 0,00095	< 0,00104	< 0,00108
in relation to the limit	%	< 0,9	< 1,0	< 1,1
in relation to the measured value	%	< 18,8	< 16,0	< 12,8
PCDD/PCDF-concentration in TEQ (norm dr)	ng TEQ/m³	0,005	0,006	0,008
PCDD/PCDF-concentration in TEQ (norm dr) with 11 Vol.-% Reference oxygen concentration	ng TEQ/m³	0,005	0,006	0,008
PCDD/PCDF-(TEQ)-mass flow	µg TEQ/h	0,46	0,79	0,98
Benzo(a)pyrene-mass, in partial gas volume	µg	< 0,02	< 0,02	< 0,02
BaP-mass, field blank value	µg	< 0,02		
as concentration at partial gas volume (norm dr)	µg/m³	< 0,0030	< 0,0033	< 0,0034
in relation to the limit	%	-	-	-
in relation to the measured value	%	< 100,0	< 100,0	< 100,0
Benzo(a)pyrene-concentration (norm dr)	µg/m³	< 0,002	< 0,003	< 0,003
Benzo(a)pyrene-concentration with 11 Vol.-% Reference oxygen concentration	µg/m³	< 0,002	< 0,003	< 0,003
Benzo(a)pyrene-mass flow	mg/h	< 0,28	< 0,40	< 0,40

Table 3: Determination of PCDD/PCDF mass

Plant		Waste incineration plant					
Measuring point		Chimney					
Date		25.03.2021		26.03.2021		27.03.2021	
Measurement		1		2		3	
Start of measurement		16:55 Uhr		11:17 Uhr		10:26 Uhr	
Measuring time		23:01 Uhr		17:23 Uhr		16:32 Uhr	
PCDD/PCDF	TEF	ng/Sample	ng(TEF) Sample	ng/Sample	ng(TEF) Sample	ng/Sample	ng(TEF) Sample
PCDD 2378-Congeners							
2378-TetraCDD	1	0,001	0,00128	0,002	0,00167	0,001	0,00115
12378-PentaCDD	1	0,008	0,00798	0,009	0,00861	0,010	0,01046
123478-HexaCDD	0,1	0,004	0,00039	0,004	0,00041	0,005	0,00053
123678-HexaCDD	0,1	0,012	0,00116	0,013	0,00126	0,017	0,00169
123789-HexaCDD	0,1	0,005	0,00053	0,007	0,00074	0,009	0,00086
1234678-HeptaCDD	0,01	0,020	0,00020	0,020	0,00020	0,026	0,00026
12346789-OctaCDD	0,0003	< 0,045	< 0,00001	< 0,045	< 0,00001	< 0,045	< 0,00001
PCDF 2378-Congeners							
2378-TetraCDF	0,1	0,010	0,00096	0,012	0,00117	0,013	0,00134
12378-PentaCDF	0,03	0,017	0,00052	0,018	0,00054	0,025	0,00076
23478-PentaCDF	0,3	0,029	0,00872	0,036	0,01089	0,047	0,01403
123478-HexaCDF	0,1	0,014	0,00143	0,016	0,00164	0,019	0,00193
123678-HexaCDF	0,1	0,019	0,00190	0,018	0,00181	0,022	0,00225
123789-HexaCDF	0,1	< 0,003	< 0,00030	< 0,003	< 0,00030	< 0,003	< 0,00030
234678-HexaCDF	0,1	0,020	0,00200	0,021	0,00209	0,027	0,00266
1234678-HeptaCDF	0,01	0,022	0,00022	0,021	0,00021	0,025	0,00025
1234789-HeptaCDF	0,01	< 0,015	< 0,00015	< 0,015	< 0,00015	< 0,015	< 0,00015
12346789-OctaCDF	0,0003	< 0,045	< 0,00001	< 0,045	< 0,00001	< 0,045	< 0,00001
Polychlorierte Biphenyle							
Non ortho PCB							
PCB 77	0,0001	0,135	0,00001	0,118	0,00001	0,147	0,00001
PCB 81	0,0003	< 0,050	< 0,00002	< 0,050	< 0,00002	< 0,050	< 0,00002
PCB 126	0,1	0,064	0,00638	0,084	0,00844	0,112	0,01124
PCB 169	0,03	< 0,050	< 0,00150	< 0,050	< 0,00150	< 0,050	< 0,00150
Mono ortho PCB							
PCB 105	0,00003	< 0,500	< 0,000015	< 0,500	< 0,000015	< 0,500	< 0,000015
PCB 114	0,00003	< 0,100	< 0,000003	< 0,100	< 0,000003	< 0,100	< 0,000003
PCB 118	0,00003	< 1,000	< 0,000030	< 1,000	< 0,000030	< 1,000	< 0,000030
PCB 123	0,00003	< 0,100	< 0,000003	< 0,100	< 0,000003	< 0,100	< 0,000003
PCB 156	0,00003	0,125	0,000004	0,124	0,000004	0,146	0,000004
PCB 157	0,00003	< 0,100	< 0,000003	< 0,100	< 0,000003	< 0,100	< 0,000003
PCB 167	0,00003	< 0,100	< 0,000003	< 0,100	< 0,000003	< 0,100	< 0,000003
PCB 189	0,00003	< 0,100	< 0,000003	< 0,100	< 0,000003	< 0,100	< 0,000003
PCDD/PCDF-mass (TEQ) in the partial gas volume			0,03369		0,03970		0,04943

