

REINHOLD ENVIRONMENTAL Ltd.



2016 APC-Wastewater Round Table & Expo Presentation

July 18 & 19, 2016 in Dearborn, MI / Hosted by DTE Energy

All presentations posted on this website are copyrighted by Reinhold Environmental, Ltd (RE). Any unauthorized downloading, attempts to modify or to incorporate into other presentations, link to other websites, or obtain copies for any other uses than the training of attendees to RE's Conferences is expressly prohibited, unless approved in writing by RE or the original presenter. RE does not assume any liability for the accuracy or contents of any materials contained in this library which were presented and/or created by persons who were not employees of RE.

Bag House Optimization Tools
Evonik Filtration Test Rig
Mercury Evaluations

APC – Wastewater Round Table

*July 18-19, 2016, Edward Village Michigan Hotel,
Dearborn, MI*

Florin Popovici

florin.popovici@evonik.com

florin@absamail.co.za

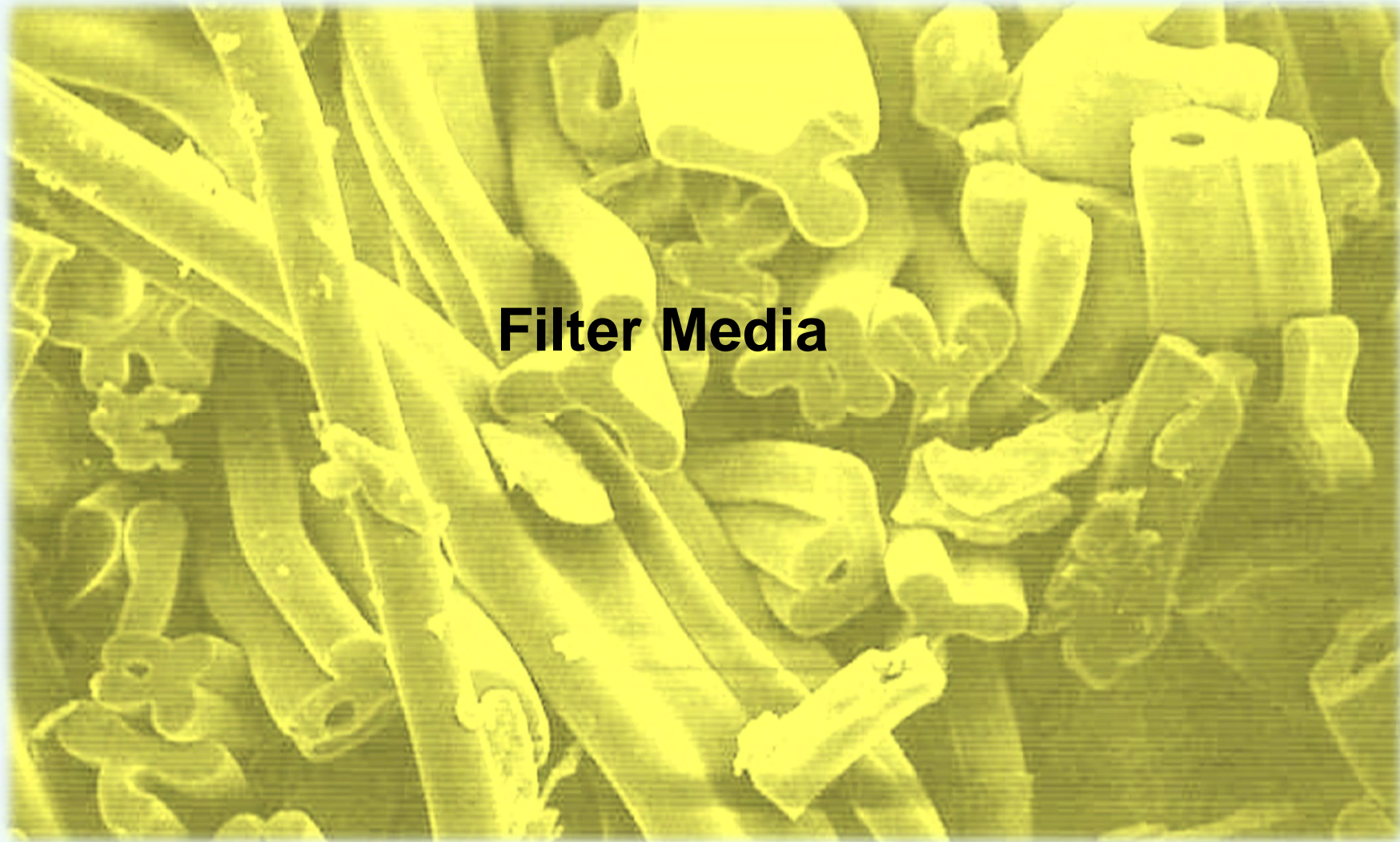
Tel: +390392301578

Mobile: +39 3456019848

Content

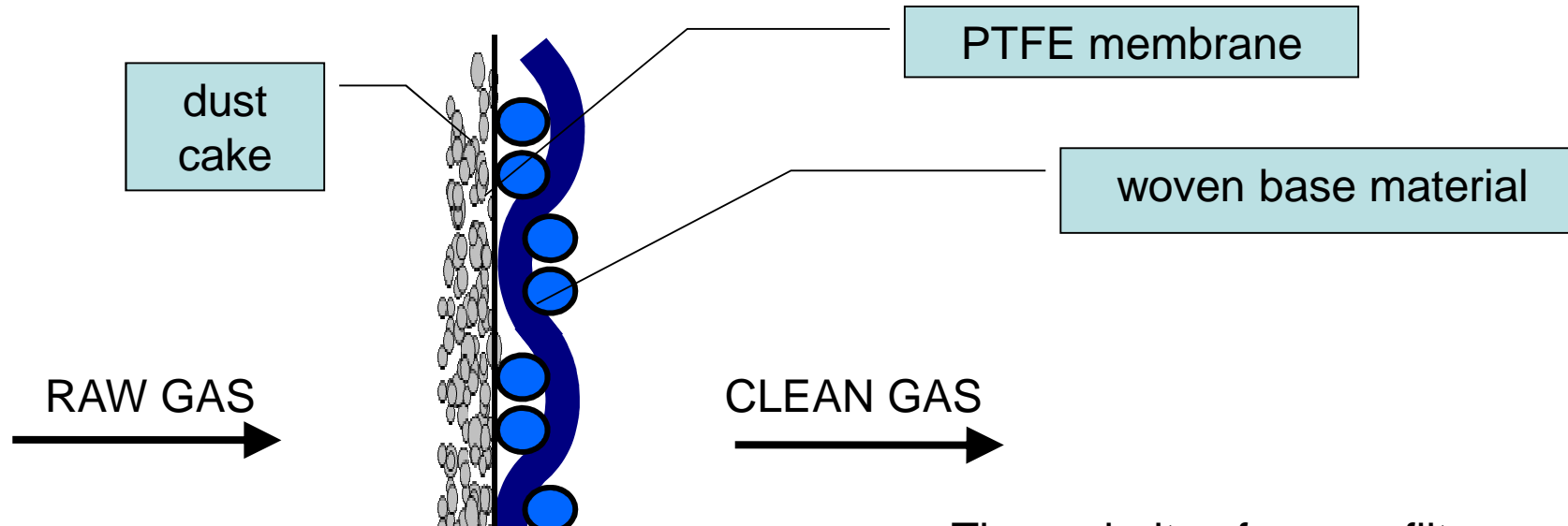
- 
- **Filter media**
 - **Evonik Fibres Filtration Test Rig (FTR) - description**
 - **FTR mercury test results**
 - **Filtration mechanism**
 - **Dust cake implications**
 - **EPA mercury concentrations**

