SNAS Reg. No. 226/S-188

REPORT OF DISCONTINUOUS EMISSION MEASUREMENTS

of polychlorinated dibenzodioxins and dibenzofurans
in the exhaust gas from waste incinerator

Customer: **UAB Gren Klaipeda, Lithuania**

Report number: **494/2022**

Date of measurements: **October 21, 2022**

Date of issue of report: **November 18, 2022**

…….
Stamp

……
Ing. Ignác Kožej
managing director

EKO-TERM SERVIS s.r.o., Napájadlá 11, 040 12 Košice, Slovakia
Laboratory is accredited by SNAS (Slovak National Accreditation Service),
which is the signatory to the ILAC MRA and EA MLA, in the scope of laboratories accreditation.
Laboratory fulfils the requirements of the ISO/IEC 17025:2005 and ISO/IEC 17020:1998 standards.

CONTENTS

ABBREVIATIONS

CEMS	- Continuous Emission Monitoring System
ELV	- Emission Limit Value
EN	- European Norm
EV	- Emission Value
ISO	- International Organization for Standardization
I-TEF	- International Toxicity Equivalent Factor
I-TEQ	- International Toxic Equivalent (obtained by multiplying the concentrations and the corresponding I-TEF)
PCDD's /PCDF's	- polychlorinated dibenzodioxins and polychlorinated dibenzofurans
U	- relative expanded uncertainty of the measurement

This report contains 7 authorized pages without annexes.

LIST OF AUTHORIZED ANNEXES		
No.	**Title**	**No. of pages**
1	Sites specific protocol	2
2	Analytical protocols of samples of PCDD's / PCDF's, (from subcontractors)	9
3	Protocols of the determination of pollutants	1
4	Diagram of technology	1
5	Copy of records of waste incinerators	1
6	Chart of oxygen content during measurement	1
7	Automatic isokinetic sampling system – PCDD's / PCDF's	1
8	Comparative tables of working characteristics of measuring instruments	3
ALTOGETHER		**19**

1. BUYER AND OPERATOR

1.1 BUYER

Name:	**UAB Gren Klaipeda, Lithuania**
Residence:	**Kretainio street 3, LT-94103, Klaipeda, Lithuania**
Statutory representative:	**Ramunas Jakovlevas** – Laboratory work and Safety Engineer
ID:	**301 276 531**

1.2 OPERATOR

Name:	**UAB Gren Klaipeda, Lithuania**
Residence:	**Kretainio street 3, LT-94103, Klaipeda, Lithuania**
Statutory representative:	**Ramunas Jakovlevas** – Laboratory work and Safety Engineer
ID:	**301 276 531**

Emission measurements were carried out under the purchase order No. MXKLJ2211020 for discontinuous emission measurements of selected pollutants based on an order dated: October 14, 2022.

2. MEASURING RANGE

Measurements were performed from October 21, 2022 in the following range:

- polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDD's / PCDF's),
- reference oxygen content and status variables.

Records of preparation measurement is in Annex No. 1.

3. PARTICIPANTS OF MEASUREMENT

3.1 PERSONNEL OF EKO-TERM SERVIS s.r.o.

To the emission measurements participated the following personnel of EKO-TERM SERVIS s.r.o., Košice:

- Ing. Miloš Varga - manager of the measurement,
- Martin Kuba, Vladimír Kyseľ - sampling of PCDD's/ PCDF's,
- Patrik Hrubší - sampling reference and status parameters.

3.2 SUBCONTRACTORS

The analyses of PCDD's / PCDF's in the samples were performed by subcontracting laboratory - EKOLAB s.r.o. Košice. The protocols were prepared by Mrs. Eva Jusková.

The analytical protocols of the determination of PCDD's / PCDF's issued by subcontracting laboratories are attached in the Annex No. 2 of this report.

3.3 REPRESENTATIVES OF OPERATOR

The measurements were performed by the participation of Mr. Ramunas Jakovlevas, representatives of the operator.

4. RESULTS OF MEASUREMENTS AND NOTICES

4.1 OVERVIEW OF RESULTS OF THE MEASUREMENTS

Table No. 1 - Summary of results of measurements of PCDD's / PCDF's and the oxygen content in flue gas.

Operator:	UAB Gren Klaipeda, Lithuania	
Emission source:	Waste incinerator	
Equipment:	Steam boiler	
Date of measurements:	October 21, 2022	
Pollutant	**PCDD's / PCDF's**	
Sampling time	[ng-TEQ.m^{-3}] [1) 3)]	[µg-TEQ.h^{-1}]
09:15 – 15:15	0,010	2,2
U_{max} [%] [3)]	32	34

1) The value of the mass concentration of PCDD's / PCDF's in ng-TEQ.m^{-3} is expressed in standard conditions (101325 Pa; 0 °C) in the dry gas and converted to a reference oxygen content of 11 % vol.

2) The reported expanded uncertainties are based on the standard uncertainty which is multiplied by a coverage factor k = 2. In this case the normal distribution provides a level of confidence approximately 95 %. Uncertainty values are expressed in %.

3) The weight of pollutants was determined by subcontracting analytical laboratory EKOLAB s.r.o. Košice, Slovakia.

Detailed results are given in Annex No. 3 of this report.

4.2 NOTICE OF COMPLIANCE OR NON-COMPLIANCE OF THE REQUIREMENTS

Table No. 2 – Notice of compliance or non-compliance with the specified requirements.

Operator:	UAB Gren Klaipeda, Lithuania			
Emission source:	Waste incinerator			
Equipment:	Steam boiler			
Date of measurements:	October 21, 2022			
Pollutant	Requirements for compliance of EL [1)]	Emission limit [1, 2)]	Measured value [2)]	Verbal notice
PCDD/PCDF	each average EV≤ EL	0,1 ng.m^{-3}	0,01 ng.m^{-3}	**COMPLIANCE**

1) The requirements for compliance with EL and the EL values are given in DIRECTIVE 2010/75/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on the incineration of waste.

