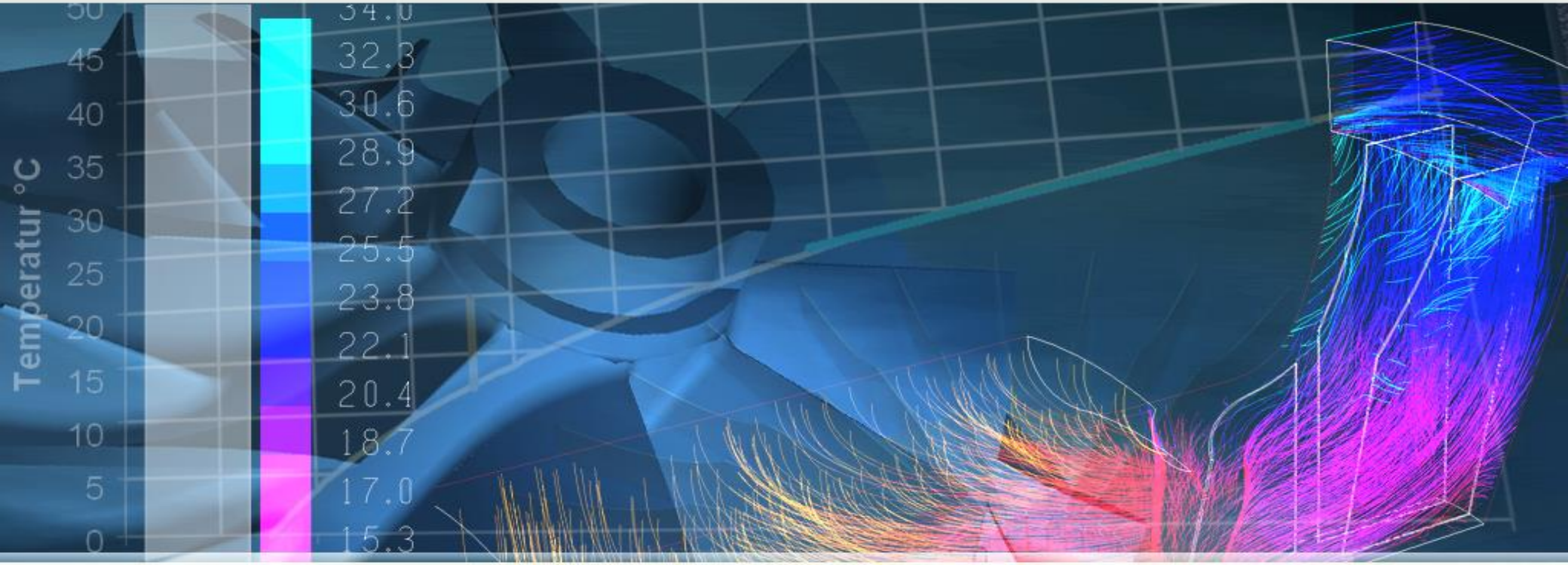
Untersuchungen zu neuen Emissionsminderungstechniken bei Anlagen der Ziffer 3 der TA Luft in Sachsen

ILK Dresden



Institut für Luft- und Kältetechnik Dresden gGmbH

Verbesserung der Abgasreinigung in der Nichteisenmetallproduktion durch neue Filtertechniken auf Basis von Polfaser- Vliesstoffen

R. Heidenreich[1], L. Patzig[2], A. Ränger[2], F. Gebler[3]

[1] Ralf Heidenreich, Institute for Air Handling and refrigeration, Dresden,
[2] Feinhütte Halsbrücke GmbH, Halsbrücke
[3] Entstaubungsgeräte Pulsnitz GmbH; Pulsnitz , Germany

7. Kolloquium – BVT/Stand der Technik
30.11.2016, SAB Dresden

Feinhütte Halsbrücke - “Hohe Esse”

- **Reingas wird über die “Hohe Esse” abgeleitet**
- **höchstes Ziegelbauwerk in Europa - 140 m**
- **technisches und industriegeschichtliches Denkmal**

Begriffsbestimmung:
Anlagen der Ziffer 3 der 4. BImSchV Anhang 1 / TA Luft

Anlagen der Nr. 3: Stahl, Eisen und sonstige Metalle einschließlich Verarbeitung

Nr. in TA Luft mit Erwähnung	Anlagenbeschreibung
Anlagen der Nummer 3.1:	Anlagen zum Rösten, Schmelzen oder Sintern von Erzen
Anlagen der Nummer 3.2:	Anlagen zur Gewinnung, Herstellung oder zum Erschmelzen von Roheisen oder Stahl
Anlagen der Nummer 3.3:	**Anlagen zur Herstellung von Nichteisenrohmetallen**
Anlagen der Nummer 3.4:	**Anlagen zum Schmelzen, zum Legieren oder zur Raffination von Nichteisenmetallen**
Anlagen der Nummer 3.6:	Walzanlagen
Anlagen der Nummern 3.7 + 3.8:	Gießereien
Anlagen der Nummer 3.9:	Anlagen zum Aufbringen von metallischen Schutzschichten
Anlagen der Nummer 3.10:	Anlagen zur Oberflächenbehandlung von Metallen durch Beizen oder Brennen unter Verwendung von Fluss– oder Salpetersäure
Anlagen der Nummer 3.21:	Anlagen zur Herstellung von Bleiakkumulatoren

