Testing of Cleanable Filter Media - Status and Perspectives

Status of ISO 11057:2011 - "Test method for filtration characterization of cleanable filter media"

Dr. Peter Gäng

FilTEq
Filtration Testing Equipment & Services GmbH

Amthausstr. 14, D-76227 Karlsruhe, Germany

Tel.: (+49)-(0)721-406544
Fax: (+49)-(0)721-406545

www.filteq.de
office@filteq.de

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Abstract

ISO 11057:2011 presents a flat sheet test method for the comparative characterization of pulse-jet cleanable filter media, to be used in filter elements (e.g. bag filters, pocket filters, cartridge filters) applied in dry gas cleaning under standardized test conditions. It comprises the main features of national standard VDI/DIN 3926 (Germany 1994 and 2004) and ASTM D6830-02 (USA 2008). It also replaces national standards of other ISO p-members such as JIS Z 8909-1 (Japan 2005) and GB/T 6719 (China 2009).

The reference rig in ISO 11057 is identical with the rigs defined in VDI3926 and ASTM D6830-02. The given set-up and test methods have been used worldwide for more than 20 years now.

There is a variety of reasons for using this testing method, such as research, quality control and marketing, by most major players in the filtration business.

The number of test-rigs around are not exactly know but FilTEq GmbH alone has delivered more than 50 installations worldwide.

Inevitably this lead to the question how reproducible and reliable the results are, which are produced using this test method and requires the installation of calibration and maintenance routines.

This presentation is dealing with the measures to be taken in order to gain reliable and comparable result when using different test-rigs. It also gives an outlook on further developments for testing cleanable filters in the laboratory and in the field.

ISO standard 11057:2011 was developed in

ISO TC146 SC1 "Air Quality" – Working Group 23

It is presenting a test method for the comparative characterization of pulse-jet **cleanable filter media**

The operation of cleanable filters is simulated using round shaped **flat filter samples**

The purpose of testing is to gain information about the operational performance **and** the particle emission

This test is generating data for an indicative comparison of filter media regarding their operational behavior **not** an accurate representation of likely field performance

- although, correlation to field results are possible

Slide 3

History of the development of ISI11057

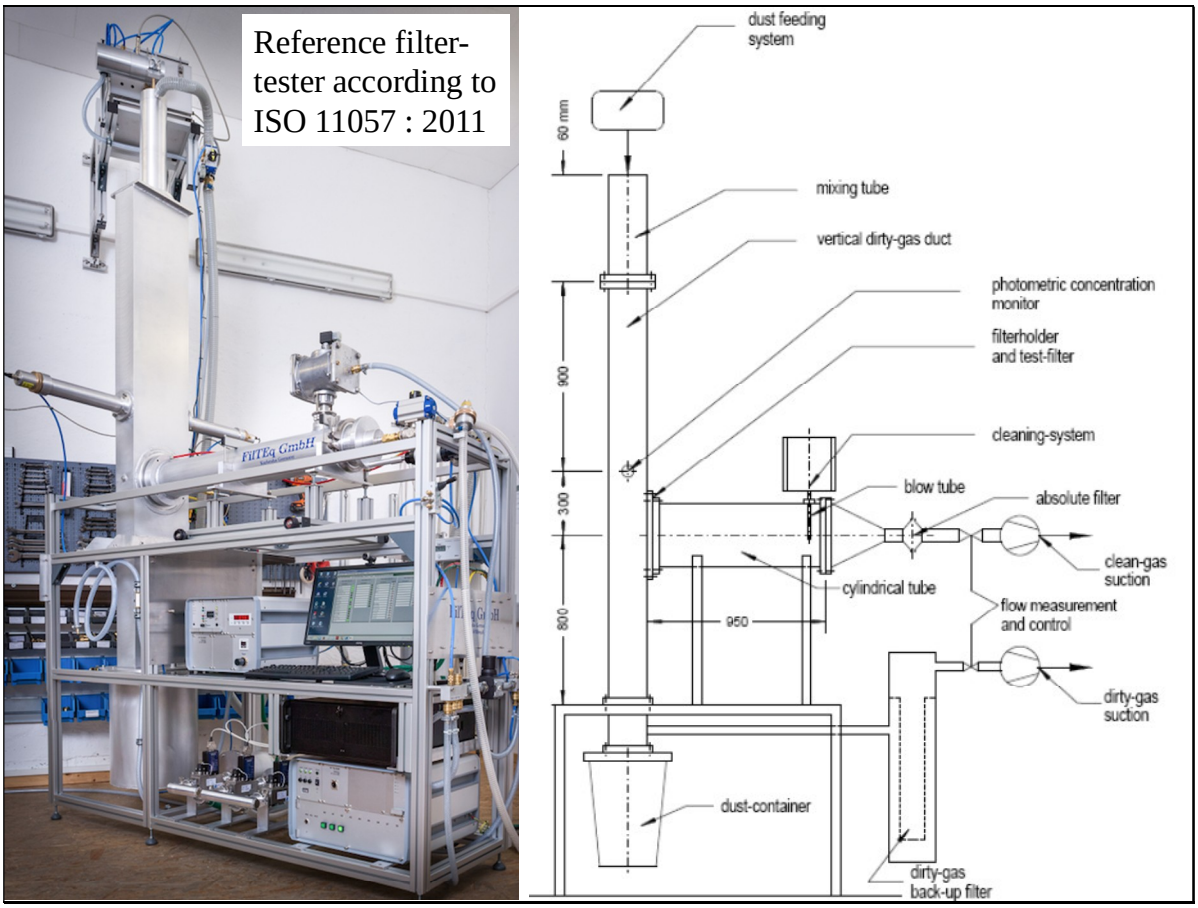
Germany
VDI/DIN 3926 was first published in 1994
Update of VDI/DIN 3926 was published in 2004
-> filtration velocity reduced from 3 to 2 m/min
-> only one test dust (alumina Pural NF)
-> "aging" phase introduced, 10,000 cleanings / 5 sec period

USA
First rig according to VDI/DIN 3926 installed in 1998
Used in EPS's ETV project for verification of BFP
Experience lead to new ASTM-standard D6830-02 published in 2002
- same operational conditions as VDI/DIN 3926
- also aging phase plus cleaning on demand (1000 Pa)
- additional 6 h measuring phase using PM 2.5 impactor

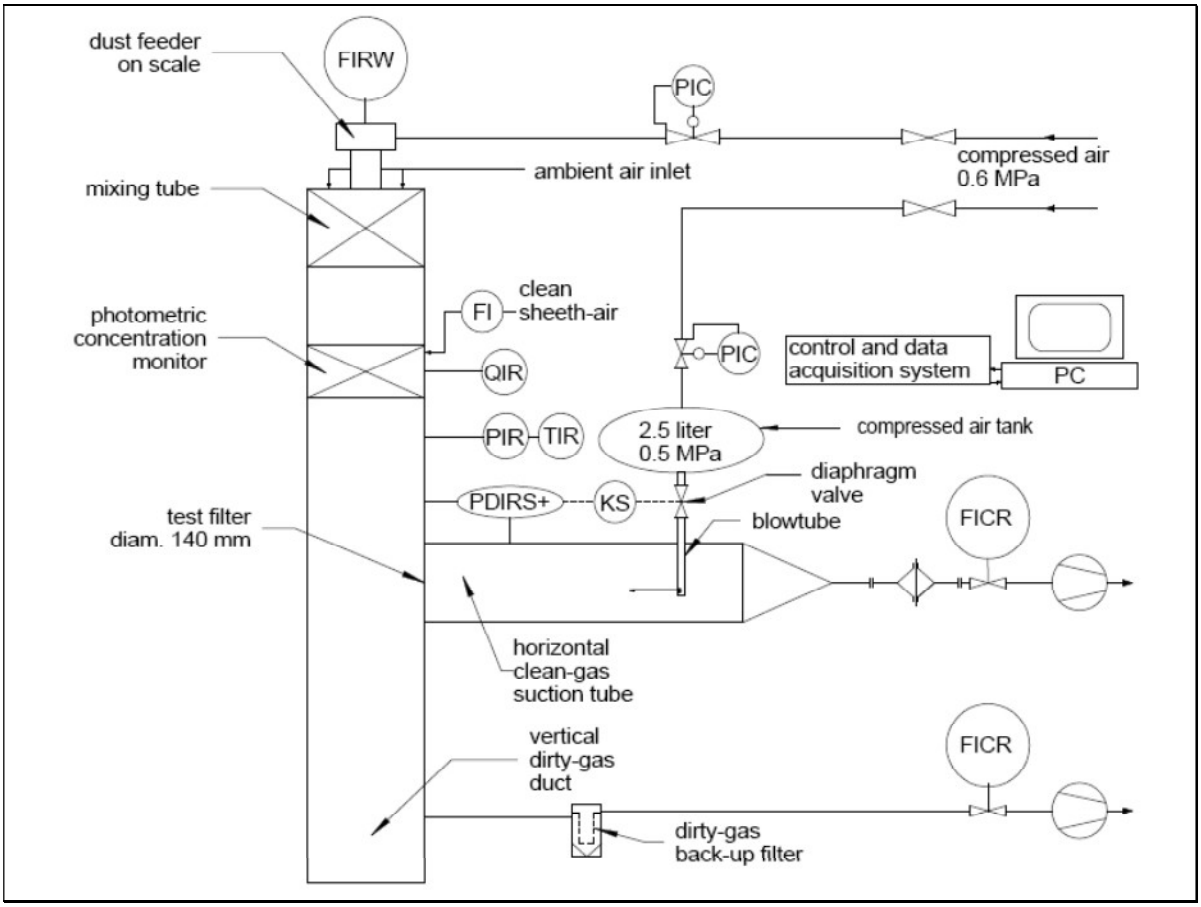
Japan: -> new national standard JIS 8909-1 (2005)
China: -> GB 12625 (Draft 2005)