2) ELV and EV are expressed by standard state conditions (101,325 kPa, 0 °C), in dry gas and by reference oxygen content 11 % vol.

5. DESCRIPTION OF EQUIPMENT

5.1 CHARACTERISTICS AND PRINCIPLE OF TECHNOLOGY

The company UAB "Fortum Klaipeda", operates waste incineration with the annual capacity of 255 000 tons per year of waste. The incinerator is designed for thermal destruction of solid waste.

The solid waste is stored in a hopper, from there is dosed into the movable grate. Where is waste burn. The ash are transferred the into the ash container. The flue gases from the boiler are kept through the vertical boiler body and subsequently through the super heater and economizer. The boiler is used to produce steam that is used to generate electricity for the own use of the incinerator and for supply to the public network.

The flue gases are then conducted through the gas cleaning system to reduce gaseous pollutants. The ammonia is added on boiler for reduce NO_X. Next step lime and activated charcoal is fed into the flue gas semidry treatment plant. The solid sorbents with the absorbed pollutants are captured in the fabric filter and transported to the ash and dust. The flue gases are further purified in flue gas condenser . The cleaned flue gases are then discharged into the atmosphere.

The primary chimney fan maintains negative pressure in the combustion chamber and also in the gas cleaning facilities. The secondary fan allows recirculation of flue gases.

The technological scheme is given in Annex No. 4 of this report.

The following technological parameters are monitored to control the combustion process and waste gas cleaning:

- amount of dosed solid waste
- the gas temperature in the boiler
- O_2 concentration in the boiler
- dosed amount of ammonia, lime and activate coal.

Detailed results are given in Annex No. 5 and 6 of this report.

5.2 FUELS AND RAW MATERIALS

Incinerated waste:	- household waste, waste from industry
Stabilizing fuel:	- natural gas
Sorbents:	- ammonia, lime, active coal
Wastes from the combustion process	- slag, ash from the heat exchanger, ash from the textile filter, waste water, flue gases emitted into the atmosphere.

5.3 WASTE GASES AND APPARATUS FOR REDUCING OF EMISSIONS

Table No. 3 – Equipment nameplate data.

Flue gas fan	
Constructor:	Flakt Woods Oy, Finland
Type:	HACB-180-290-LG75
Serial number:	F500607/010/1
Year of const.:	2012
Inlet volume:	101,3 m^3/s
Total pressure:	8,5 kPa
Max. temp. of gas:	200 °C

Flue gas treatment	
Constructor:	ALSTOM Power Sweden AB
Order number:	301276531
Constructor:	Fisia Babcock Enviroment GmbH
Type:	KA-01-00848
Year of construction:	2012
Serial number:	8466
Mass flow of steam:	109,2 t/h

5.4 OPERATION MODES AND OPERATIONAL CONDITIONS

- operation mode: one-mode technology
- emission generation: continuous, steady-state technology

5.5 COMPLIANCE ASSESSMENT OF OPERATION COMPARED WITH DOCUMENTATION

Copy of waste incinerator operator record is listed in Annex No. 5 and 6 of this report.

6. PROCEDURE AND EVALUATION OF MEASUREMENT

6.1 MEASUREMENT METHODOLOGIES

The discontinuous emission measurement was planned and carried out under the following methodologies:

Table No. 4 - List of the used methodologies.

Standard reference	Title	Measured values
ISO 10396	Stationary source emissions - Sampling for the automated determination of gas emission concentrations for permanently-installed monitoring systems.	gaseous pollutants
ISO 16911-2	Stationary source emissions – Manual and automatic determination of velocity and volume flow rate in duck – Part 2	velocity and volume flowrate in duck
EN 14790	Stationary source emissions - Determination of the water vapour in ducts.	water vapour
EN 15259	Air quality - Measurement of stationary source emissions – Requirements for measurement sections and sites and for the measurement objective, plan and report.	measurement
EN 1948-1	Stationary source emissions - Determination of the mass concentration of PCDDs/PCDFs and dioxin-like PCBs - Part 1: Sampling of PCDDs/PCDFs.	PCDD's/PCDF's
EN ISO 11771:2011	Air quality – Determination of time - averaged mass emissions and emission factor. General approach	averaged mass emissions and emission factor
EN 14789	Stationary source emissions - Determination of volume concentration of oxygen (O_2) - Reference method - Paramagnetism.	O_2
ISO 12039	Stationary source emissions - Determination of carbon monoxide, carbon dioxide and oxygen - Performance characteristics and calibration of automated measuring systems.	CO_2

The number of individual measurements of emission values was planned in accordance with the recommendation of Directive 2010/75/EC of the European Parliament and the Council of 24 November 2010 on the incineration of waste, as follows:

The measurements of the concentration of PCDD's and PCDF's were performed using an external sampling (extractive) emission measurement system according to internal methodologies and internal working procedures in accordance with EN 1948-1. The determination of PCDD's and PCDF's was carried out by means of apparatus Kalman Systems KS-404 - isokinetic gravimetric. The diagram is shown in Annex No. 7.

The summary tables of used equipment and accessories are listed in Annex No. 8 to this report.

Table No. 5 - Number and duration of samplings.

Kind of operation	Measuring method	Type of measurement	The number of individual samplings / period		Evaluation of sampling conditions
			Recommended	Reality	
continuous, steady-state technology	manual	discontinuous	PCDD's/ PCDF's 1 sampling / 6 - 8 hours	PCDD's/ PCDF's 1 sampling / 6 hours	compliance

6.2 COMPARISON OF RESULTS OF MEASUREMENTS IN RELATION TO EMISSION LIMIT VALUES

The following tables show the mass concentrations of individual samples of pollutants in relation to the emission limit values.

Table No. 6 - Results from individual samples of PCDD's / PCDF's - hazardous waste incinerator.