BGBl. I 2013, 975 - 996

Besondere Emissionsbeschränkungen

Nr. in TA Luft mit Erwähnung	Besondere Grenzwerte
Anlagen der Nummer 3.1:	1 mg/Nm³ Blei, 0,4 ng/Nm³ PCDD/F, 0,4 g/Nm³ NO_X
Anlagen der Nummer 3.2:	10 mg/Nm³ Staub, 5 mg/Nm³ Elektrostahl
Anlagen der Nummer 3.3:	**5 mg/Nm³ Staub, Metalle Kl. II 1 mg/Nm³, Metalle Kl. III 2 mg/Nm³, 0,4 ng/Nm³ PCDD/F**
Anlagen der Nummer 3.4:	
Anlagen der Nummer 3.6:	0,4 g/Nm³ NO_X
Anlagen der Nummern 3.7 + 3.8:	0,15 g/Nm³ CO, 5 mg/Nm³ Benzol, 5 mg/Nm³ Gesamt-C, 0,5 g/Nm³ SO_X
Anlagen der Nummer 3.9:	5 mg/Nm³ Staub, 10 mg/Nm³ HCl
Anlagen der Nummer 3.10:	0,7 g/Nm³ NO_X bei Altanlagen
Anlagen der Nummer 3.21:	1 mg/Nm³ Schwefelsäuredämpfe

Neue Anforderungen nach den Referentenentwurf der TA Luft vom 09.09.2016

Nr. in TA Luft mit Erwähnung	Besondere Grenzwerte

Anlagen der Nummer 3.3/ 3.4:	• **5 mg/Nm³ Gesamtstaub**
	  • **4 mg/Nm³ für Blei- Anlagen**
	• **Metalle Kl. II 1 mg/Nm³**
	  • **0,02 mg/Nm³ Hg und – Verbindungen**
	  • **1 mg/Nm³ Zn bei Zink- Anlagen**
	• **40 mg/Nm³ Gesamt- C**
	• **0,1 ng/Nm³ PCDD/F + PCB**

Outline

- Motivation
- Characteristics of exhaust gas and used filter media
- High-performance filter media manufacturing
- Filtration behavior and test results in flue gas
- Conclusions

Motivation

- **WHO published studies - significant shortening of lifetime in case of fine dust exposion**
- **European community has given new immission limits for fine dust directive 2008/50/EC „…cleaner air for Europe.“**
  - **20 µg/m³ of PM 2.5 fine dust shall be realized in ambient air until 2015 [additional reduction target 20 % (2020)]**
- **Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004**
  - **Target values for arsenic, cadmium, nickel and benzo(a)pyrene (Arsenic 6 ng/m³, Cadmium 5 ng/m³)**

Situation

1
- Immission is regulated by EC
- Dicreased level of heavy metals

2
- Feinhütte company in the south east of Germany actually meet german emission limit; future & neighborhood: decrease emission
- Feinhütte is a small enterprise – high invest difficult

3
- New additional filter unit – invest cost > 300 k EUR
- Demonstration project – founding by German government 2010/11