APC – Wastewater Round Table



Filter media construction

Woven / Membrane materials



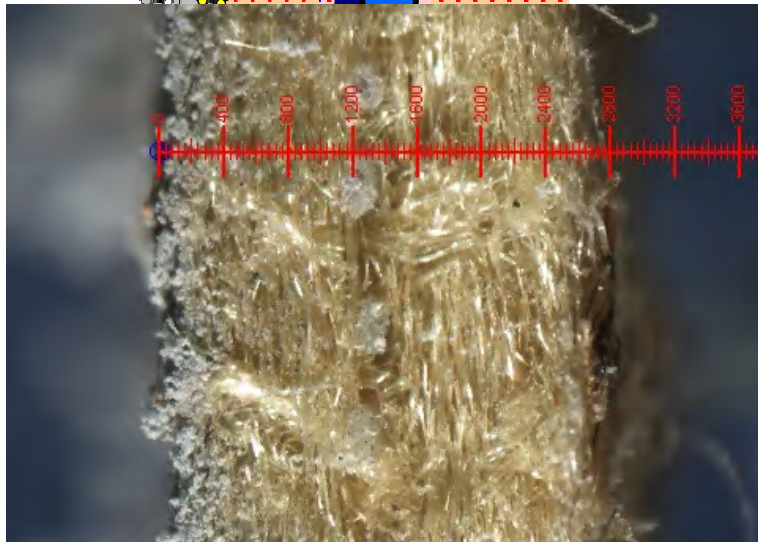
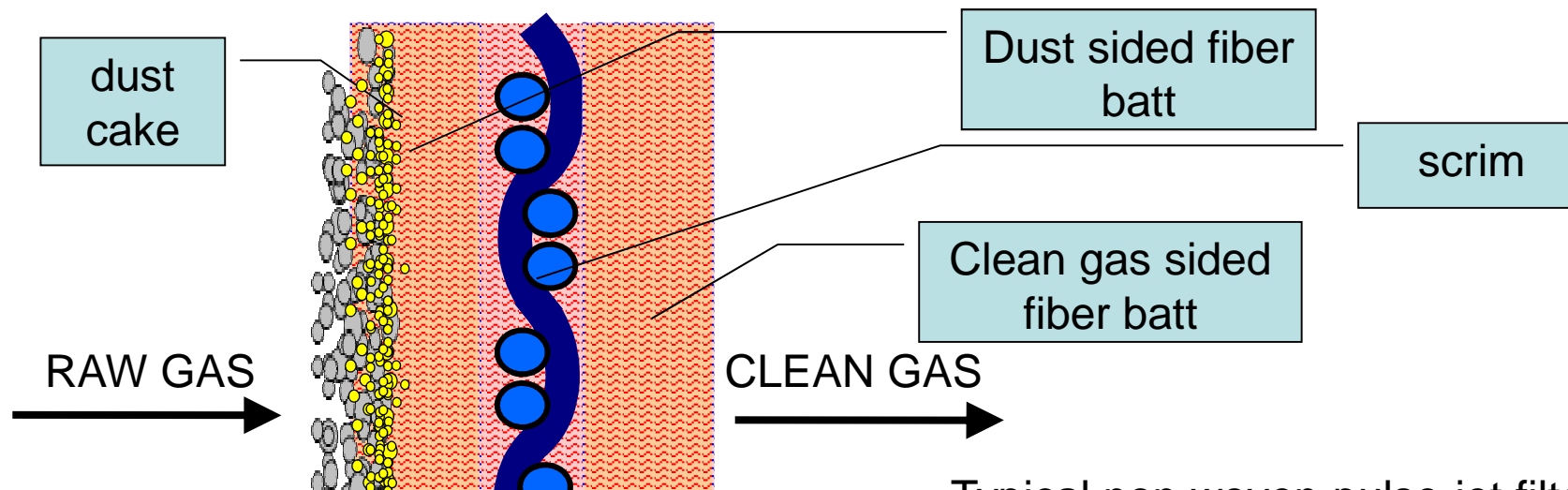
The majority of woven filter media in dry filtration are based on glass fibres.