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Table 4: Determination of heavy metal emissions No. 1

Plant:		Waste incineration plant					
Measuring point		Chimney					
Date		25.03.2021					
Messung-Nr.		1					
		particulate portion			non-filterable portion		
Start	hh:mm	18:45			18:45		
End	hh:mm	20:51			20:51		
	Vol.-%	8,5			8,5		
Reference oxygen concentration		Vol.-% 11,0					
main volume flow (Norm dr)		m³/h 92.170					
Extracted partial gas volume							
Duration of suction	min	120			120		
Probe diameter	mm	7					
partial gas volume (t,p,dr)	m³	1,737			0,382		
Correction factor of the gas meter		1,007			1,004		
average temperature at the gas meter	°C	23,0			22,0		
average temperature absolute	K	296,2			295,2		
pressure	hPa	1007			1007		
partial gas volume (norm dr)	m³	2,183			(with non-filterable portion) 0,353		
Isokinetic ratio	%	107					
Information on individual components		particulate portion		non-filterable portion		sum	detection limit
		concentration	concentration	concentration	concentration	concentration	concentration
		µg/sample	mg/m³ (n,dr)	µg/sample	mg/m³ (n,dr)	mg/m³ (n,dr)	mg/m³ (n,dr)
Cadmium		< 0,1	< 0,00023	< 0,1	< 0,00014	< 0,00016	< 0,00016
Thallium		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Antimony		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Arsenic		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Lead		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Chromium		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Cobalt		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Copper		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Manganese		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Nickel		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Vanadium		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Tin		< 0,5	< 0,00023	< 0,5	< 0,00142	< 0,00165	< 0,00165
Benzo(a)pyrene						< 0,000003	< 0,000003
components/summations relevant to the limit value		concentration	concentration	expanded measurement uncertainty	mass flow		
		mg/m³ (n,dr)	mg/m³ (n,dr, O2)	mg/m³ (n,dr, O2)	g/h		
Summe Cd/Tl		< 0,001	< 0,001	0,001	< 0,17		
Summe Sb-Sn		< 0,01	< 0,01	0,01	< 1,5		
Summe As-Cr, BaP		< 0,005	< 0,005	0,004	< 0,47		

For the sum values, non-detected individual components with the specified detection limit were taken into account.