Filter unit with new material for agglomeration of fine dust

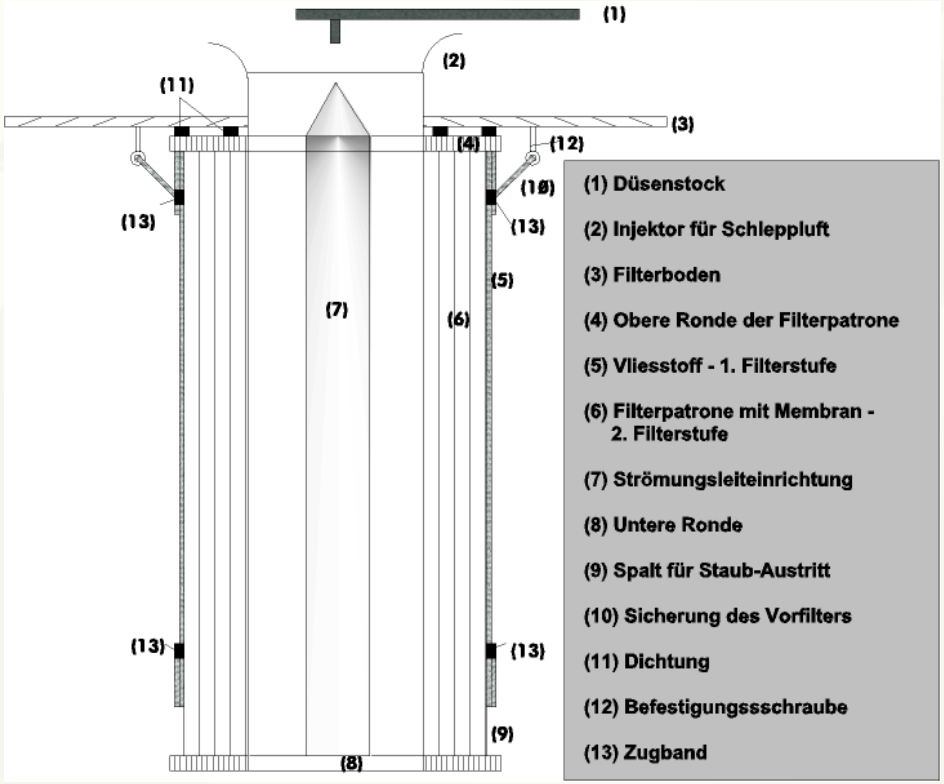
Results of monitoring

Mean	week 1	week 2	week 3	week 4	week 5
Pressure [Pa]	568	549	589	706	735
Temperature [°C]	87	90	92	89	88
Gas velocity [m/s]	19.2	18.7	19	20.5	20.7
Maximum value					
Temperature [°C]	117	124	123	126	125
Gas velocity [m/s]	21.8	22.2	22	22.2	22.3

Rohgasbedingungen für Filterstufe

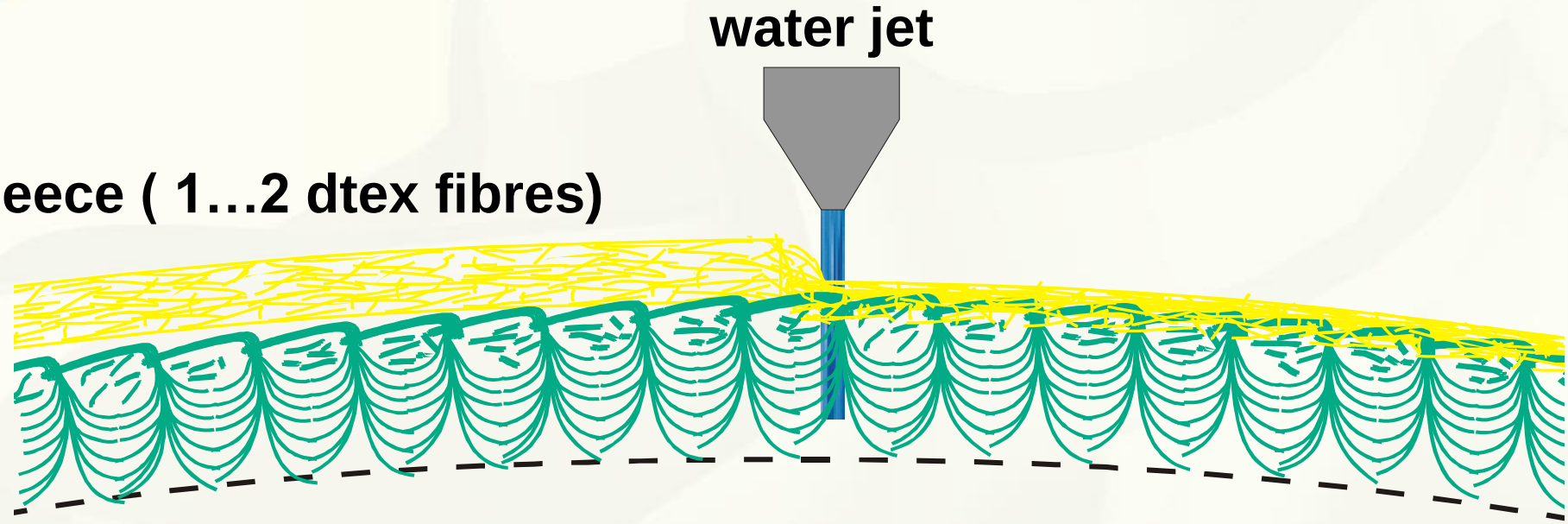
- **Process temperature:** **90 °C, 130 °C peak**
- **Gas conditions:** **O_2-concentration changes (15 –21%)**
  variability in humidity,
  hydrolysis risk
- **Raw gas :** **lower than 0,01 g/m³, fine dust**
  (most of particles: < 0,5 µm,
  lead particles: 0,01 – 1 µm)
  to low for dust cake formation
  temperature < 80 °C

Filter stage & filter element



- Filter stage 1.
  Agglomeration & prefilter made by water jet technology patent DE 198 04 940 B4 / DE 195 41 252 C1)
- Filter stage 2.
  Filtercartridge als compleate unit; see Patent DE 42 42 991