In reverse air bag houses crude woven glass is commonly used without membrane.

Pulse jet filter media from woven glass are typically laminated with PTFE membrane to increase the filtration efficiency.

Filter media construction

Nonwoven materials



Typical non woven pulse-jet filter media consist of a supporting scrim between two non-woven fibre bats.

Scrim less constructions are also available.

For reverse-air filters the scrim and felt weight are typically lower (lower a/c-ratio, gentle cleaning)

CFB bag houses – typical filter media

- Polyacrylic (PAN) homopolymer: low temperature bag houses
- Polyphenylenesulfide (PPS): medium and high temperature bag houses
- Polyimide (P84): high temperature BHs and low temperature BHs (blends)
- PTFE: high temperature bag houses

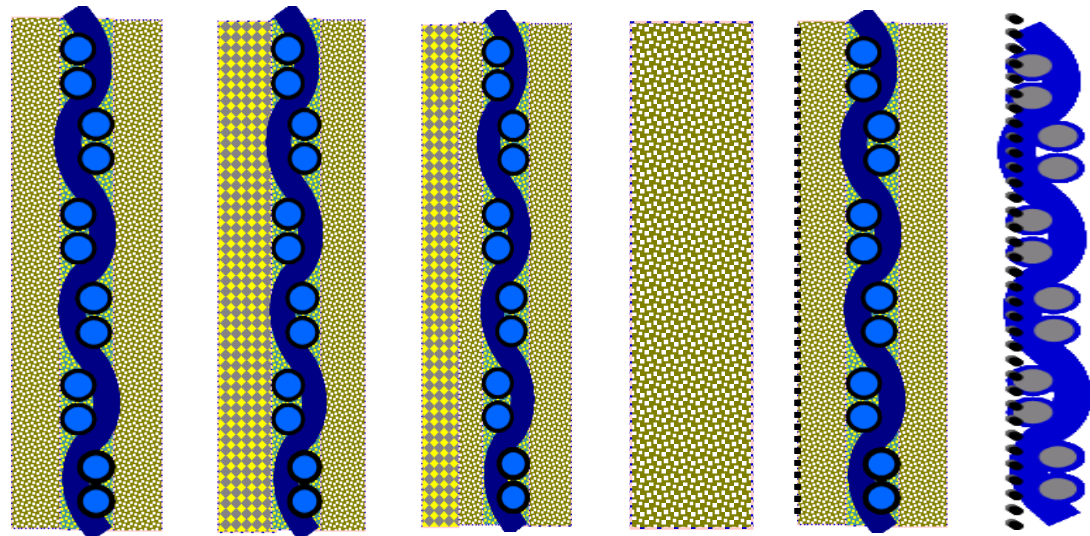
Fibre Blends:

- PAN + P84 / PAN scrim
- PPS + P84 / PPS scrim
- PPS + P84 / PTFE scrim
- PTFE + P84 / PTFE scrim

