



Institut für Gießereitechnik gGmbH

Measurement Report LIFE10 ENV/FI/059

**Determination and Assessment of Pollutant and Odour Emissions
from Contained and Diffuse Sources at an aluminium foundry**

Foundry:
Aluminium pilot foundry in the Netherlands



Prepared by:

IfG – Institut für Gießereitechnik gGmbH
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IfG Measurement Report Life 10 ENV/FI/059

Date: 14.- 16.01.2014

Determination and Assessment of Pollutant and Odour Emissions from Contained and Diffuse Sources at an aluminium foundry

Owner-operator: Aluminium pilot foundry, Netherlands

Type of measurement: Measurement of odour and pollutant emissions on selected contained and diffuse sources

Date of the measurement: January 14 – January 16 2014

Scope of the report: 15 pages

3 attachments

Task: Concentrations and mass flow of odours and pollutants have been measured in foundry emissions and inside the foundry shop. It have been measured:

- contained sources at exhaust extraction systems in the core shop , along the pouring and cooling line, at shake out and sand preparation plant;
- diffuse sources at cooling, shake out and sand preparation.

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1 Formulation of the measuring task

1.1 Customer The measurements were undertaken in the following foundry as part of the EU project Odourless Casting LIFE ENV/FI/059:

1.2 Owner-operator Aluminium pilot foundry

1.3 Location See above

1.4 Plant

Aluminium foundry

Machine moulding shop
Hand moulding shop
Pouring and cooling line
Sand preparation

1.5 Measurement period (date) 14.01.2014
16.01.2014

1.6 Reason for the measurement

The emission characteristics of seven European pilot foundries are investigated as part of the Odourless Casting project (LIFE ENV/FI059). In addition to a general assessment of the emissions situation, the aim is more particularly to identify manufacturing processes associated with major odour and pollutant emissions. In the course of these investigations it is IfG gGmbH's task as a project partner to detect and to measure emissions of odours and hazardous substances induced by various manufacturing processes at the aluminium pilot foundry.

These measurements serve control purposes and are intended to provide a quantitative overview of the odour levels and gaseous pollutant levels prevailing in the environment of this aluminium foundry.

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Task

Both contained and diffuse sources were identified, sampled and assessed with regard to their odour and pollutant emissions.

1.7 Measurement components

Odour as an olfactometric cumulative parameter, TVOC, hydrocarbons (formaldehyde, BTEX, naphthalene, phenol, cresol, carbon monoxide, sulphur dioxide, and volumetric flow rates of the contained sources

1.8 Persons with whom the measurement plan was coordinated

The test plan was coordinated with the person in charge at the pilot foundry

1.9 Names of all persons involved in sampling on site and number of auxiliaries

Alexander Gieselmann (IfG), Inna Lammert (IfG), Tobias Spenner (IfG)

1.10 Other institutes involved

Not applicable

1.11 Person technically responsible

Dr. rer. nat. Guido Furth

1.11.1 Phone

0049/ 211/6871-262

2 Description of the plant, substances handled

2.1 Type of plant

Aluminium foundry

2.2 Description of plant

- Melting shop: aluminium was previously melted in gas heated furnaces, 4 furnaces for melting and holding;
- Core shop: 13 core shooting machines and urethane cold box system with amine catalyst, water based coating, thermal sand reclamation;
- Moulding: two automatic moulding plants by HWS with green sand preparation;
- Hand moulding: using no bake system with furan resin, mechanical sand reclamation – only prototyping;
- Pouring, cooling and shake out line: with exhaust extraction system;
- Fettling shop: shotblasting, grinding by automatic machine or by hand.
- Operating hours: 2-shift operation

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2.3 Location of the plant and description of the emission sources