→ ISO 11057:2011 (published in May 2011)

Slide 4

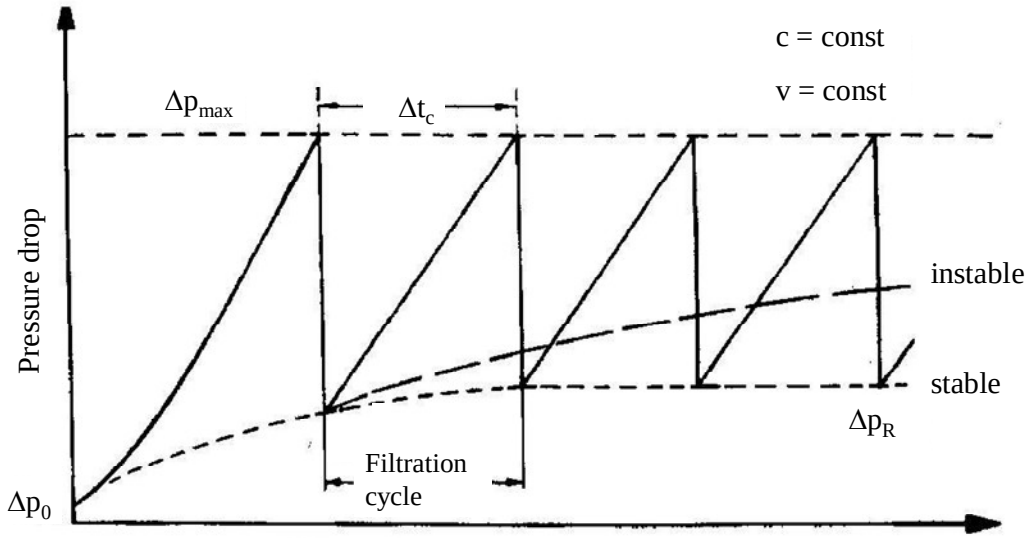


Slide 5



Slide 6

Testing method bases on the basic behavior of cleanable filter media as shown in slides 7 and 8



Schematic course of pressure drop of a cleanable filter for stable and instable operation

$\Delta p = \Delta p_1 + \Delta p_2$

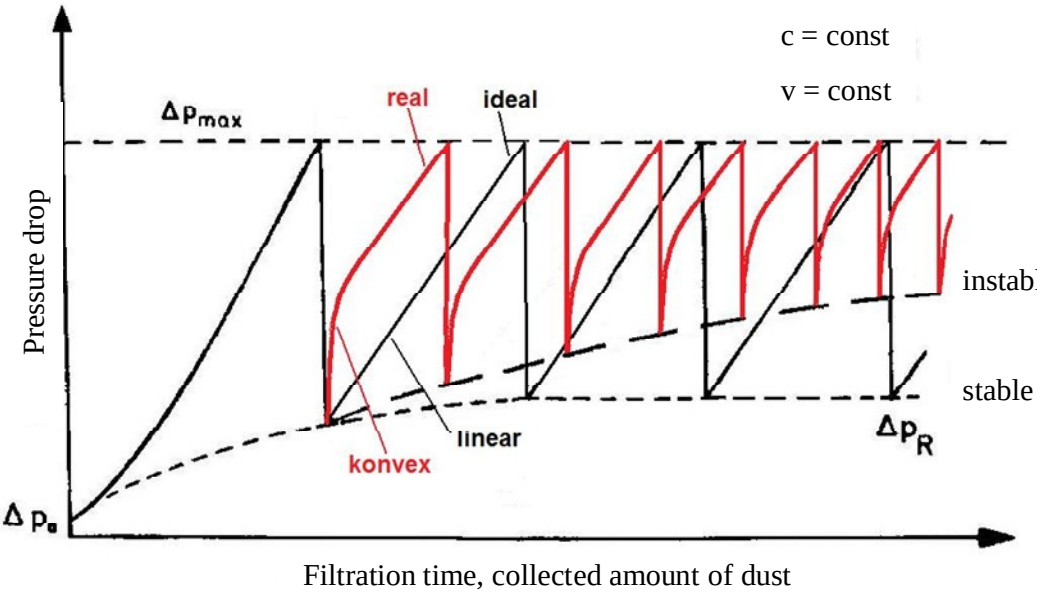
$\Delta p = K_1 \mu v + K_2 \mu w v$

$w = c v t$

$\Delta p = K_1 \mu v + K_2 \mu c v^2 t$

Slide 7

areal dust mass w in kg/m2; K1 in 1/m; my in Pa s, K2 in m/kg; filtration velocity v in m/s; pressure drop △p in Pa – linear pressure drop curves in slide 7 for forming of undisturbed cake. The REAL behavior is shown in slide 8, pressure drop curves rising sharply after cleaning, showing a convex shape, becoming linear when again undisturbed filter cake is built



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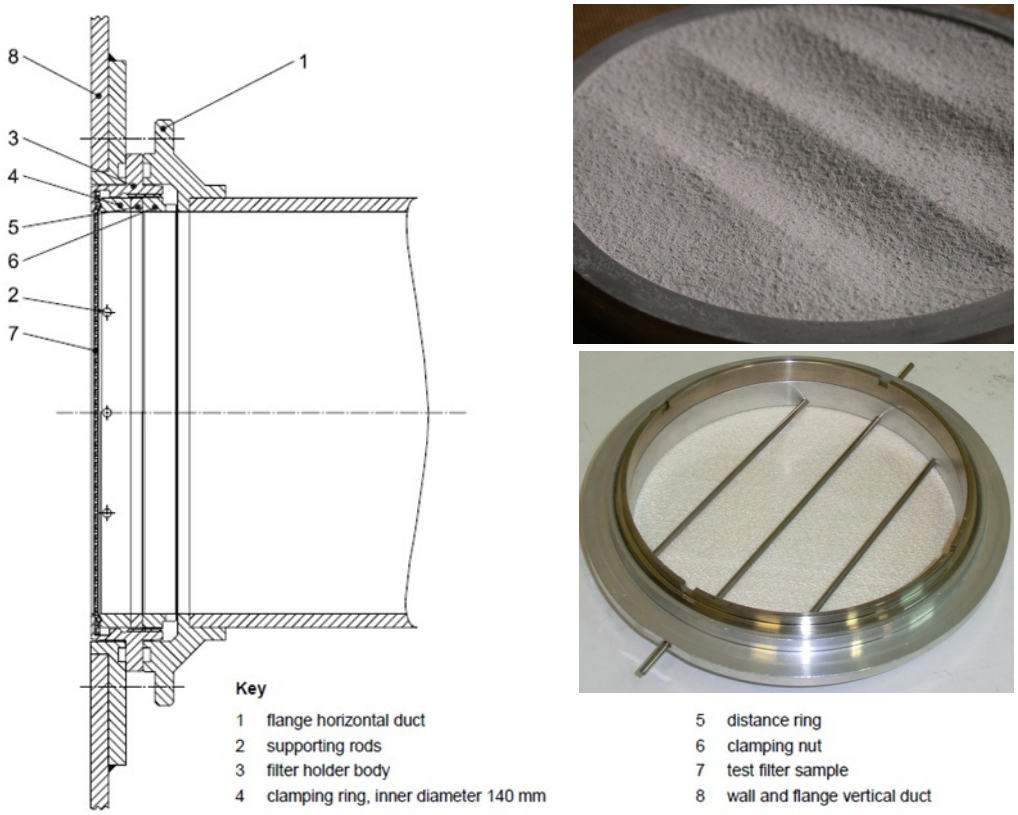