Manufacturing of a new type of filter material – Hycoknit ™



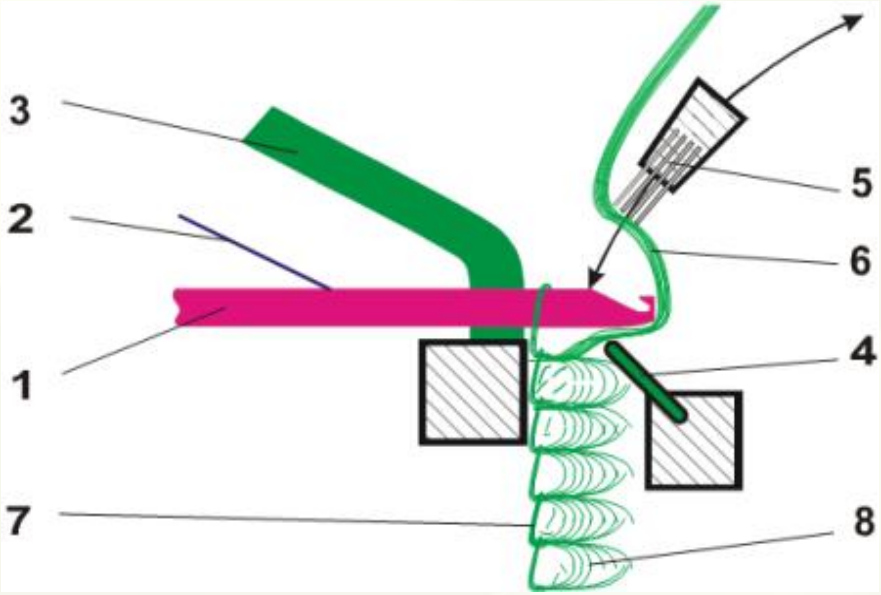
Compound of 2 different material types

stitch-bonded **nonwoven**

(7…10 dtex fibres)

- **high permeability**
- **homogenous**
- **open structure**

Sketch of the manufacturing process for high loft layer



- 1 Needle
- 2 Closing wire
- 3 Knock-over bit
- 4 Support rail
- 5 Brush
- 6 Fibrous web
- 7 Fibrous stitch
- 8 Nap pleats