2.3.1 Location (geographical)

Netherlands

2.3.2 Emission sources, heights, exit areas, description of sources

Contained sources

Measurement

Measuring point	Identification	Sample type	Date and time		Adsorption rate (l/min)	Volume load (l)	Substance	Device number
			from	to				
			14.01.2014					
Amine scrubber (core making)	MP4-BTXEN	Activated carbon	14:20	14:30	0.3	3	BTXEN	Desaga 4
Knock-out station sand reclamation line 1	MP2-BTXEN	Activated carbon	14:35	14:45	0.3	3	BTXEN	Desaga 5
Knock-out station sand reclamation line 1	MP2-K/P	Silica gel	14:42	15:02	1.0	20	Kresol/Phenol	Desaga 4
Amine scrubber (core making)	MP4-F	DNPH	15:10	15:30	1.0	20	Formaldehyd	Desaga 4
Knock-out station sand reclamation line 1	MP2-F	DNPH	15:40	16:00	1.0	20	Formaldehyd	Desaga 4
			16.01.2014					
Knock-out station sand reclamation line 2	MP1-K/P	Silica gel	14:10	14:30	1.0	20	Kresol/Phenol	Desaga 5
Knock-out station sand reclamation line 2	MP1-F	DNPH	14:30	14:50	1.0	21,4	Formaldehyd	Desaga 5
Knock-out station sand reclamation line 2	MP1-BTXEN	Activated carbon	14:50	15:00	0.3	3	BTXEN	Desaga 5

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Measuring time / Measuring conditions

	Amine scrubber (core making)	Knock-out station sand reclamation line 1	Knock-out station sand reclamation line 2	Dimension
Date	14.01.2014	14.01.2014	16.01.2014	
Time	8:30-9:30	11:45-12:45	12:00-12:30	
Identification	MP4	MP2	MP1	
Equatorial distance	2509674.008re 5689243.462ho	2509650.377re 5689210.041ho	2509594.786re 5689125.383ho	
Diameter	1.2	1.5	0.82	m
Area cross-section	1.1310	1.7671	0.5281	m ²
Atmospheric pressure	1005	1004	1008	hPa
Humidity	14.4615	21.0982	15.1071	l/m ³
Exhaust gas temperature	14.5	27.5	20.7	°C
Exhaust gas velocity	11.7	15.0	12.4	m/s
	11.6	18.0	12.2	m/s
	11.3	24.0	12	m/s
	11.5	24.0	11.5	m/s
Middle exhaust gas velocity	11.5	20.3	12.0	m/s
Master volume flow during operation	46924	128825	Source	m ³ /h
Normal condition, moist	44195	115967	Date	m ³ /h
Normal condition, dry	43516	113249	20795	m ³ /h

Meteorological data				
Date	14.01.2014	14.01.2014	16.01.2014	16.01.2014
Time	9:28	10:36	10:45	12:01
Atmospheric pressure (hPa)	1005	1005	1011	1008
Air temperature (°C)	4	6,6	8,7	10,4
Relative humidity (%)	86	79	76	73

Volume flow

	Amine scrubber (core making)	Knock-out station sand reclamation line 1	Knock-out station sand reclamation line 2	Dimension
Date	14.01.2014	14.01.2014	16.01.2014	
Time	8:30-9:30	11:45-12:45	12:00-12:30	
Identification	MP4	MP2	MP1	
Equatorial distance	2509674.008re 5689243.462ho	2509650.377re 5689210.041ho	2509594.786re 5689125.383ho	
Diameter	1.2	1.5	0.82	m
Area cross-section	1.1310	1.7671	0.5281	m ²
Atmospheric pressure	1005	1004	1008	hPa
Humidity	14.4615	21.0982	15.1071	l/m ³
Exhaust gas temperature	14.5	27.5	20.7	°C
Exhaust gas velocity	11.7	15.0	12.4	m/s
	11.6	18.0	12.2	m/s
	11.3	24.0	12	m/s
	11.5	24.0	11.5	m/s
Middle exhaust gas velocity	11.5	20.3	12.0	m/s
Master volume flow during operation	46924	128825	22862	m ³ /h
Normal condition, moist	44195	115967	21140	m ³ /h
Normal condition, dry	43516	113249	20795	m ³ /h

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Diffuse (non contained) sources
Measurement