Key

1 flange horizontal duct
2 supporting rods
3 filter holder body
4 clamping ring, inner diameter 140 mm
5 distance ring
6 clamping nut
7 test filter sample
8 wall and flange vertical duct

Reference: ISO 11057:2011(E)

Figure A.2 —Design of the filter sample holder for the standard reference apparatus

Slide 9

High speed video off cleaning pulse when cleaning of filter cake in the test rig

http://www.filteq.de/images/videos/FILTEQ-Short2b-cleaning-pulse.mp4

Other videos on website www.filteq.de

Measuring of characteristic data for the comparison and assessment of filter media

From the course of pressure drop over a number of cycles:

-> development of residual pressure drop

-> development of filtration and cleaning cycle time

and

- weight gain of the filter sample through residual dust mass
- dust penetration to the clean gas and clean gas concentration

Slide 10

Required test parameter tolerances

Table 4.1 — Primary test parameters and tolerances

Parameter	Unit	Value	Tolerance
Filter face velocity	m/min	2	± 3 %
Dust concentration presented to the sample filter	g/m^3	5	± 7 %
Test dust		Pural NF	mps approx. 4,5 µm
Pressure drop prior to pulse-jet cleaning	Pa	1 000	± 1 %
Tank pressure	MPa	0,5	± 3 %
Valve opening time (electric)	ms	60	may be adjusted to correct cleaning pulse duration, see 4.9.7 and Appendix A.9

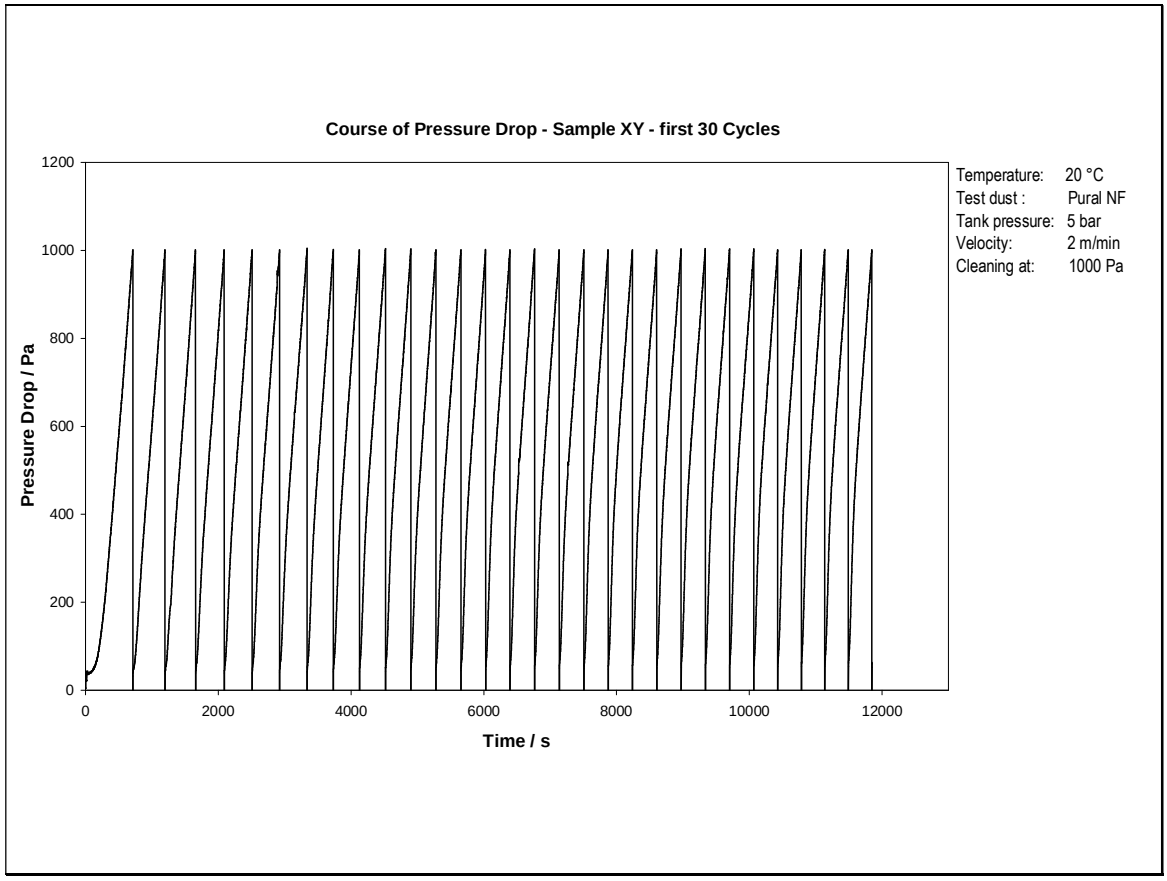
Slide 11

Table 5.1 — Sequence of the standard test phases

Measuring phases	Conditions	Determination of clean-gas concentration
Phase 1: conditioning	30 loading cycles with differential pressure controlled pulse-jet cleaning and a cleaning set-point of 1 000 Pa	yes
Phase 2: ageing	2 500 pulse-jet cleaning cycles at an interval of 20 s each	no
Phase 3: stabilizing	10 loading cycles with differential pressure controlled pulse-jet cleaning	no
Phase 4: measuring	2 hour loading cycle with differential pressure controlled pulse-jet cleaning and a cleaning set-point of 1 000 Pa	yes
Phase 5: optional measuring	2 hour loading cycle with raised cleaning set-point of 1 800 Pa	yes