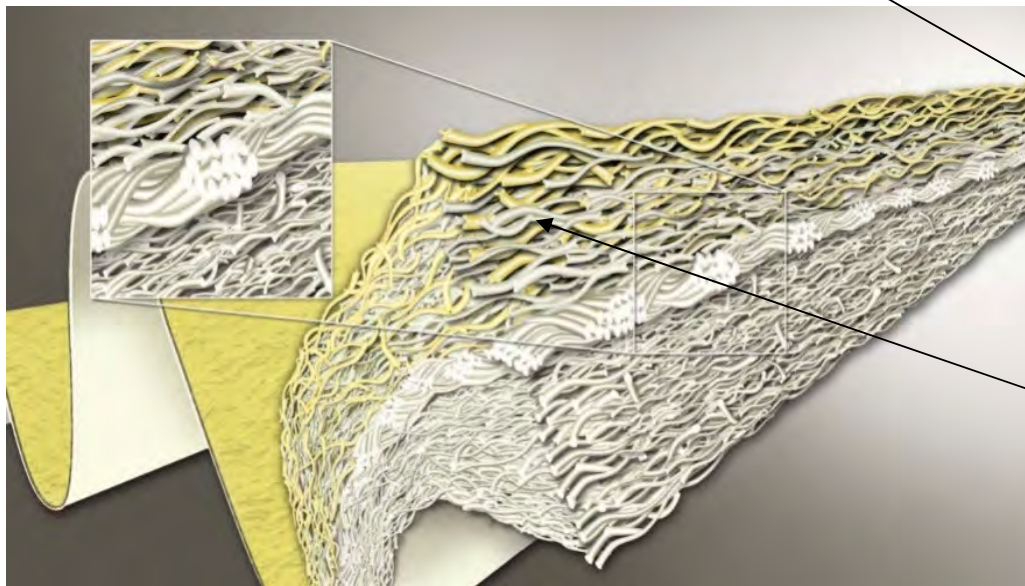
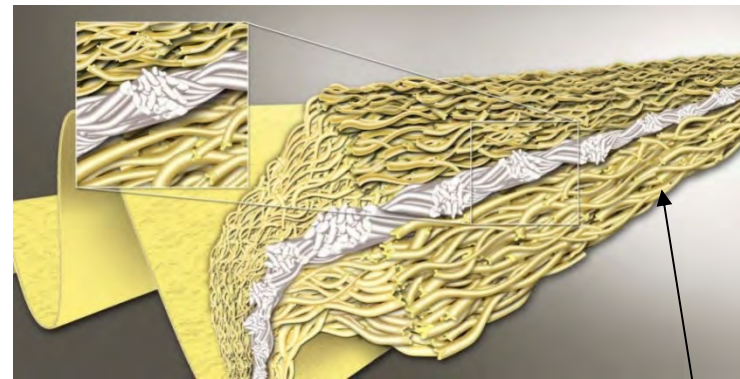
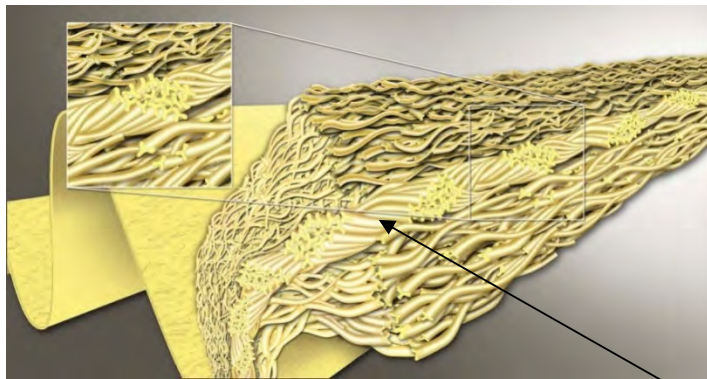
Membrane materials