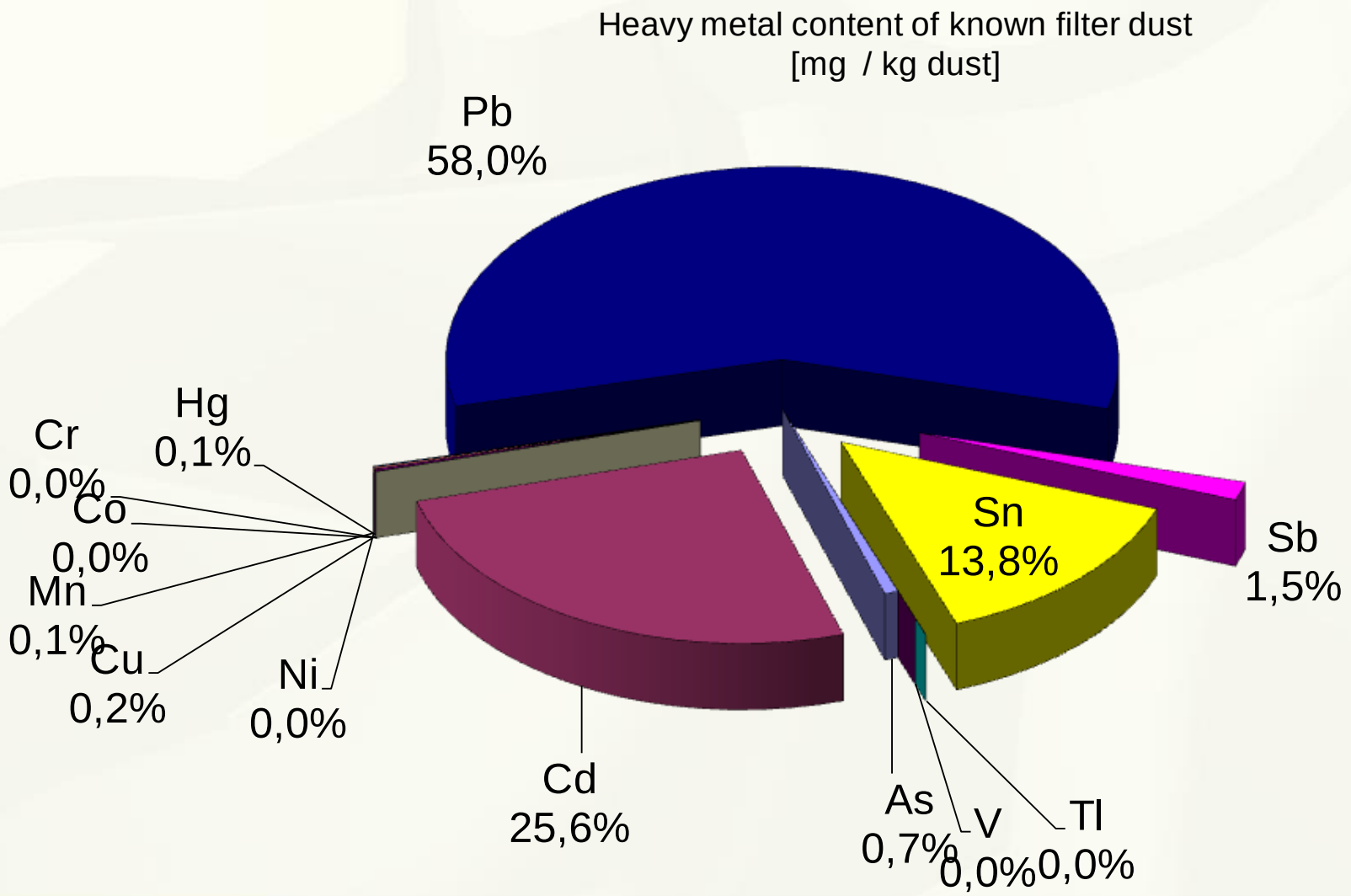
Structure of Hycoknit filter material

- **Pile structure**
- **Fine pore layer**

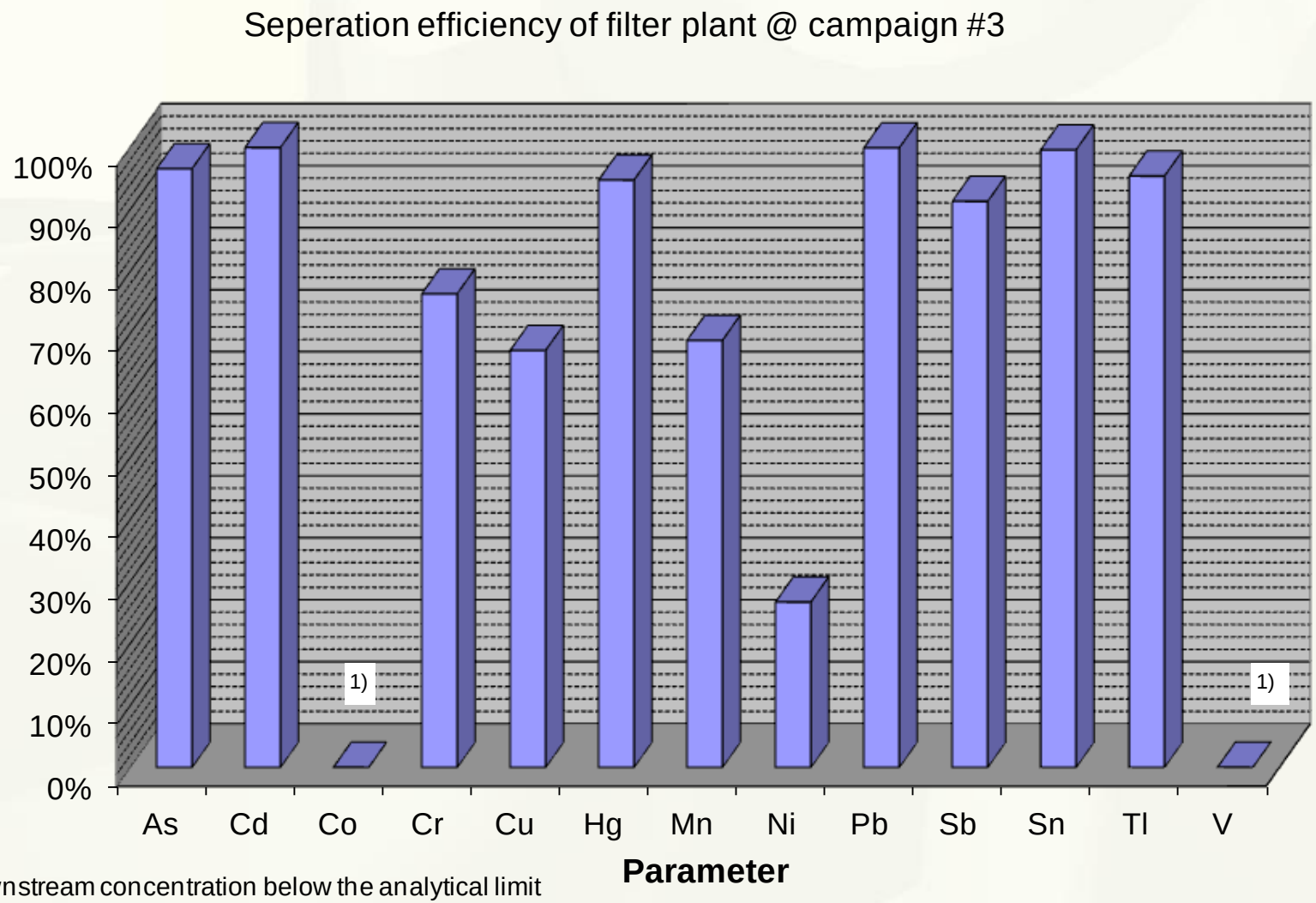
Pretest in a bypass gas volume

Filter cartridge & stabebillity

Composition of dust and its spreading to the metal elements

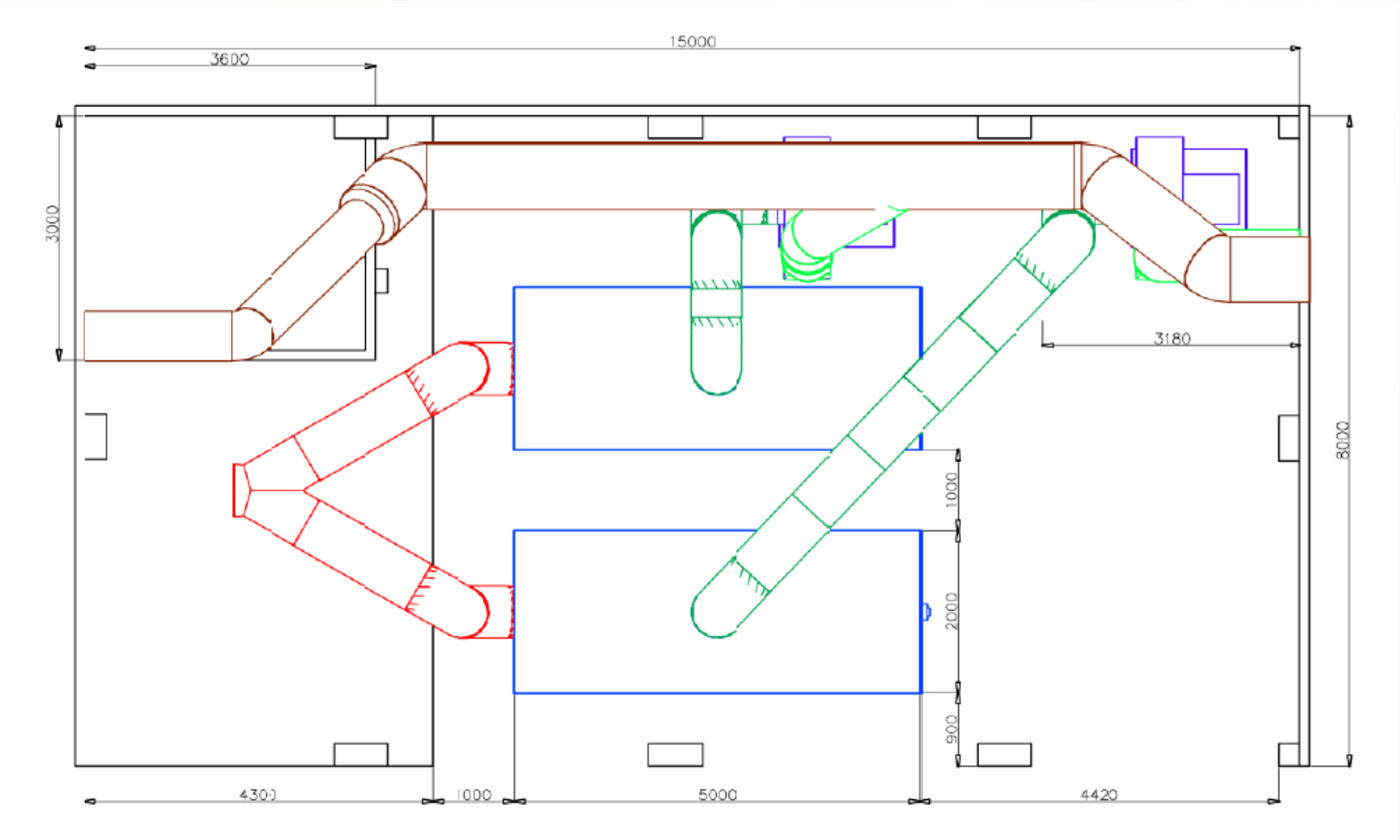