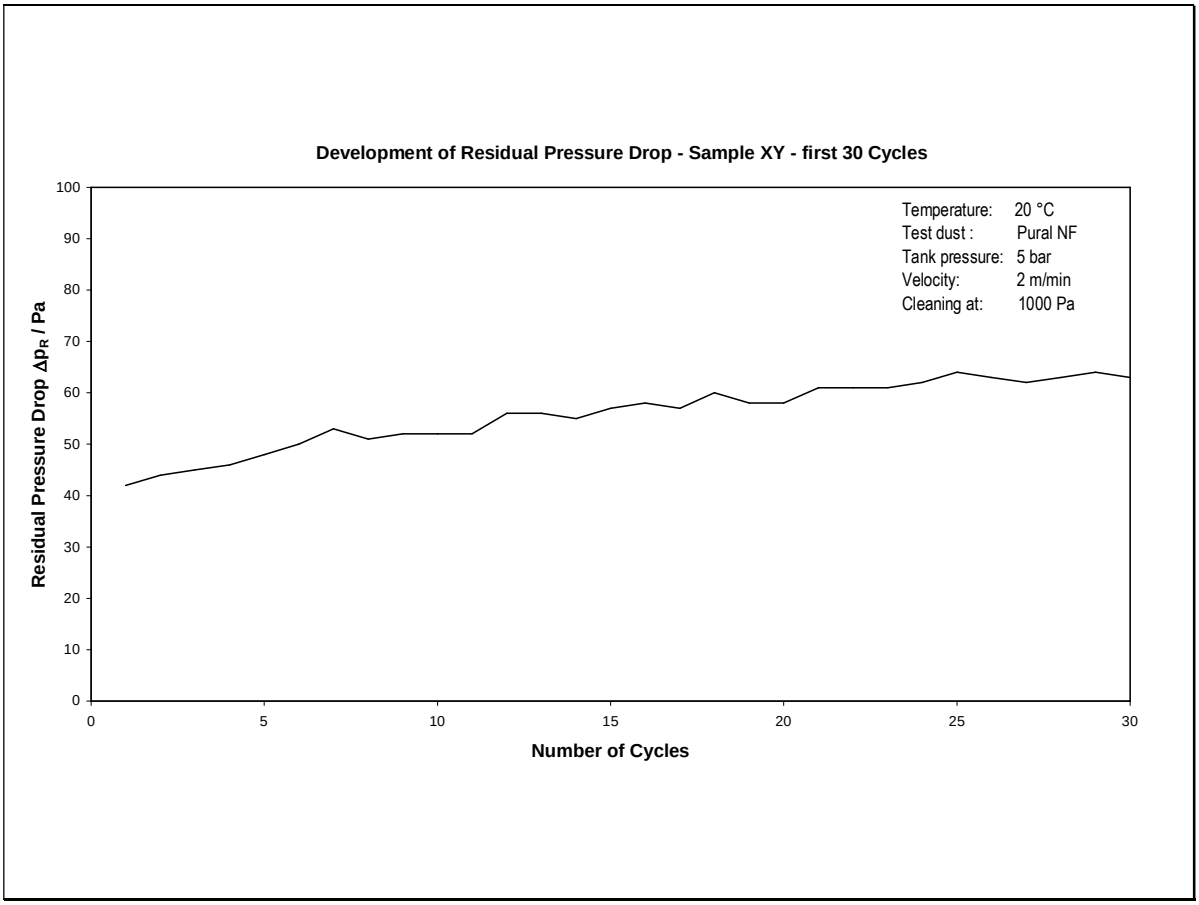
Slide 12

Typical pressure drop curves for the first measuring phase



Slide 13

Slides 14 and 15 extracted from the data file of slide 13



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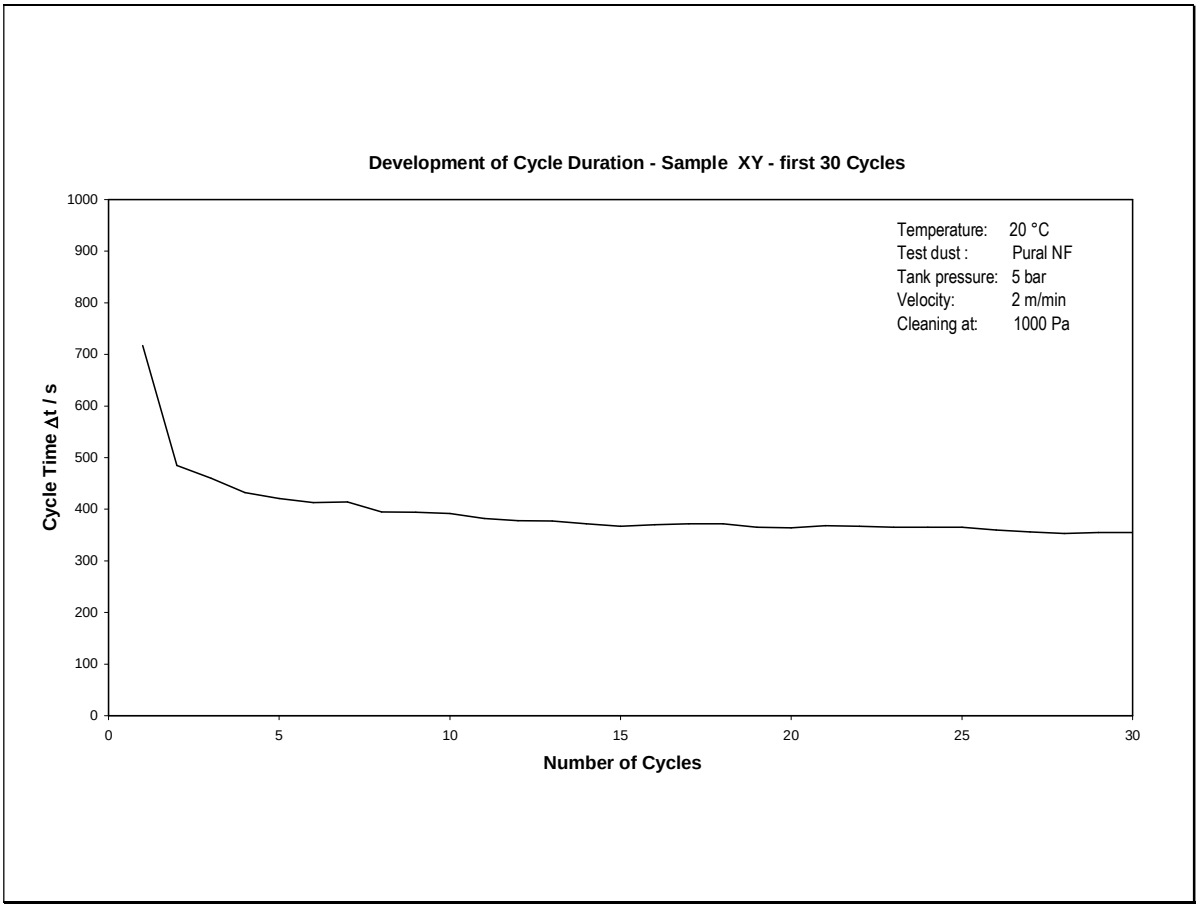
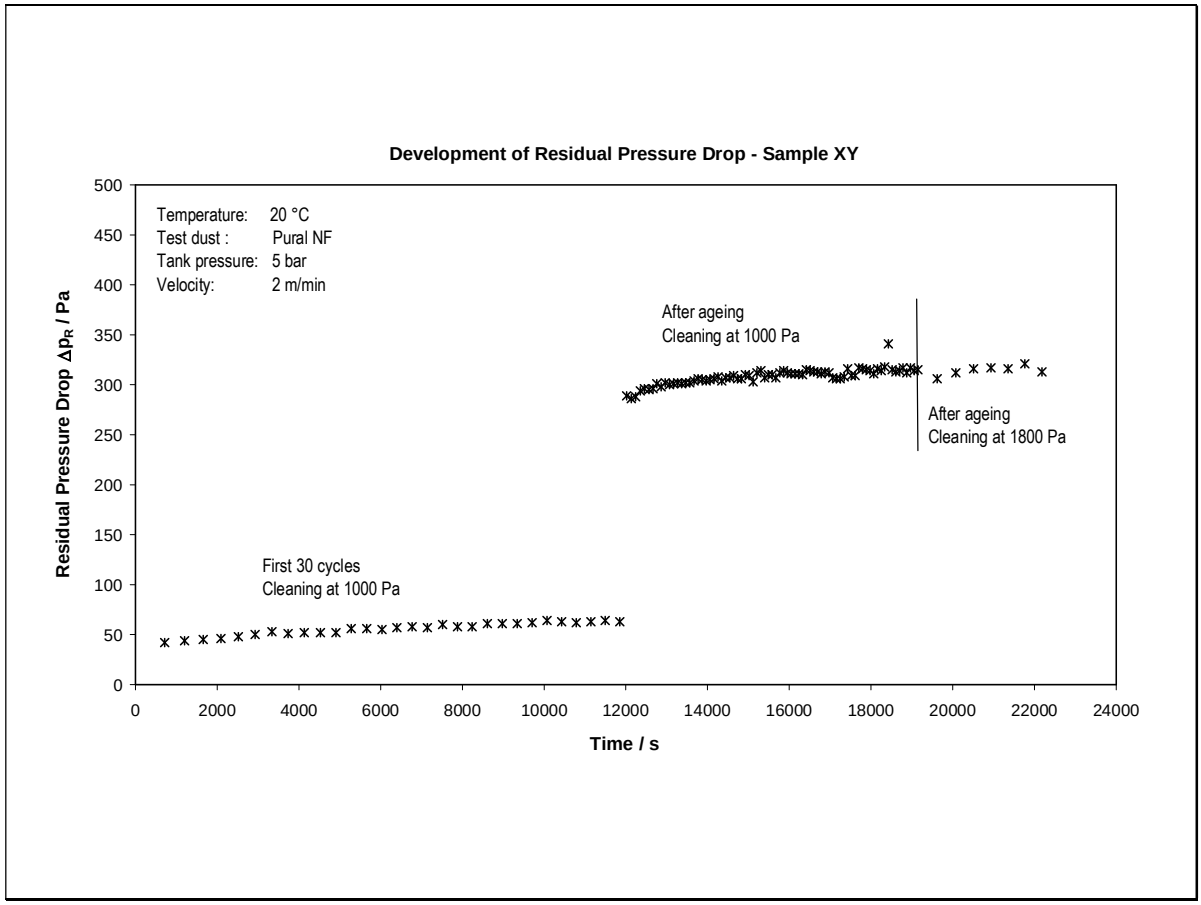
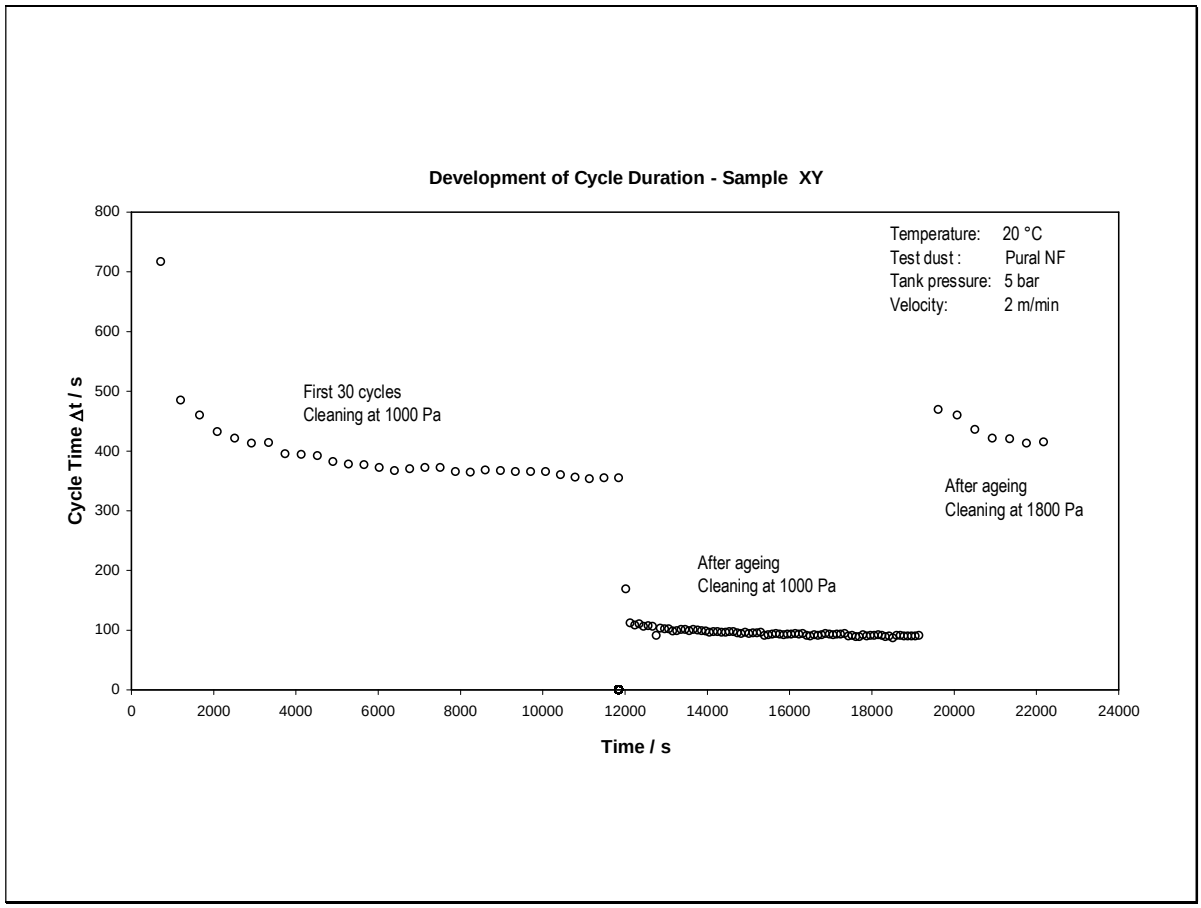