- M / Woven glass
- M / PTFE felt
- M / PPS felt

CFB BH filter material constructions



Illustrations of typical filter media for CFB bag houses

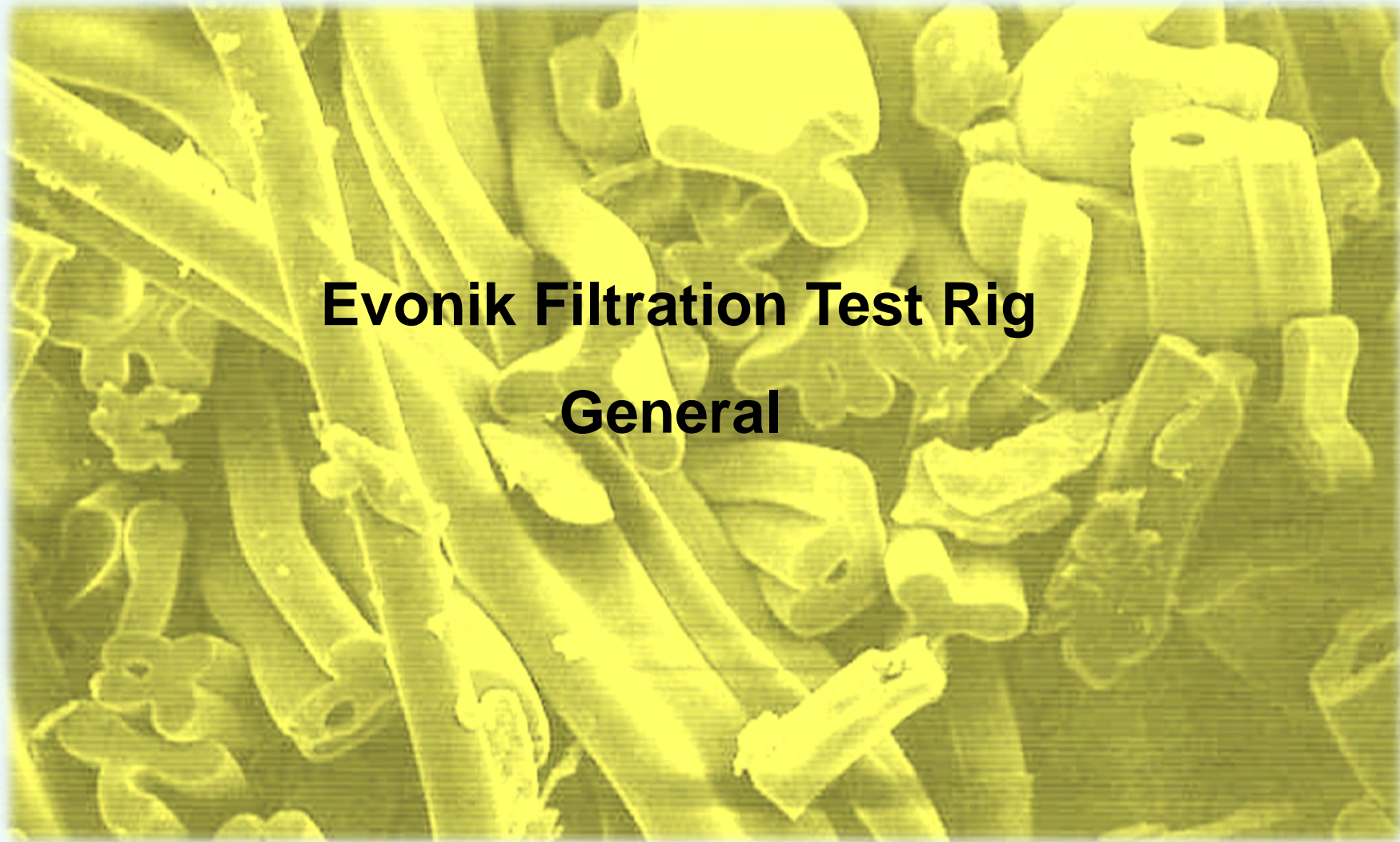


PPS on PPS scrim
P84 on P84 scrim

P84 or PPS on PTFE scrim

P84 surface in a blend with
PPS fibres with PPS scrim
- typical Enel, Eskom, ESBI,
etc.