Separation efficiency for filter unit



1) downstream concentration below the analytical limit of determination

Plot of plant configeration

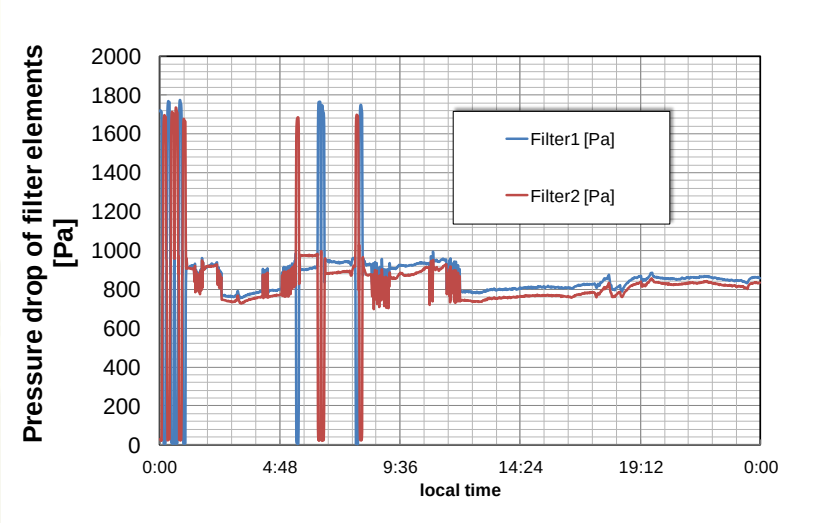


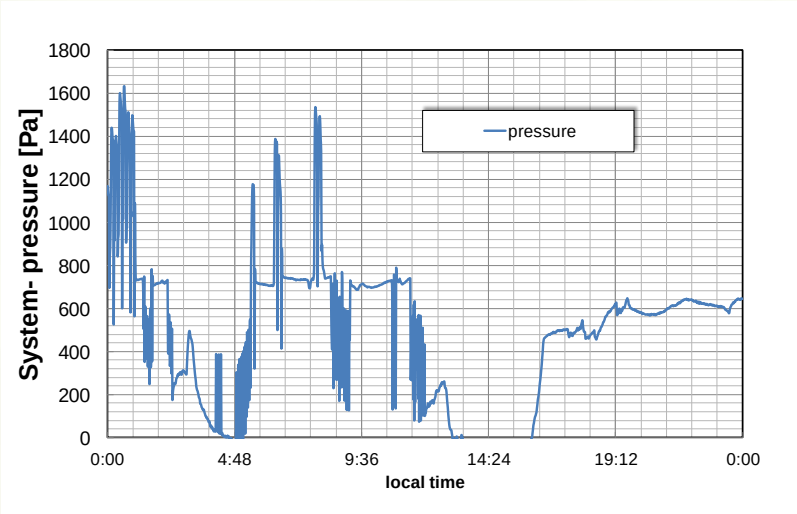
Filter configuration

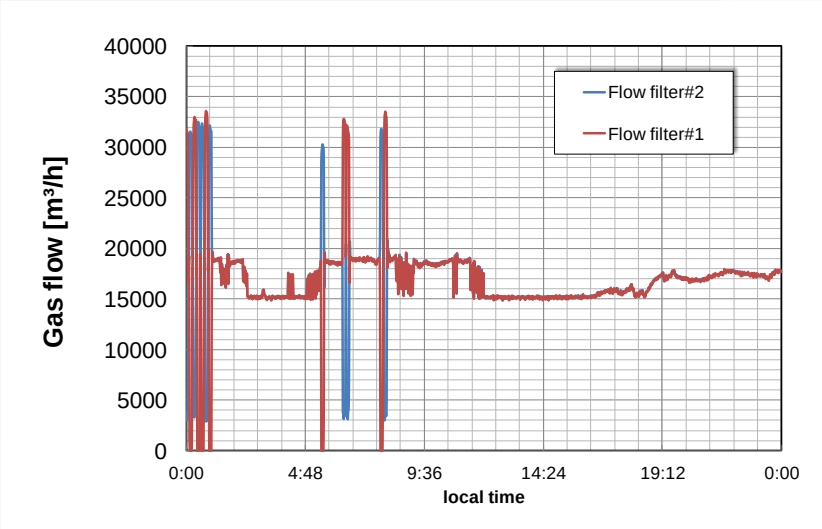
Total length of cartridge:	1500 mm