Parameter / sample		**Value**	**Unit**	**Remark**
Emission limit value (ELV)		0,1	$ngTEQ.m^{-3}$	-
blank 1	concentration	0,001	$ngTEQ.m^{-3}$	control irrigation + filter prior to sampling
	% from ELV	1,2	%	
sampling	concentration (at O_2^r)	0,014	$ngTEQ.m^{-3}$	condensate, PUF and scavenging
	% from ELV	13,6	%	
control zone	concentration (at O_2^r)	0,001	$ngTEQ.m^{-3}$	control zone of adsorber of gaseous PCDD's / PCDF's - PUF2
	% from ELV	1,3	%	
	% from total concentration	9,8	%	
	requirement of standard	< 10	% from total concentration	
Recovery of sampling standard > 50 %		71	%	see Protocols in Annex. 2
Detection limit	concentration	0,001	$ngTEQ.m^{-3}$	-
	% z EL	1	%	

Based on the foregoing, it can declare the results of determination of the mass concentration of pollutants and the determined uncertainties are credible.

6.3 EVALUATION OF UNCERTAINTY OF MEASUREMENT RESULTS

The uncertainties of the results of measurements were evaluated according to the working procedures described in chapter 6.1, Table No. 4 and 5 (combination of uncertainties of sampling and analysis).

6.4 OPINIONS, INTERPRETATIONS AND RECOMMENDATIONS

Result is under value of emission limit, therefore do not included any interpretation of the results.

PROTOCOL OF DETERMINING PCDD's AND PCDF's

Order: UAB Gren Klaipeda
Emission source: Waste incineration plant
Steam boiler
Date of sampling: 21.10.2022

Procurement apparatus: KS-408
Determination of the meth. EN 13284-1, EN 1948-1
1 m
Sampling time: 9:15 - 15:15

Details of the measuring spot:

Duct specification:	circle		Area of sampling plane (SP):	3,801	m^2	Duct lenght upstream of th	62,2	m
Duct diameter:	2,200	m	Hydraulic diameter (d_H):	2,200	m	Duct lenght downstream o	5	m
Side A x B:	-	m	Sampling points per sampling	1		Sampling lines:	28,3	

Average values calculated

Variable	Value	Unit
Atmospheric pressure	101560	Pa
Absolute pressure	102066	Pa
Humidity of waste gas	8,55	vol. %
Density waste gas (dry gas)	1,341	$kg.m^{-3}_n$
Temperature of waste gas	133,0	°C
Measured O_2 content	7,66	vol. %
Measured O_2 content	11	vol. %

Sampling

Variable	Value	Unit
Total sampling time	5:59	h:mm
Nozzle diameter	5,6	mm
Isokinetic conditions - avera	101	%
Filtering area	31,4	cm^2
Filter efficiency	99,9	%
Nominal sample flowrate	1,10	$m_n^3.h^{-1}$
The lowest vac. in the appa	94635	Pa

Leak test results

Real flow test	80000	Pa
Leak in the apparatus prior to sampling	0,034	$m_n^3.h^{-1}$
% of sample flowrate during sampling	3,1	%
Leak in the apparatus after sampling	0,034	$m_n^3.h^{-1}$
% of sample flowrate during sampling	3,1	%
Leaks criterion of sampling apparatus	≤ 5	%

Terms of sampling and evaluation

Filtration tepmerature	123,5	°C
Cooler temperature at inlet	59,3	°C
Cooler temperature at outle	4,2	°C
Absorber temperature	2,0	°C
Flowmeter temperature	30,9	°C
Condensing efficiency	100,0	%

Sampling standard

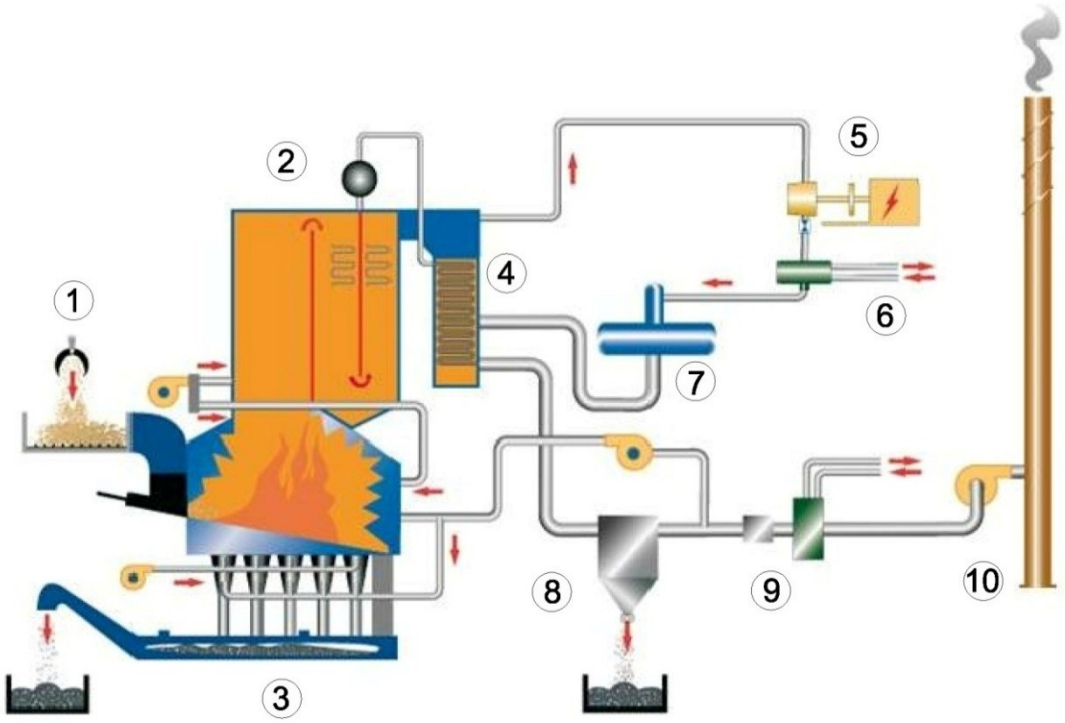
Type of standard	$^{13}C_{12}$ - 1,2,3,7,8 - PeCDF
Labeled parts of apparatus	filter, condensation vessel, polyurethane filter
Used quantity of standard	300 µl / sample