Measuring point	Identification	Sample type	Date and time		Adsorption rate (l/min)	Volume load (l)	Substance	Device number
			from	to				
			14.01.2014					
Moulding shop line 1	MPB-BTXEN	Activated carbon	14:30	14:40	0.3	3	BTXEN	Desaga 4
Moulding shop line 1	MPB-K/P	Silica gel	15:01	15:21	1.0	20	Kresol/Phenol	Desaga 5
Moulding shop line 1	MPB-F	DNPH	15:31	15:56	1.0	20	Formaldehyd	Desaga 5
			16.01.2014					
Moulding shop line 2	MPA-BTXEN	Activated carbon	14:50	15:00	0.3	3	BTXEN	Desaga 4
Moulding shop line 2	MPA-K/P	Silica gel	14:10	14:30	1.0	20	Kresol/Phenol	Desaga 4
Moulding shop line 2	MPA-F	DNPH	14:30	14:50	1.0	20	Formaldehyd	Desaga 4

	Moulding shop line 1	Moulding shop line 2	Dimension
Date	14.01.2014	16.01.2014	
Time	10:35-11:35	10:45-11:45	
Identification	MPB	MPA	
Equatorial distance	2509655.944re 5689214.502ho	2509636.534re 5689159.950ho	
Area cross-section	1,2	1,02	m ²
Atmospheric pressure	1005	1011	hPa
Humidity	7.5374	9.8487	l/m ³
Exhaust gas temperature	8	28,3	°C
Exhaust gas velocity	0.8	1.13	m/s
	0.8	0.81	m/s
	0.9	0.71	m/s
	0.8	1.95	m/s
	0.80	1.1	m/s
Middle exhaust gas velocity	0.8	1.1	m/s
During operation	3542	4186	m ³ /h
Normal condition, moist	3414	3784	m ³ /h
Normal condition, dry	3387	3743	m ³ /h

Meteorological data	14.01.2014	14.01.2014	16.01.2014	16.01.2014
Date	14.01.2014	14.01.2014	16.01.2014	16.01.2014
Time	9:28	10:36	10:45	12:01
Atmospheric pressure (hPa)	1005	1005	1011	1008
Air temperature (°C)	4	6,6	8,7	10,4
Relative humidity (%)	86	79	76	73

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	Moulding shop line 1	Knock-out station sand reclamation line 2	Dimension
Date	14.01.2014	14.01.2014	
Time	10:35-11:35	10:45 – 11:45	
Identification	MPB	MPA	
Exhaust geometrie	2.0 m x 1.2 m	2.0 m x 1.3 m	
Exit field	1.2	1.02	qm
Relative humidity	73	29	%
Exhaust gas temperature	8	28.3	°C
Exhaust gas velocity	0.8	0.81	m/s
	0.8	0.71	m/s
	0.9	1.95	m/s
	0.8	1.1	m/s
Middle exhaust gas velocity	0.80	1.14	m/s
Peristaltic pump	1.7	1.7	l/min

The contained sources were operating in accordance with their specifications. One particular feature of the contained sources is that the extracted emissions from the cooling line, knock-out station and sand preparation are emitted jointly through one stack (MP2)

2.3.3 National correlation

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2.4 Possible charge materials according to the permit

Not specified

2.5 Operating hours

2.5.1 Total operating hours

Two shifts; 06:00- 22:00

2.5.2 Emission period (in conjunction with the measurements)

14.01.2014: 06:00 –16:00; 16.01.2014: 10:00-13:00

2.6 Equipment for detecting and reducing emissions

2.6.1 Equipment for detecting emissions

Enclosures, piping and fans are part of the exhaust gas ducting for the sand reclamation area and the cooling line.

2.6.2 Equipment for reducing emissions

Bag filters for dust separation.

3 Description of the sampling points

3.1 Position of the sampling sections

In the case of the contained sources the measurements were undertaken in the vertical clean gas stack using the openings provided for this purpose.