Upstream diameter :	330 mm
Downstream diameter:	210 mm
Filter material:	PS/ PTFE
Filter housing:	2
Air flow:	40.000 m^3/h each filter
Number of cartridges:	30 / each housing
Process gas:	30.000 m^3/h
Cooling air:	20.000 m^3/h

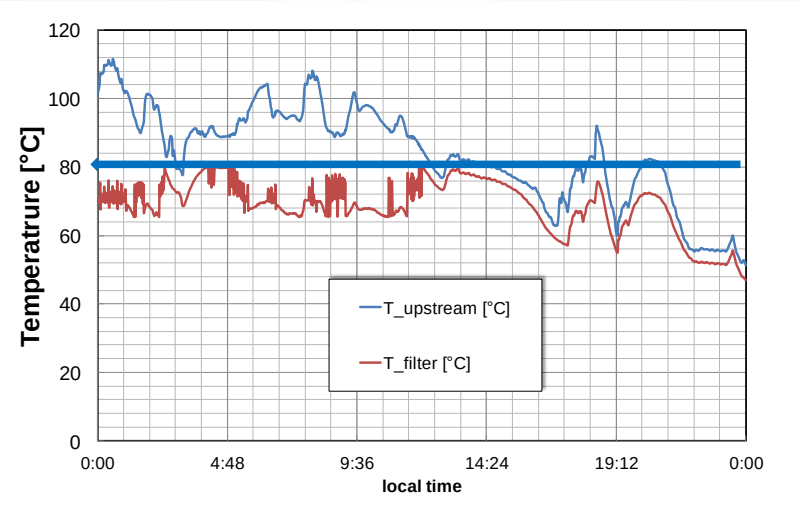
Realized demonstration unit and filter control unit