Adsorption stage

Material	PUF
Dimensions (Φ/lenght)	50/50 mm
Control zone (Φ/lenght)	50/50 mm

Average velocity of waste gas in duct	**19,2**	**$m.s^{-1}$**	**U(k=2) =**	**5 %**
Average volumetric flowrate at duct (standard conditions, dry gas)	**162399**	**$m^3_{ns}.h^{-1}$**	**U(k=2) =**	**9,1 %**
Blank	**0,001**	**$ng\text{-}TEQ.m^{-3}$**		
Sampled volume of waste gas (standard conditions, dry gas)	**6,598**	**m_n^3**		
Total sampled mass PCDD	**0,008**	**ng-TEQ**		
Mass concentration PCDD	**0,001**	**$ng\text{-}TEQ.m^{-3}$**		
Total sampled mass PCDF	**0,081**	**ng-TEQ**		
Mass concentration PCDF	**0,012**	**$ng\text{-}TEQ.m^{-3}$**		
Total sampled mass PCDD + PCDF	**0,090**	**ng-TEQ**	**U(k=2) =**	**30 %**
Mass concentration PCDD + PCDF	**0,014**	**$ng\text{-}TEQ.m^{-3}$**	**U(k=2) =**	**32 %**
Mass flowrate PCDD + PCDF	**2,204**	**$\mu g\text{-}TEQ.h^{-1}$**	**U(k=2) =**	**34 %**
Mass concentration PCDD + PCDF (referenced oxygen content 11 % vol.)	**0,010**	**$ng\text{-}TEQ.m^{-3}$**		

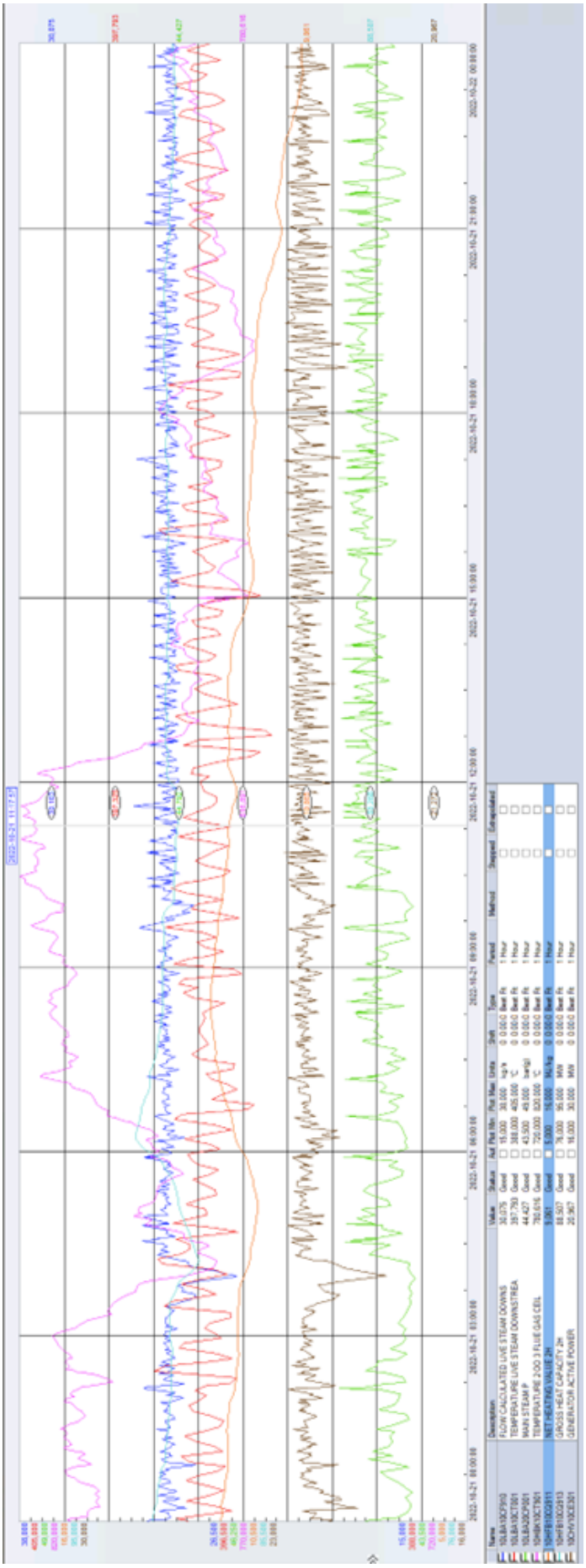
DIAGRAM OF TECHNOLOGY



DESCRIPTION:

1. Fuel supply
2. Steam boiler
3. Slag handling system
4. Economiser
5. Steam turbine with generator
6. Heat exchanger
7. Deaerator
8. Flue gas treatment plant
9. Flue gas condenser
10. Stack