Table 5: Determination of heavy metal emissions No. 2

Plant:		Waste incineration plant					
Measuring point		Chimney					
Date		26.03.2021					
Messung-Nr.		2					
		particulate portion			non-filterable portion		
Start	hh:mm	13:07			13:07		
End	hh:mm	15:13			15:13		
	Vol.-%	8,8			8,8		
Reference oxygen concentration		Vol.-% 11,0					
main volume flow (Norm dr)		m³/h 121.590					
Extracted partial gas volume							
Duration of suction	min	120			120		
Probe diameter	mm	6					
partial gas volume (t,p,dr)	m³	1,6727			0,376		
Correction factor of the gas meter		1,007			1,004		
average temperature at the gas meter	°C	22,0			21,0		
average temperature absolute	K	295,2			294,2		
pressure	hPa	1005			1005		
partial gas volume (norm dr)	m³	2,183			0,348 (with non-filterable portion)		
Isokinetic ratio	%	110					
Information on individual components		particulate portion		non-filterable portion		sum	detection limit
		concentration	concentration	concentration	concentration	concentration	concentration
		µg/sample	mg/m³ (n,dr)	µg/sample	mg/m³ (n,dr)	mg/m³ (n,dr)	mg/m³ (n,dr)
Cadmium		< 0,1	< 0,00002	< 0,1	< 0,00014	< 0,00017	< 0,00017
Thallium		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Antimony		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Arsenic		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Lead		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Chromium		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Cobalt		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Copper		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Manganese		1,2	0,00055	< 0,5	< 0,00144	0,00055	< 0,00167
Nickel		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Vanadium		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Tin		< 0,5	< 0,00023	< 0,5	< 0,00144	< 0,00167	< 0,00167
Benzo(a)pyrene						< 0,000003	< 0,000003
components/summations relevant to the limit value		concentration	concentration	expanded measurement uncertainty	mass flow		
		mg/m³ (n,dr)	mg/m³ (n,dr, O2)	mg/m³ (n,dr, O2)	g/h		
Summe Cd/Tl		< 0,002	< 0,002	0,001	< 0,22		
Summe Sb-Sn		< 0,02	< 0,02	0,01	< 2,0		
Summe As-Cr, BaP		< 0,005	< 0,005	0,004	< 0,63		

For the sum values, non-detected individual components with the specified detection limit were taken into account.

Report on the implementation of emission measurements on the waste incineration plant in Vilnius of the company AB Ignitis grupė for the measuring objects PCDD/PCDF, WHO PCB, Benzo(a)pyrene and heavy metals, Report No. 936/ 21252753/A1

Table 6: Determination of heavy metal emissions No. 3

Plant:		Waste incineration plant					
Measuring point		Chimney					
Date		27.03.2021					
Messung-Nr.		3					
		particulate portion		non-filterable portion			
Start	hh:mm	12:16		12:16			
End	hh:mm	14:22		14:22			
	Vol.-%	8,7		8,7			
Reference oxygen concentration	Vol.-%	11,0					
main volume flow (Norm dr)	m³/h	117.630					
Extracted partial gas volume							
Duration of suction	min	120		120			
Probe diameter	mm	6					
partial gas volume (t,p,dr)	m³	1,5968		0,39			
Correction factor of the gas meter		1,007		1,004			
average temperature at the gas meter	°C	19,0		23,0			
average temperature absolute	K	292,2		296,2			
pressure	hPa	1005		1005			
partial gas volume (norm dr)	m³	2,111		0,358 (with non-filterable portion)			
Isokinetic ratio	%	110					
Information on individual components		particulate portion		non-filterable portion		sum	detection limit
		concentration	concentration	concentration	concentration	concentration	concentration
		µg/sample	mg/m³ (n,dr)	µg/sample	mg/m³ (n,dr)	mg/m³ (n,dr)	mg/m³ (n,dr)
Cadmium		0,1	0,00003	< 0,1	< 0,00014	0,00003	< 0,00016
Thallium		< 0,5	< 0,00024	< 0,5	< 0,00140	< 0,00163	< 0,00163
Antimony		< 0,5	< 0,00024	< 0,5	< 0,00140	< 0,00163	< 0,00163
Arsenic		< 0,5	< 0,00024	< 0,5	< 0,00140	< 0,00163	< 0,00163
Lead		0,6	0,00028	< 0,5	< 0,00140	0,00028	< 0,00163
Chromium		1,8	0,00085	< 0,5	< 0,00140	0,00085	< 0,00163
Cobalt		< 0,5	< 0,00024	< 0,5	< 0,00140	< 0,00163	< 0,00163
Copper		1,5	0,00071	< 0,5	< 0,00140	0,00071	< 0,00163
Manganese		15,0	0,00710	< 0,5	< 0,00140	0,00710	< 0,00163
Nickel		2,0	0,00095	< 0,5	< 0,00140	0,00095	< 0,00163
Vanadium		1,2	0,00057	< 0,5	< 0,00140	0,00057	< 0,00163
Tin		< 0,5	< 0,00024	< 0,5	< 0,00140	< 0,00163	< 0,00163
Benzo(a)pyrene						< 0,000003	< 0,000003
components/summations relevant to the limit value		concentration	concentration	expanded measurement uncertainty	mass flow		
		mg/m³ (n,dr)	mg/m³ (n,dr, O2)	mg/m³ (n,dr, O2)	g/h		
Summe Cd/Tl		< 0,002	< 0,002	0,001	< 0,21		
Summe Sb-Sn		0,02	0,02	0,01	2,6		
Summe As-Cr, BaP		< 0,005	< 0,005	0,004	< 0,60		