Slide 15

Proposed presentation of data for the complete test – slides 16 and 17

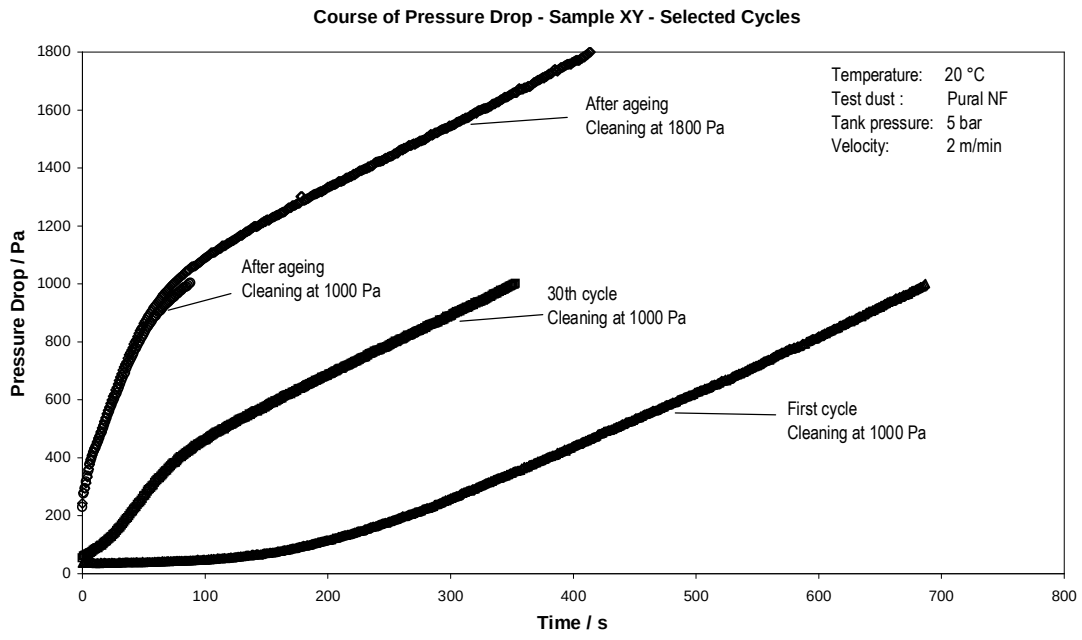


Slide 16



Slide 17

Representative pressure drop curves taken from different phases of the test



Slide 18

Summary for standard procedure

Measuring method and apparatus have proven to be a very useful and reliable tool to cope with all conceivable requirements so far

Results are in good accordance with experiences from industrial application

Extended and mobile versions can be used for field tests to gain data for design and optimization of the operation of filter plants

Slide 19

Additional possibilities and perspectives

- Testing at enhanced temperatures with heated versions of the rig
- Verify filter media by PM2.5 measurements using impactors or cyclones
- Testing of woven filter media using more gentle reverse flow air cleaning

Above points already frequently applied procedures

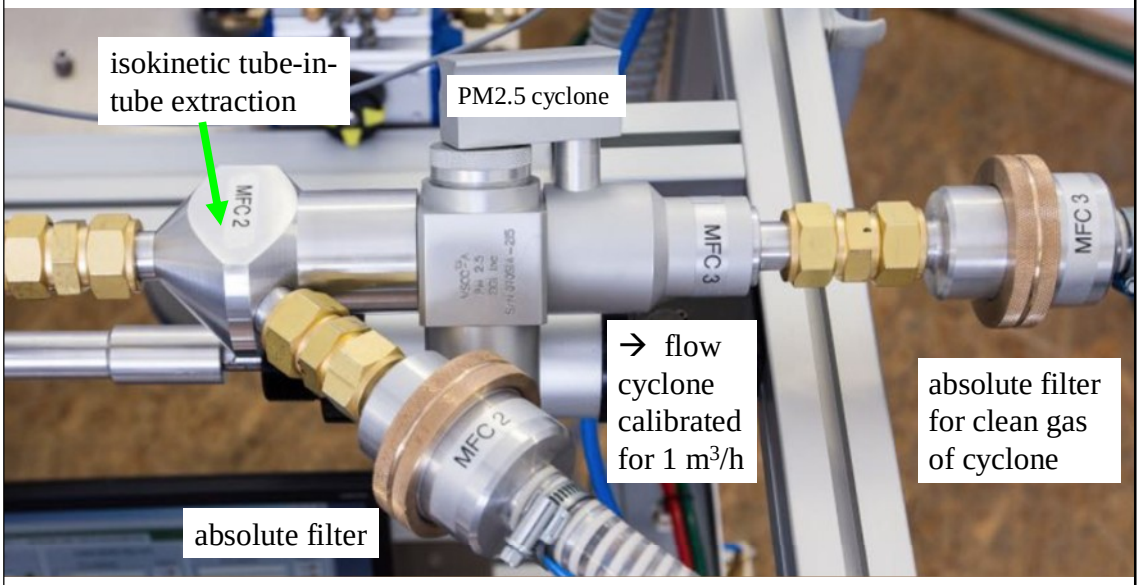
Future tasks:

- Measuring PM2.5 values using calibrated Optical Aerolsol Spectrometers (already done)
- Classification of different media according to their filtration performance (needs definition of classes)
- Assessment of cleanability and durability of filter media, taking into account the influence of reactive gases on fiber stability
  -> projection of bag life-time