COPY OF RECORDS OF WASTE INCINERATORS



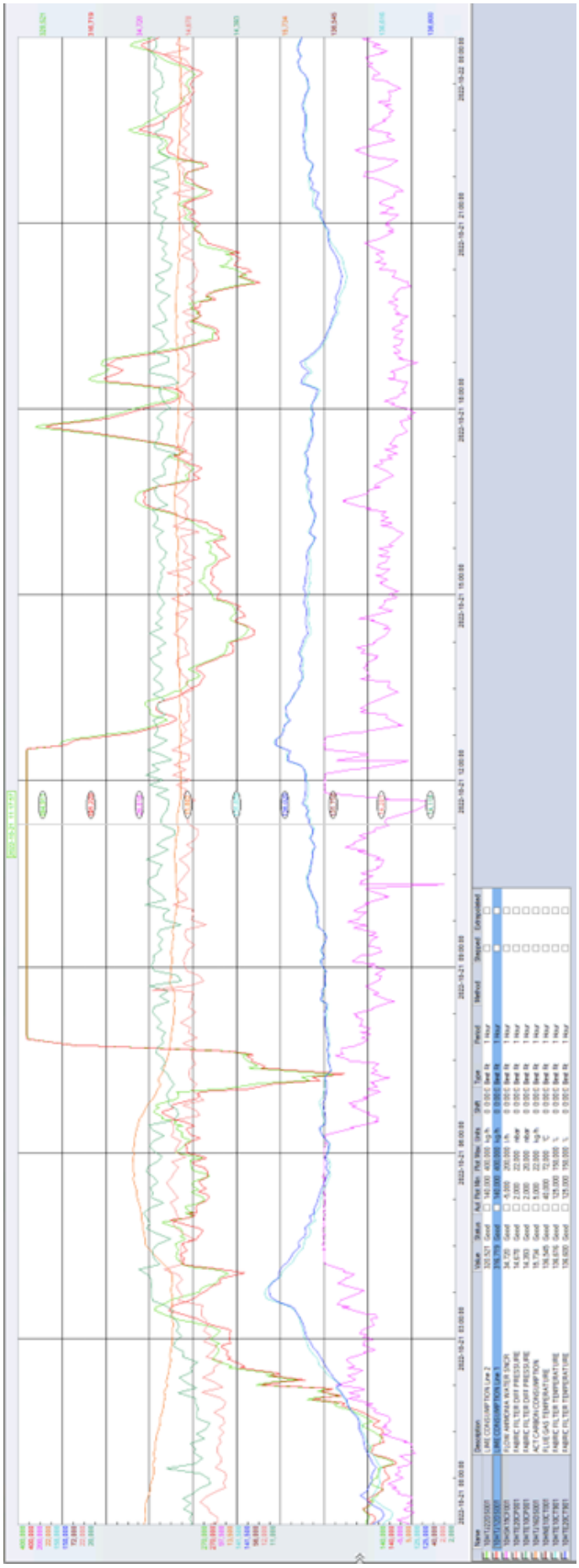
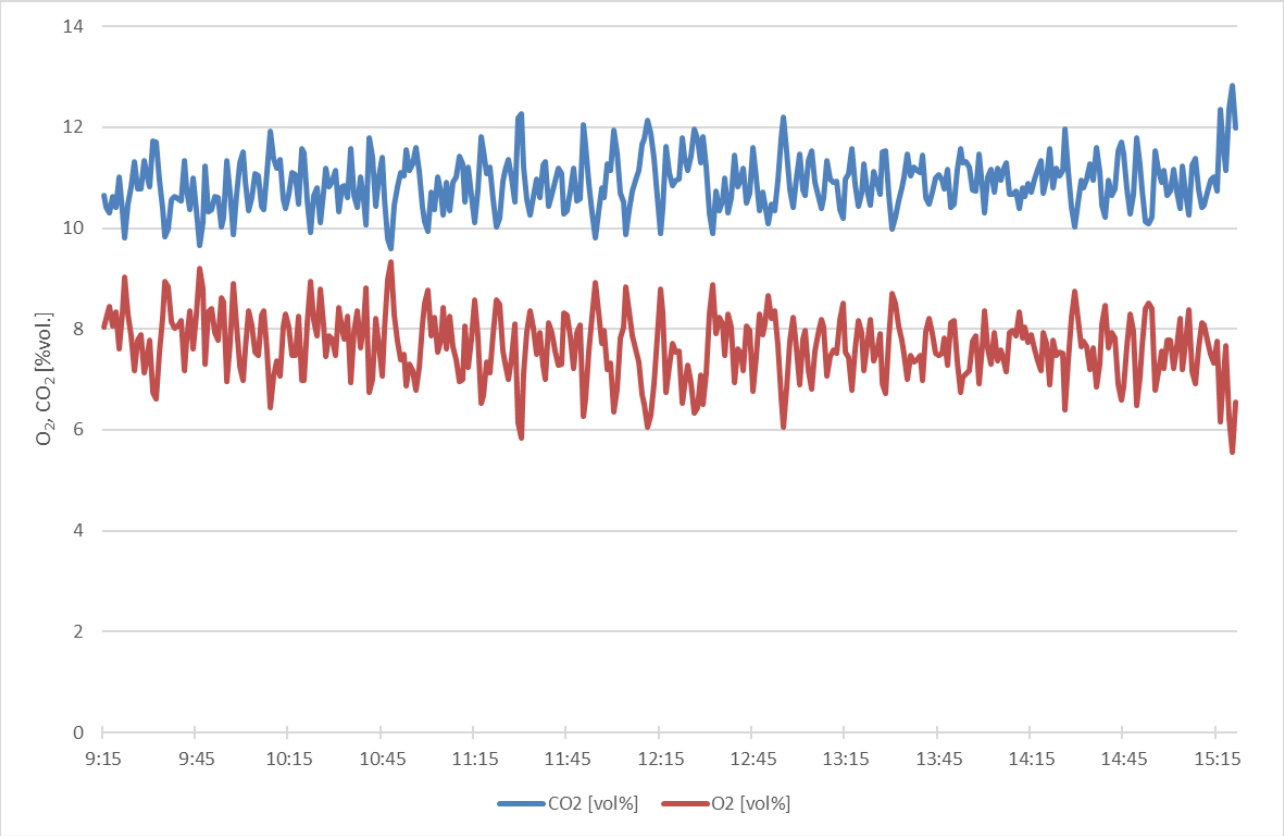