Filter parameter for one day





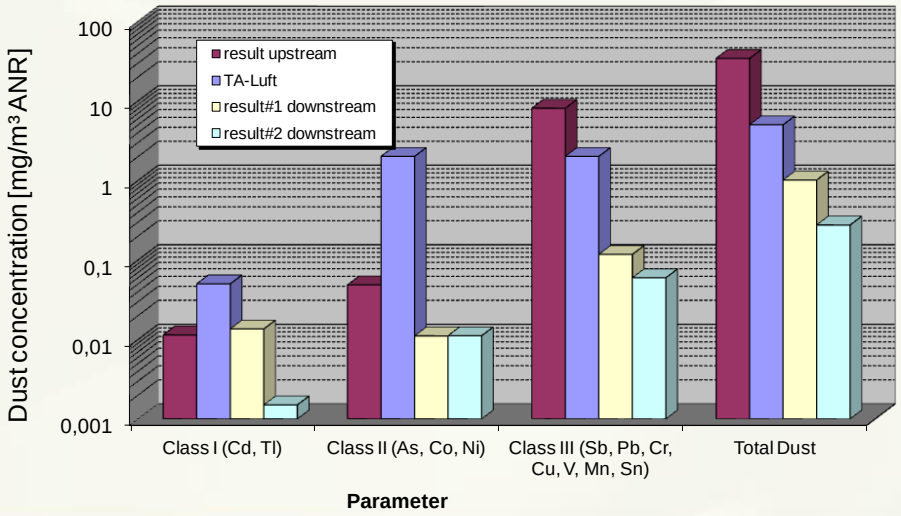


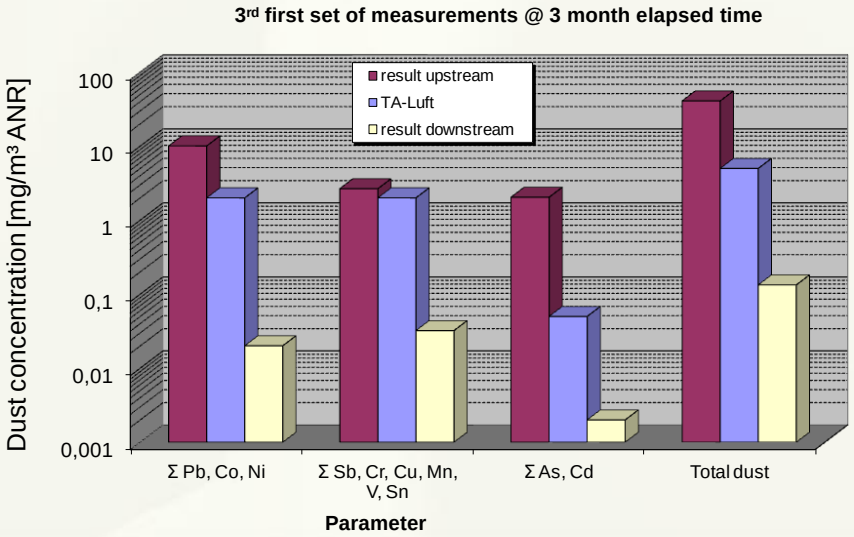


Results of measurement compared to emission limit – high dust product

Measurement with extream high dust load in raw gas

Parameter	German Limit mg/m³	Result downstream mg/m³	Result upstream mg/m³	seperation efficiency %
Class I (Cd, Tl)	0.05	0.0009	0.4	99.8%
Class II (As, Co, Ni)	2	0.01	0.02	41.3%
Class III (Sb, Pb, Cr, Cu, V, Mn, Sn)	2	0.02	2	98.9%
Total dust	5	0.1	10	98.2%





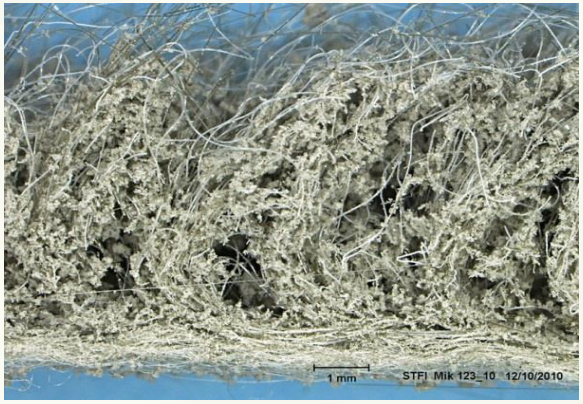
Conclusions

- **Specific filtration conditions in flue gas cleaning after drum furnaces in non-ferrus metal production require efficient and resistant filter media for deposition of fine dusts.**
- **Adjustment of fiber selection and media structure to operating conditions is necessary.**

Solution:

New filter media HYCOKNIT® of high performance fibers characterized by

a high voluminous, air permeable pile structure for dust deposition



- **The media structure prevents a closed, compacted dust cake with high filtration resistance. Heavy metal (Cd) reduction of 98 % reached.**

Acknowledgement

We thank the German ministry of environment and the environmental agency for the financial support of the demonstration project (UBA MBc3-00128).

Thank‘s to my coauthors.

http://www.umweltinnovationsprogramm.de/sites/default/files/benutzer/36/dokumente/abschlussbericht_final.pdf

ILK Dresden

& Thank you for attention ☺ .

Institut für Luft- und Kältetechnik Dresden gGmbH
Institute for Air handling & refregeraton – non profit org.

Dipl.- Ing. Ralf Heideneich

Tel.:	+49 351 / 4081-720
Fax:	+49 351 / 4081-725
E-Mail:	umwelt@ilkdresden.de
www:	www.ilkdresden.de

Any questions ?