Slide 20

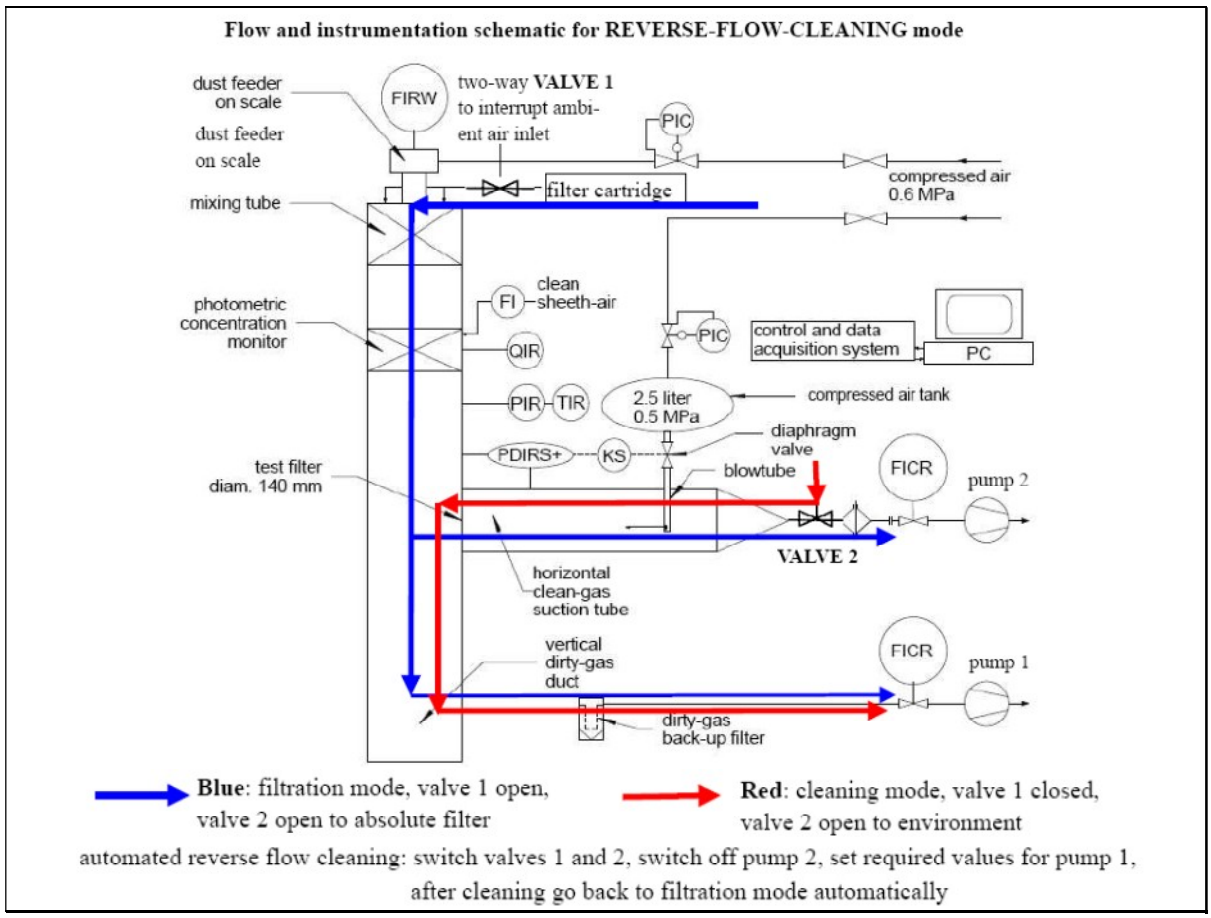
Verify filter media by PM2.5 measurements using a cyclone

Example for PM2.5 measurement set-up



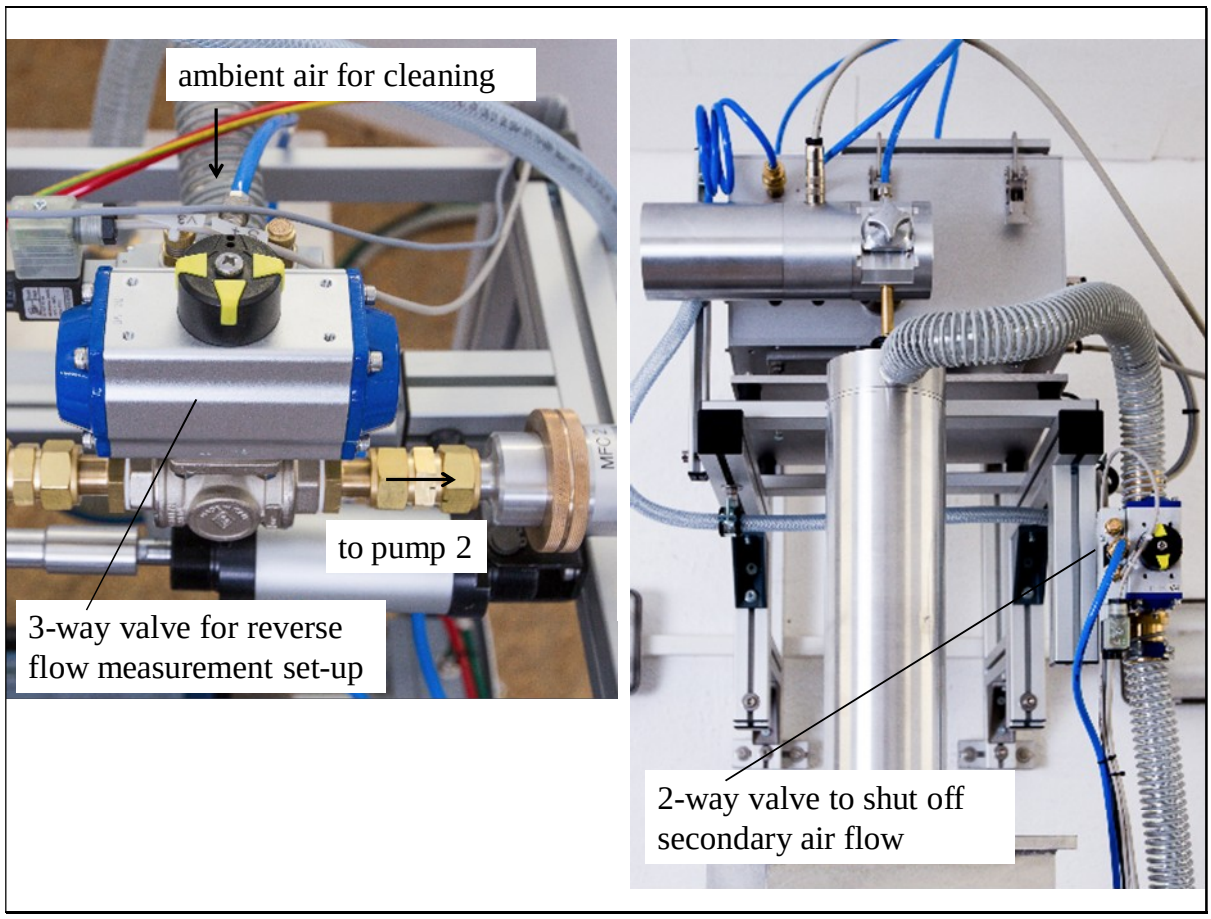
Slide 22

Testing of woven filter media using more gentle reverse flow air cleaning



Slide 24

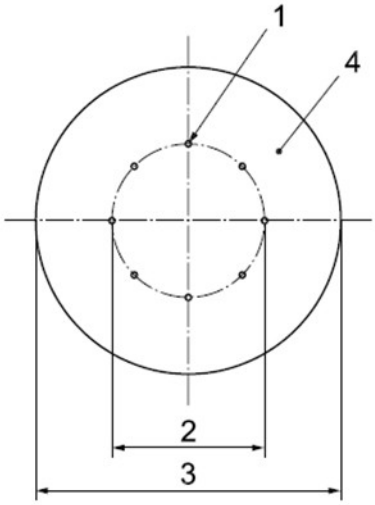
Additional set-up for reverse flow cleaning using the standard filter tester



Slide 25

Measures to be taken in order to gain reliable and comparable results when using different test-rigs

A.3 Perforated plate for calibrating the cleaning system of the standard reference apparatus



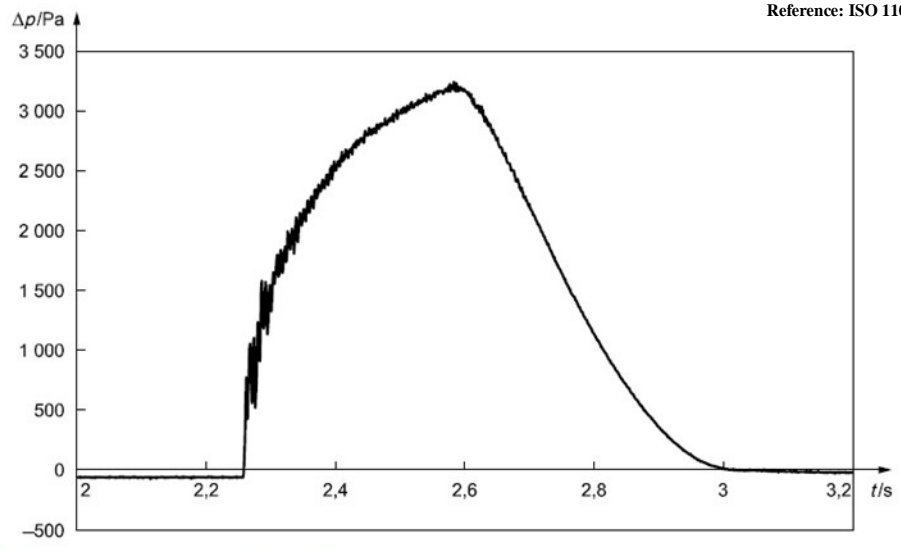
Key

1 one of eight holes, diameter 3 mm, distribution 8 × 45°
2 pitch circle of holes diameter 75 mm
3 diameter of plate 150 mm
4 aluminium plate thickness 2 mm