For the sum values, non-detected individual components with the specified detection limit were taken into account.

Table 7: Determination emissions - Hg

Plant:	Waste incineration plant			
Measuring point	Chimney			
Date:		25.3.2021	26.3.2021	27.3.2021
Measurement No.		1	2	3
Start	time	18:45	13:07	12:16
End	time	19:15	13:37	12:46
Main volume flow				
Volume flow measurement	No.	1	2	3
Related to standard condition dryn (Norm tr)	m³/h	92.170	121.590	117.630
non-filterable portion				
partial gas volume dry gas meter				
Duration of suction	min	30	30	30
partial gas volume (t,p,dr)	m³	0,0640	0,0627	0,6220
Correction factor of the gas meter		1,006	1,006	1,006
Average temperature at the gas meter	°C	18	18	18
Average temperature absolute	K	291	291	291
Pressure	hPa	1007	1005	1005
partial gas volume (norm dr)	m³	0,0600	0,0587	0,5824
mass found in the sample	µg	< 0,01	< 0,01	< 0,01
mass, field blank value	µg	< 0,01		
related to the partial gas volume (Norm dr)	mg/m³	< 0,00017	< 0,00017	< 0,00002
Blank value in relation to the limit value	%	< 0,3	0,3	< 0,1
Blank value in relation to the measured value	%	< 100,0	< 100,0	< 100,0
Mass concentration (norm dr)	mg/m³	< 0,00017	< 0,00017	< 0,00002
mass flow	g/h	< 0,015	< 0,020	< 0,002
average total oxygen	Vol.-%	8,7	8,8	8,7
Reference oxygen content	Vol.-%	11,0	11,0	11,0
Mass concentration (norm dr, 11 Vol.-% O2)	mg/m³	< 0,00017	< 0,00017	< 0,00002
Particular fraction Hg (isokinetic sampling)				
Extracted partial gas volume dry gas meter				
Duration of suction	min	120	120	120
partial gas volume (t,p,dr)	m³	1,737	1,673	1,597
Correction factor of the gas meter		1,007	1,007	1,007
Average temperature at the gas meter	°C	23	22	19
Average temperature absolute	K	296	295	292
Pressure	hPa	1007	1005	1005
partial gas volume (norm dr)	m³	2,1830	2,1830	2,1114
Isokinetic ratio	%	107	110	110
mass found in the sample	µg	0,06	0,08	0,07
Mass, field blank value	µg	< 0,06		
partial gas volume (t,p,dr)	mg/m³	< 0,00003	< 0,00003	< 0,00003
Blank value in relation to the limit value	%	< 0,1	< 0,1	< 0,1
Blank value in relation to the measured value	%	< 100,0	< 75,0	< 85,7
average total oxygen	Vol.-%	8,5	8,8	8,7
Reference oxygen content	Vol.-%	11,0	11,0	11,0
mass concentration (norm dr)	mg/m³	< 0,00003	0,00004	0,00003
mass concentration (norm dr, 11 Vol.-% O2)	mg/m³	< 0,00003	0,00004	0,00003
mass flow	g/h	< 0,00253	0,0045	0,0039
sum mass concentration (norm dr)	mg/m³	< 0,00019	0,00021	0,00005
sum mass concentration (norm dr, 11 Vol.-%)	mg/m³	< 0,00019	0,00021	0,00005
Total mass flow	g/h	< 0,018	0,024	0,005