Inflow and outflow sections were in compliance with VDI Guideline 2066, sheet 1, corresponding to > 3 times the pipe diameter.

3.2 Diameter of the exhaust gas pipe at the sampling point, or dimensions of the sampling point

In the case of contained sources, the stated cross-sectional area is also the measurement plane; refer to 2.3.2.

3.3 Number of axes and position of the measuring points in the sampling area

Not applicable

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4 Measurement and analysis methods / equipment

4.1 Determination of basic exhaust gas conditions

4.1.1 Flow velocity

Equipment type:	Vane anemometer, Testoterm combination instrument Type 445 Measuring range: 0-60 m/s
Make:	Testo, Lenzkirch
If calculated theoretically - operating data:	--

4.1.2 Air pressure at sampling point

Equipment type:	Precision aneroid barometer
Make:	Lufft, Stuttgart
Last inspection:	Annual comparison with a mercury barometer

4.1.3 Exhaust gas temperature

Equipment type:	Vane anemometer with built-in NiCrNi temperature sensor, Testoterm 445 combination instrument Measuring range: -120 to 70 °C
Make:	Testo, Lenzkirch
Recording of measured values:	Manual
Representative nature of the measuring point:	The influence of the measuring point over the cross section equalled ± 1 °C; the measuring point represents the mean value.

4.1.4 Water vapour content of the exhaust gas (exhaust gas humidity)

Method:	Capacitive change
Equipment type:	NTC moisture sensor, Testoterm 445 combination instrument Measuring range: 2 - 98 % relative humidity
Make:	Testo, Lenzkirch

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4.2 Gaseous and vapour emissions

4.2.2 BTXE emissions

4.2.2.1 Object of measurement

BTX, ethylbenzene, naphthalene, VOC, formaldehyde, phenol, cresol

4.2.2.2 Measurement method / VDI Guideline, methodological basis

A part-stream is extracted from the exhaust gas via a probe and is drawn through a tube containing pollutant-specific adsorbents with the aid of a vacuum device. These samples are then analyzed by a test laboratory accredited in accordance with DIN EN ISO/IEC 17025:2005.

4.2.2.3 Sampling equipment

- **Mechanical design (sampling train)** Probe / short Teflon hose / tube / pump
- **Specification of major parts**
 - Sampling probe: Stainless steel probe
 - Absorption/adsorption device: Dräger activated charcoal tubes type BIA, Supelco DNPH tubes, Dräger silica tubes
 - Sorption agents: Activated carbon, dinitrophenylhydrazine
 - Distance between sampling probe and sorbent: 150 mm
 - Pump: Electronic pump
Gas sampler Type GS 312
(diaphragm pump with gas drying, digital indication of temperature)
 - Manufacturer: DESAGA, Heidelberg
 - Delivery capacity: 0.3 l/min up to approx. 5 l/min
 - External laboratories involved: RAG Ruhranalytik Laboratorium für Kohle und Umwelt GmbH, Henkel AG & Co. KGaA, ANECO Institut für Umweltschutz GmbH & Co.

4.2.2.4 Analytical determination

The Dräger activated charcoal tubes were assayed by gas chromatography in accordance with VDI Guideline 3865, sheet 3.

The DNPH tubes were eluted with acetonitrile/HCl and subsequently assayed by liquid

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chromatography (DIN ISO 16000).

The Dräger silica tubes were assayed by gas chromatography (DIN EN 12673).

4.2.2.5 Process characteristics

The measurement uncertainties remained within the limits specified for the indicated test methods.

4.3 Particulate emissions

Not applicable

4.4 Odour emissions

4.4.1 Measurement method / VDI Guideline

Object of measurement: olfactometric units. A part-stream is extracted from the exhaust gas via a probe and is drawn into Nalophan bags with the aid of a vacuum device. The bags are then sealed and transported to the measuring room, where they are assayed by a panel of odour assessors (test persons) using a dynamic olfactometer in accordance with DIN EN ISO 13725 (dilution based on the gas flow principle). To this end, the odorant samples are diluted with neutral air in a step-by-step process and are presented to the test persons via breathing masks.