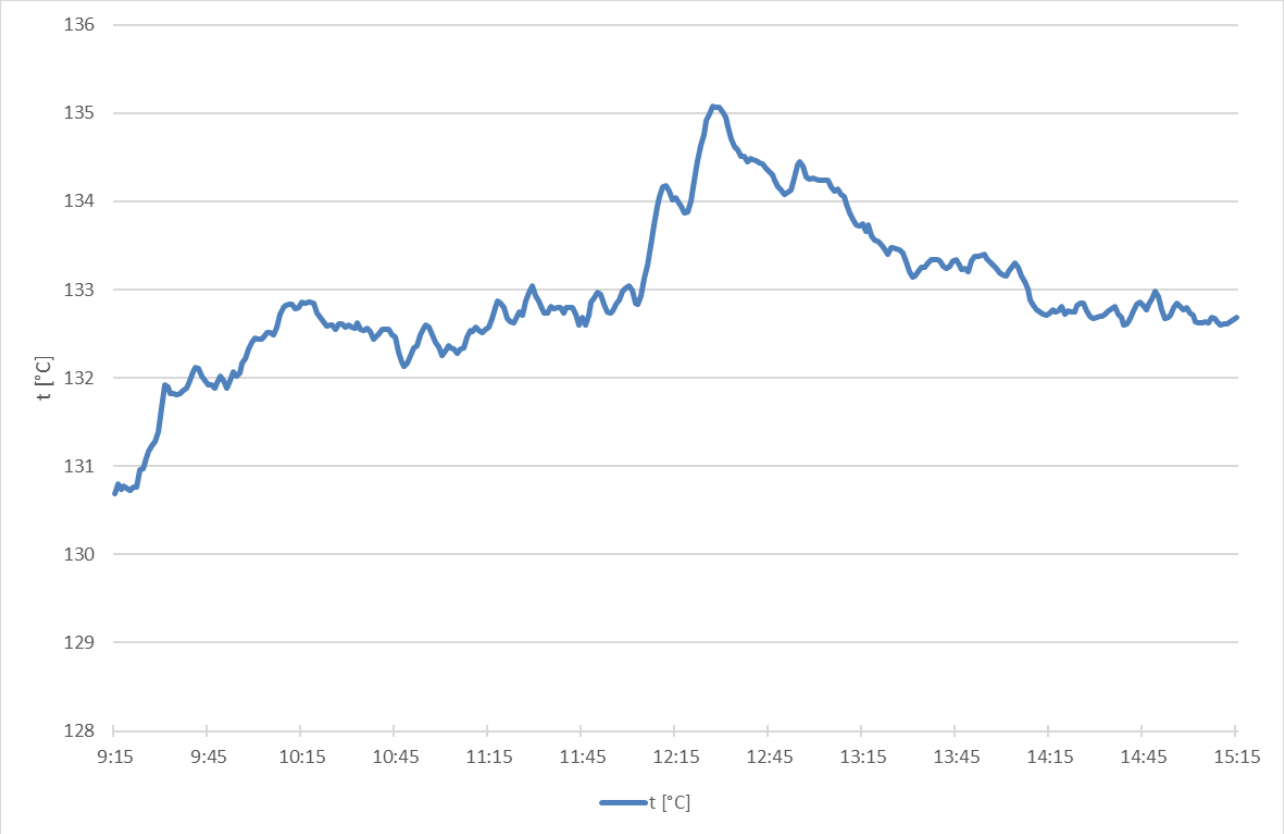
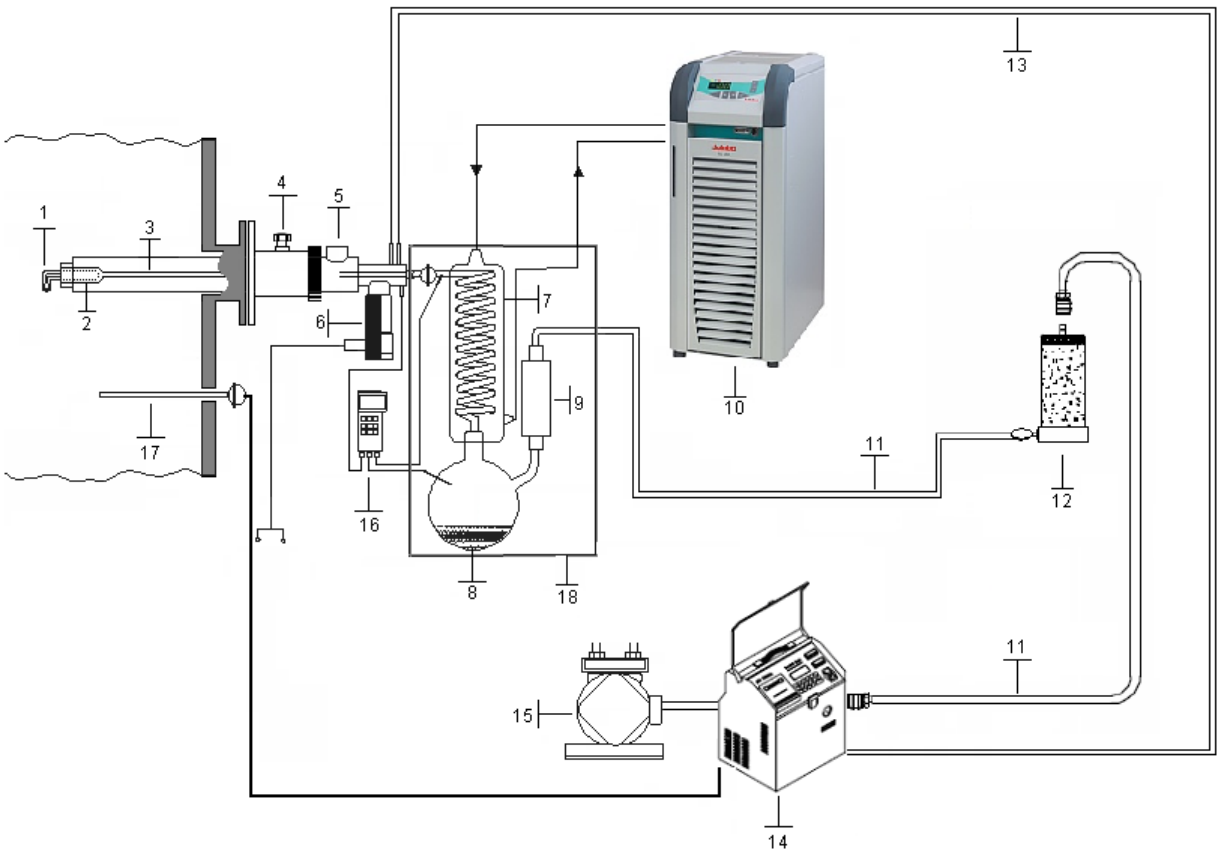