Reference: ISO 11057:2011(E)

Slide 26

Reference: ISO 11057:2011(E)



Key

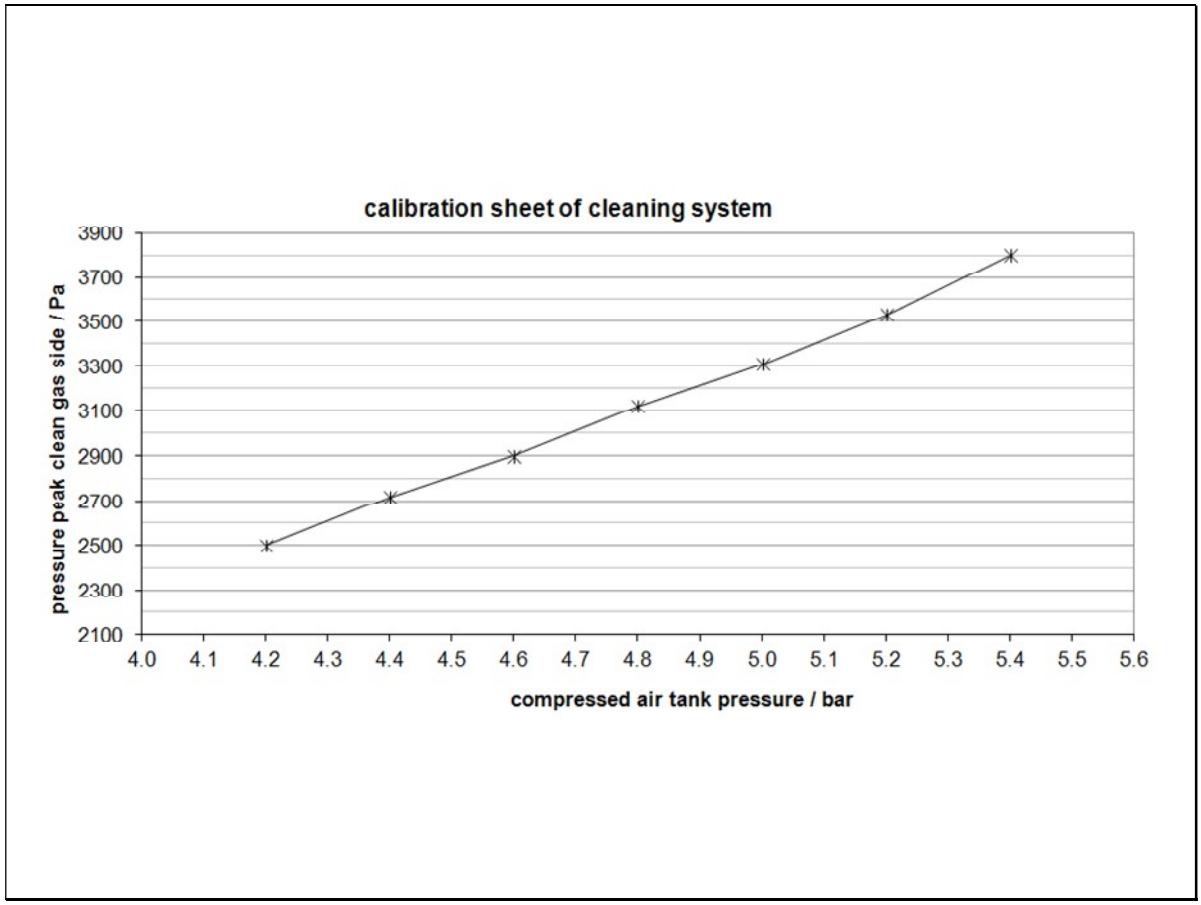
Δp pressure difference
t time

Test conditions	
Online, velocity:	2 m/min
Side flow:	1,85 m^3/h
Main flow:	4 m^3/h
Temperature:	24 °C
Tank pressure:	500 kPa
Valve opening time:	60 ms
Blow hole diameter:	3 mm

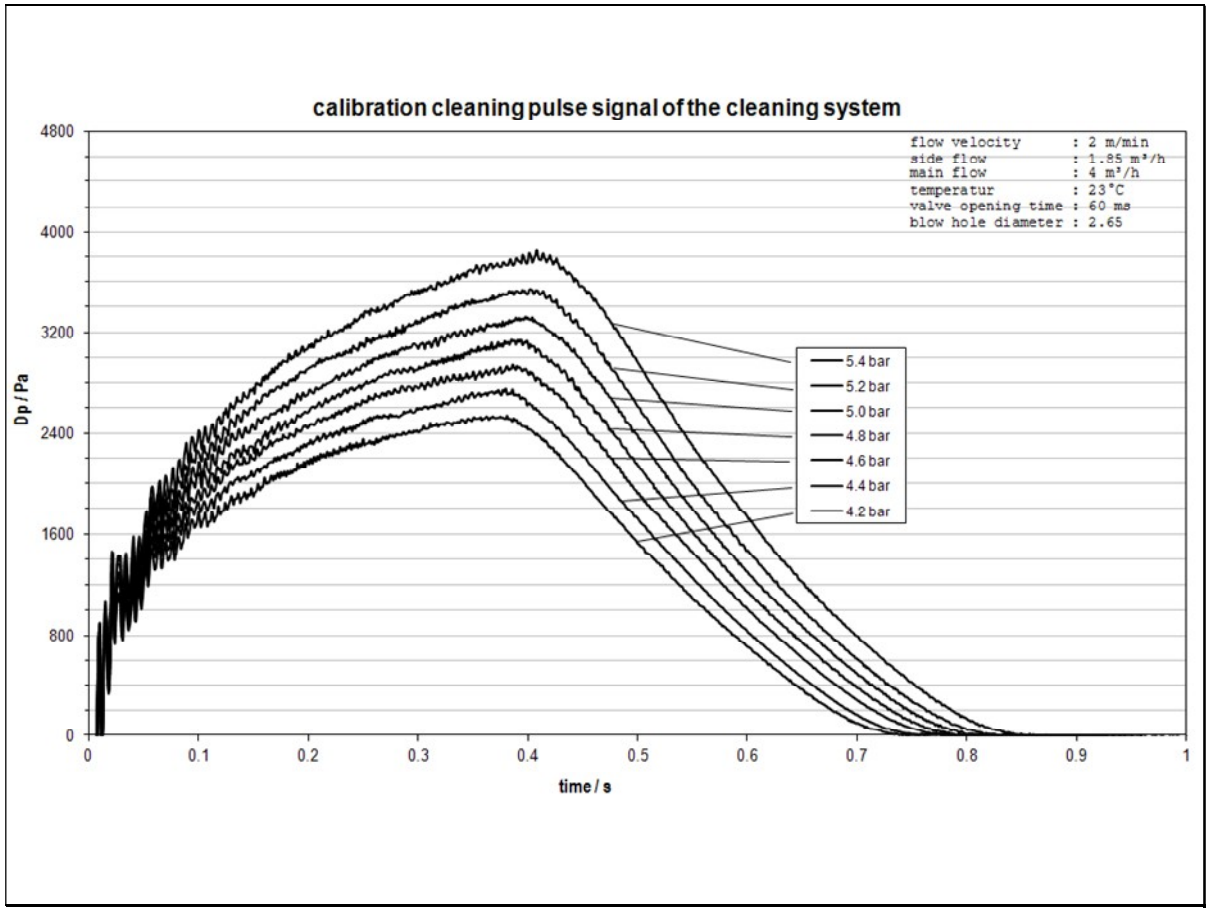
Figure A.4 — Pressure pulse signal using the perforated plate in Figure A.3 for calibration