4.4.2 Sampling equipment

- **Mechanical design (sampling train)** Probe / short PA hose / sample bag / vacuum tank / pump
- **Specification of major parts**
 - Sampling probe: Stainless steel probe
 - Sample bag: Nalophan NA©
 - Pre-filter: Not required
 - Pump: Electronic pump
 - Type: Gas sampler Type GS 312
 - Manufacturer: DESAGA, Heidelberg
 - Delivery capacity: 0.3 l/min up to approx. 5 l/min

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4.4.3 Analyzer / olfactometer

Manufacturer : Ecoma Mannebeck
 Type: TO 7
 Details see **Attachment:** Equipment specification

4.4.4 Group of test persons

One group of 4 people

4.4.5 Evaluation of the samples

On site, in the separate measuring room

4.4.6 Number of measurement series 3 series per bag

4.4.7 Presentation time 2.2 s

4.4.8 Breaks for the group of test persons Individual

4.5 Toxic dust constituents (and substances passing through the filter)

Not applicable

5 Plant status during the measurements**5.1 Production plant**

- Mode of operation: Continuous
- Throughput / capacity: Care was taken to ensure typical production conditions during the measurements
- Charge materials / fuels: Standard situation
- Characteristic parameters: Cannot be presented, the volume of molten aluminium plays a predominant role

5.2 Exhaust gas purification plant

Bag filter for dust separation.

6 Summary of results and discussion

6.1 Evaluation of operating conditions during the measurements

See 2.3.2.

6.2 Results

6.2.1 Concentration of sources

	Knock-out station sand reclamation line 1	Knock-out station sand reclamation line 2	Amine scrubber (core making)	Moulding shop line 1	Moulding shop line 2
Identification	MP2	MP1	MP4	MPB	MPA
Master volume flow during operation (m ³ /h)	128825	22862	46924	3542	4186
SO ₂ (ppm)	0.2	0.7	0.5	0.3	0
CO (ppm)	2.2	1.4	0.9	1.4	1.9
FID (ppm)	1.2	1.9	18	1.2	1.4
Odour Z ₅₀ (GE/m ³)	170	130	67	24	48
Odour threshold (d <i>B</i>)	22.3 ± 1.0	21.3 ± 1.5	18.8 ± 1.2	13.8 ± 1.5	16.8 ± 1.5
Formaldehyd (µg/m ³)	18	2.3	< 1.0	7.7	25
Benzene (mg/m ³)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Toluene (mg/m ³)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Ethylbenzene (mg/m ³)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Xylene (mg/m ³)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Naphthalin (mg/m ³)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Phenol (µg/m ³)	< 2	16		35	11
o-Cresol (µg/m ³)	< 2	7		7	< 2
m-Cresol (µg/m ³)	< 2	< 2		< 2	< 2
p-Cresol (µg/m ³)	< 2	< 2		< 2	< 2

6.3 Discussion

The selected measuring points on the roof of the departments pouring, sand reclamation and core making are the points of highest emissions of odours and hazardous gases of the aluminium foundry. Odours and all the hazardous gases which could be expected and could be relevant have been measured.

The concentrations of odours in contained sources emissions as well as in diffuse sources emissions is 24 – 170 OU per m³ (Z₅₀ value in mg OU per m³).

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At pilot foundry the highest odour mass flow is at knock out station and sand reclamation line 1 (measuring point MP2): 22 MOU per hour.

The concentrations of hazardous substances as Benzene, Toluene, Xylene, Ethylbenzene and Naphtalene are low: at all measuring points < 0.04 mg per m³.

Regarding Phenol, Cresol and Formaldehyde the highest concentrations are in the emissions of the moulding shop and at the knock out station – but absolutely the value is low too: < 0.002 - 0.035 mg Phenol per m³ and a maximum of 0.025 mg Formaldehyde per m³.

Düsseldorf, 02nd December 2014,

IfG - Institut für Gießereitechnik gGmbH - Measurement Centre –