CHART OF O_2, CO_2 AND TEMPERATURE CONTENT DURING MEASUREMENT





AUTOMATIC ISOKINETIC SAMPLING SYSTEM – PCDD's / PCDF's



DESCRIPTION:

1. Titan nozzle
2. Titan filter holder for thimble diam. 10x110 mm
3. Heated probe
4. Slide and lock device
5. Heating air outlet
6. Warm air heater
7. Sample cooler
8. Condensing vessel
9. Titan PUF holder
10. Cooler with thermostat
11. Silicon/rubber suction tube T_{max} 180 °C diam. 10/18
12. Silica gel trap
13. Pressure tubing
14. Automatic sampler apparatus tecora isostack G4
15. Pump with frequency converter
16. Thermometer - temperature apparatus monitoring (3 channels)
17. Thermometer - temperature of waste gas
18. Condensing and adsorbing box

COMPARATIVE TABLES OF WORKING CHARACTERISTICS OF MEASURING INSTRUMENTS

Pollutants: PCDD's / PCDF's

Measuring principle: isokinetic filter-condensation method without subdivision of sampling flow with filtration in the pipe / outside the pipe

Parameter / component	Requirements of reference methodology:: EN 15259, EN 13284-1, EN 1948-1,4			Validity of the calibration till:
	Requirement	Reality	Remark	
Suction nozzle	inert, sharp edge, aerodynamic shape, diameter> 4 mm	titanium, sharp edge, aerodynamic shape, inner diameter: 4.5, 5.6, 7.6, 10.7, 14, 17	replaceable, meets dimensional requirements of the standard	-
Sampling probe	inert, heating of walls of the probe, reasonable length according to the dimension of pipe	titanium interior, heating of the probe through a hot-air fan	integrated with effective length 0,9 m	-
Filter head	location in the pipeline - heated, knee bending radius > 1.5 d	titanium, placed in pipes - heating is ensured by heating of the outside shell of the probe, tangential input of sample into the filter	Applicable for type of filter: bag filter	-
Filter	from fibreglass - shape of bubble cap; with separation efficiency greater than 99.5% in the test of separation of aerosol particles with a average diameter of particles 0.3 mm and the highest expected flow	bag filter with glass fibres, the efficiency of 99.99% for particles with diameter > 0,3 mm	bag filter 603G □□10 x 110 mm	-
Flowmeter of sample	dry gas meter, with inaccuracy max. 2% of the volume gas tight	Venturi´s flowmeter, gas tight, accuracy: ± 2% of the volume	built into the sampling unit, measurement of temperature and pressure of the sample	-
Suction equipment	Gas pump with regulation to ensure isokinetic sampling, accuracy ± 5%	vacuum pump with automated flow control of sample	Lamellar pump, BECKER, Germany; output 8 $m^3.h^{-1}$	-
Moisture separator	condenser, dryer residual moisture less than 10 g/m^3	counter condensing spiral cooler, + drying tower with silica gel	separation efficiency min. 95 %, residual moisture < 10 g/m^3	-
Temperature in sampling apparatus	thermocouple, thermometer, inaccuracy max. ± 1%	resistance thermometer Pt100 accuracy: ± 0,3 %	-	6.8.2024
Temperature of gas in pipeline	thermocouple, inaccuracy max. ±1 %	thermocouple type K measuring range: 0 – 600 °C accuracy: ± 0,1 % (at t = 500 °C)	Thermocouple with compensation, connected to control device KS 404	6.8.2024
Absolute pressure in the pipeline	liquid manometer, analogue, digital manometer, inaccuracy max. ± 0.5% of absolute pressure	pressure transducer range: 0-2 bar, accuracy: ± 0.15%	pressure transducer Sensor Technics SCX3OAN	6.9.2024 6.8.2024
Gas velocity in the pipeline - the measurement of differential pressure with Pitot-Prandtl probe and micromanometer	liquid micromanometer, analogue, digital micromanometer with the capability of reading from 5 Pa	pressure transducer of differential pressure	pressure transducer of differential pressure SCXL004DN - Sensor Technics	6.8.2024
	Pitot-Prandtl probe - standard, Type L	range: 0 to 12 mbar, resolution: from 5 Pa, accuracy: ± 0.06 mbar, Pitot probe type L	Pitot probe - Type L - integrated in the sampling probe	6.9.2024
Stopwatch	periodic record of sampling values (v_1, t_1, q_2, t_2, t_{filter}) - min. every 15 minutes	software and hardware time	Software AR-IZO 404	-
Scales	ability to weigh the silica gel tower	scales able to weigh the silica gel (0 to 2000 g) Umax = 0.6 grams	digital scales SARTORIUS BL 210 S-OCE	26.5.2023

Pollutants: PCDD's / PCDF's				
Measuring principle: isokinetic filter-condensation method without subdivision of sampling flow with filtration in the pipe / outside the pipe				
Parameter / component	**Requirements of reference methodology::** EN 15259, EN 13284-1, EN 1948-1,4			**Validity of the calibration till:**
	Requirement	**Reality**	**Remark**	
Adsorbent	XAD-2, PU foam, Porapak PS, Florisil or solid adsorbents with adsorption efficiency at least 90%	solid adsorbent: PUR foam	ρ =33g.l^{-1}, Φ= 47x50 mm, made from toluene-2,4-diisocyanate / toluene-2 ,6-diisocyanate (TDI) and polyoxy-prophylentriol	-
Case for solid sorbent	inert	inert	Material: titanium / glass	-
Cooling equipment	cooling, T< 20°C	Circulating cooling equipment Julabo FL 300 or Minichiller HUBER	Working temperature range (-20 ° C to +40 ° C)	-
Condenser	inert, cooling, T< 20°C	inert, cooling to temperature below 20 ° C by circulating cooling device	spiral condensing glass piece	-
Condensing flask	inert	inert, glass	volume 2 litters	-
Temperature filtration, condensation temperature input, oupt	thermocouple, thermometer, inaccuracy max. ± 1%	Four chanel thermometer, with thermocouple type K measuring range: -200 – 1370 °C	Four chanel thermometer, with thermocouple type K Serial number 150806553, calibration certifitace number 217/16/148/16/13	22.3.2025