Slide 27

Calibration of the cleaning system



Slide 28



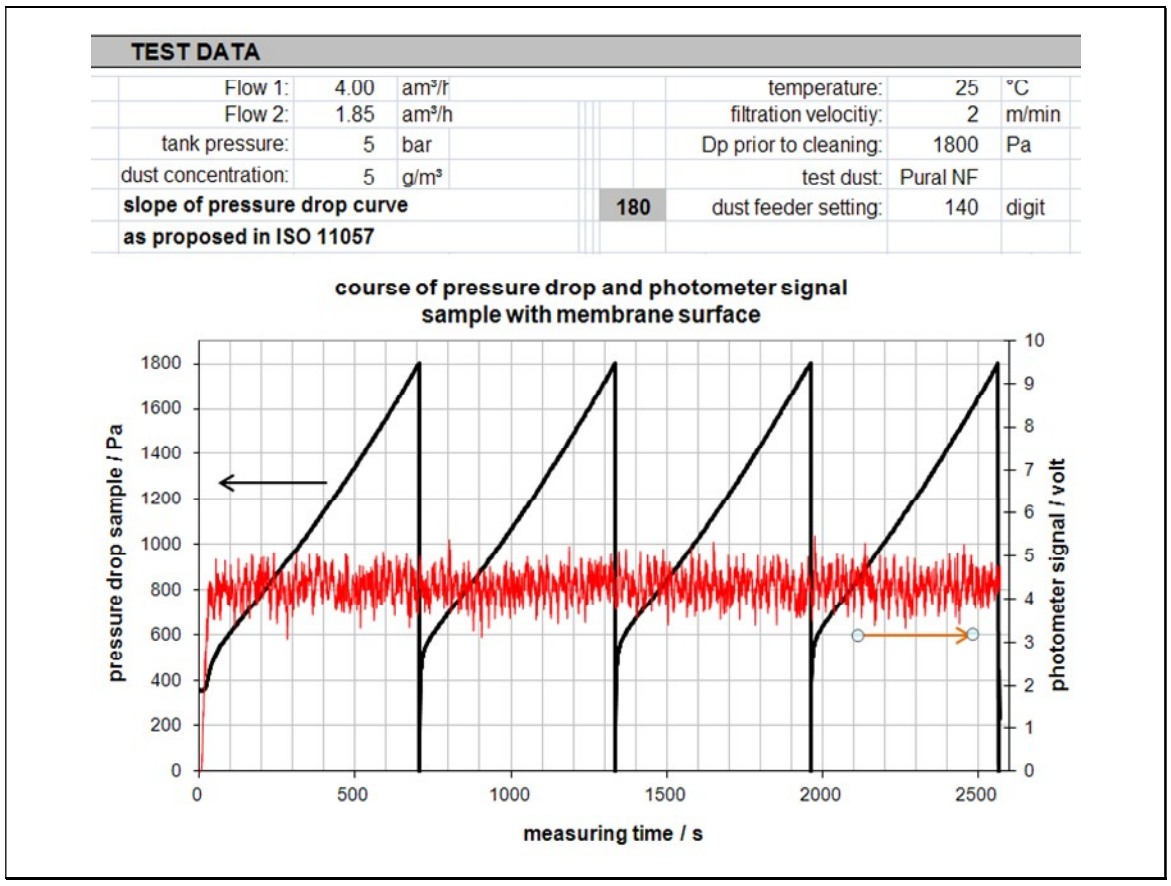
Slide 29

The overall performance of the filter tester can be checked by using a medium which provides a filter surface leading to the formation of a homogeneous, undisturbed filter cake.

This should result in a linear pressure drop curve as shown schematically in slide 7.

This means, for a given filtration velocity, dust concentration and particle size distribution of the same dust, the pressure drop curve should always show the same incline.

This, in turn, enables the operator to quickly check, if filter test rig AND including the dust feeder are operating in a correct way.



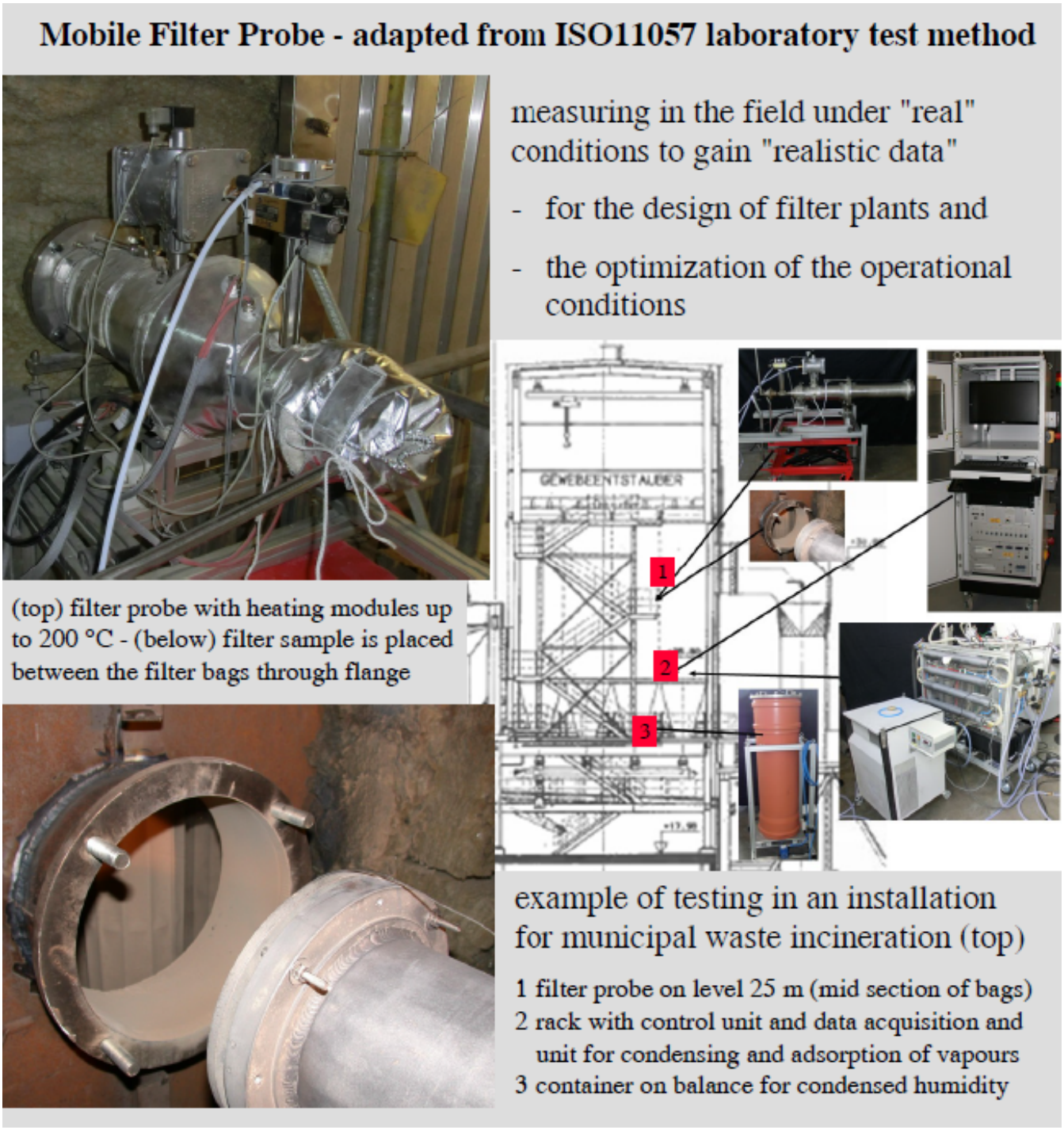
Slide 30

Further possibilities using the method and adapted equipment in field measurements

Due to the limited possibilities to reproduce the gas as well as the dust properties of 'real' dust-charged gasses that occur in practice in the laboratory, the results can only be applied to a limited extent for the selection of a filter material for a certain application and/or the design resp. optimisation of a filter system. This also requires knowledge of the properties of a reference medium.

Derived from the technology and approach applied in the laboratory, a Mobile Filter Probe for the performance of "field tests" was developed in a further step.

This method allows the direct comparison of different filter media available on the market based on the conditions prevailing in the gas flow to be cleaned. With some experience, it is also possible to use the obtained operating data for the design or optimisation of the filter system.



Slide 31

Download publications:

This paper - http://www.filteq.de/images/downloads/AFS-paper-2017

Gäng P. - “Testing and selection of filter media for dedusting”
Part 1: Standard laboratory tests in acc. with VDI/DIN 3926,
F & S Filtrieren und Separieren, International edition, no. 9/2009, p. 6-16
http://www.filteq.de/images/downloads/F%20&%20S_E_0909_Part%201

Gäng P. - “Testing and selection of filter media for dedusting”
Part 2: Field measurements with a mobile filter probe derived from VDI/DIN 3926,
F & S Filtrieren und Separieren, International edition, no. 9/2009, p. 17-23
http://www.filteq.de/images/downloads/F%20&%20S_E_0909_Part%202