Emission measurement system (EMS): HORIBA, PG 350 E-3									
Measuring principle: NDIR, chemiluminescence (NOx) and paramagnetism (O_2)									
Requirements for reference methodologies: EN 14792, ISO 7935, ISO 12039, EN 14789, EN 15058									
EMS	**Serial number**		**Year of production**		**Recalibration**		**Validity of calibration to:**		18.3.2023 no. of certificate: 016/2022/K
PG 350 E	WF6RLAE0		2015		internal				
component / range	1. range	2. range	3. range	4. range	5. range	6. range	7. range	Range	**Standard**
SO2 [mg/m³]	0 to 715	0 to 1430	0 to 2860	0 to 8580				0 to 8000	ISO 7935
NOx [mg/m³]	0 to 51	0 to 102	0 to 205	0 to 512	0 to 1025	0 to 2050	0 to 5125	0 to 3000	EN 14792
CO [mg/m³]	0 to 250	0 to 625	0 to 1250	0 to 2500	0 to 6250			6 to 62500	EN 15058
CO_2 [obj. %]	0 to 10	0 to 20	0 to 30					0 to 20	ISO 12039
O_2 [obj. %]	0 to 5	0 to 10	0 to 25					0 to 25	EN 14789

Analyzer performance - (N - standard; S - Fact)									
Parameter / component	**SO_2**		**NO – NO_2**		**CO**		**O_2**		**Note**
	N	S	N	S	N	S	N	S	
Detection limit	2 %R	0,00 %R	≤ ±2 %R	0,00 %R	≤ ±2 %R	0,50 %R1	≤ ±0,2 %R	0,00 %R	relative to the lower range
Deviation from linearity	≤±4 %R	0,10 %R	≤ ±2 %R	0,39 %R	≤ ±2 %R	0,14 %R	≤ ±0,3 % vol.	0,08 % vol.	relative to the entire range
Drift of zero value	±2 %R	0,40 %R1	≤ ±2 %R	0,00 %R	≤ ±2 %R	0,00 %R	≤ ±0,2 % vol.	0,02 % vol.	for 24 h
Drift measuring range	±4 %RM	0,123 %RM	≤ ±2 %R	0,68 %R	≤ ±2 %R	0,22 %R	≤ ±0,2 % vol.	0,07 % vol.	for 24 h
Impact of ambient temperature	≤ 2 %	±0,5%	≤ 2 %	±1 %	≤ 2 %	±1 %	≤ ±0,3 % vol. / 10K	± 0,25% vol. /10K	relative to the entire range

Impact of interfering substances	± 2 %R	0,10 %R	≤ ±4 %R	0,00 %R	≤ ±4 %R	0,06 %R	≤ ±0,2 % vol.	0,02 % vol.	relative to the entire range
Response Time T_{90} % of the value	≤ 200 sec.	47 sec.	≤ 200 sec.	30 sec.	≤ 200 sec.	27 sec.	≤ 200 sec.	27 sec.	at an average time of 30 min. and a verification value between 50-90% of the measurement range
Uncertainty of calibration	not specified	60,7 mg/m³	not specified	56,8 mg/m³	not specified	124,7 mg/m³	not specified	0,50 % vol.	based on RM
Converter efficiency NO_2/NO	-	-	≥ 95 %	99%	-	-	-	-	expressed as NO_2

Performance characteristics of emission measurement system components

Part of EMS	Standard requirement	Reality	Note
Sampling probe	minimizing interference heating above the dew point temperature suitable construction (smooth walls, material - stainless steel), suitable length according to pipe size	probe length 0.5 - 2.0 m material stainless steel - AISI-316 temp. stability to 600 ° C, Φ = 8 mm, unheated, heating by flowing gas	A reasonable length was used to prevent sample condensation in the probe from outside the pipeline.
Sampling line	Pipe line: PTFE material temperature stability up to 200 ° C, heating to prevent sample condensation 20 ° C above dew point	regulated heating of the sampling line by an electronic thermostat in the range of 0 - 200 ° C	the length of the heated pipe 25, respectively. 50 m, diameter 6/4 resp. 8/6 mm
		regulated heating of the first part of the sampling line up to the sample cooler by an electronic thermostat in the range 0-200 ° C; second part - unheated; material - PTFE	length of heated pipe 3m, length of unheated pipe 25 to 100 m, diameter 6/4
Gas sample treatment	filtration of solid particles before entering the sampling line, avoiding condensation of the sample in the filter, filtration efficiency = ŋ ≥ 98%, particles ≥ 1 µm	Ceramic filter heated to 200 ° C, Efficiency = ŋ ≥ 99%, particles ≥ 2 µm	the secondary particulate filter is located in the analyzer
Gas sample treatment	sample cooler, electrically regulated condenser, water vapor separation at 3 - 5 ° C	electronically regulated Peltier capacitor, condensation temperature 5 ° C	separate external unit with built-in sample pump
Data Recorder	graphic recorder, computer, digital recorder	integrated digital data logger, 5 channels, SD card, averaging interval of 1 min	datalogger SMA-371, archiving time 42 hours.
Gas distribution and suction equipment	minimizing interference; the gas-tightness of the suction device	PTFE hose, F = 4 mm suction device: no interference - stainless steel, gas-tight	Type: SUS-304, diaphragm - PTFE leak tightness tested over Internal workflow