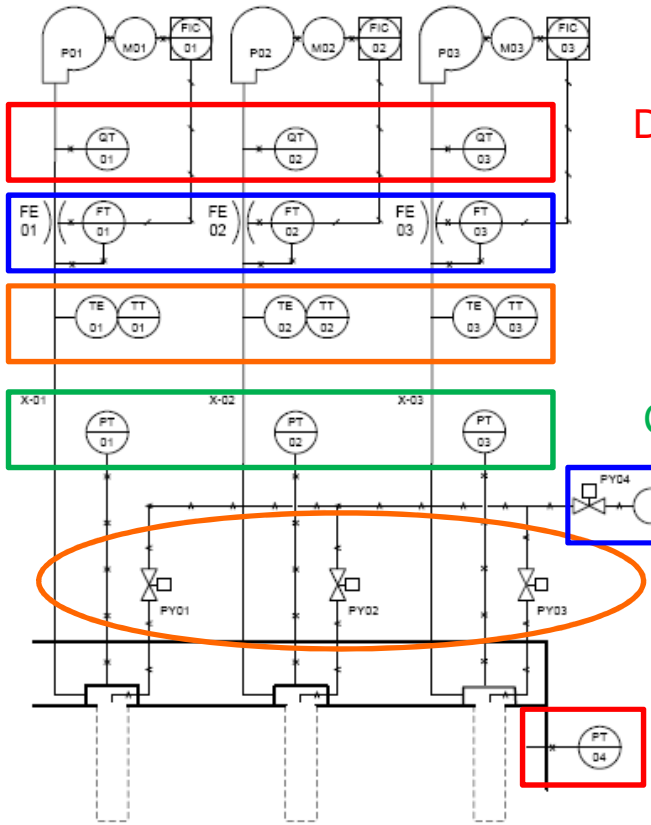
APC – Wastewater Round Table



Evonik Filtration Test Rig General

Schematic of the Filtration Test Rig

Fans with variable speed controller



Dust measurement
Flow rate measurement
Temperature measurement

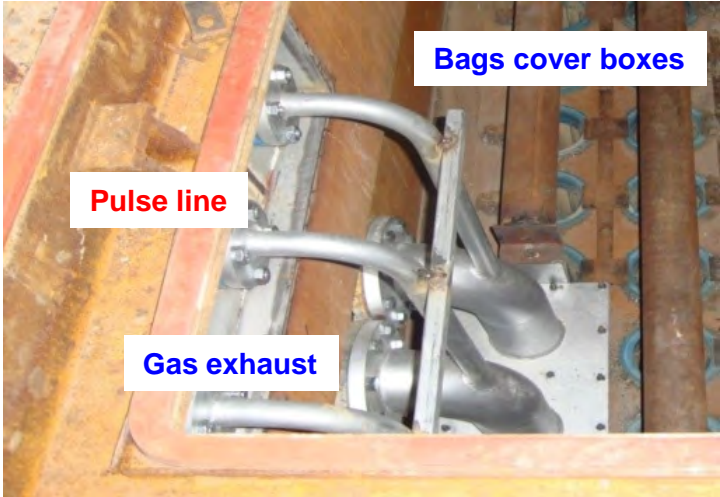
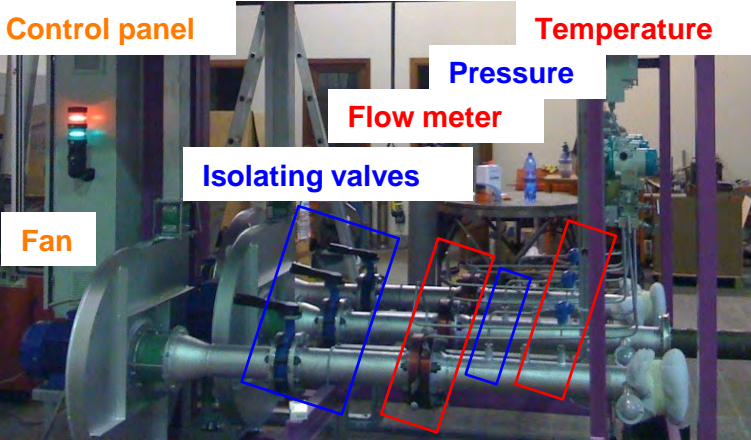
Clean gas pressure

Pulse jet cleaning air tank

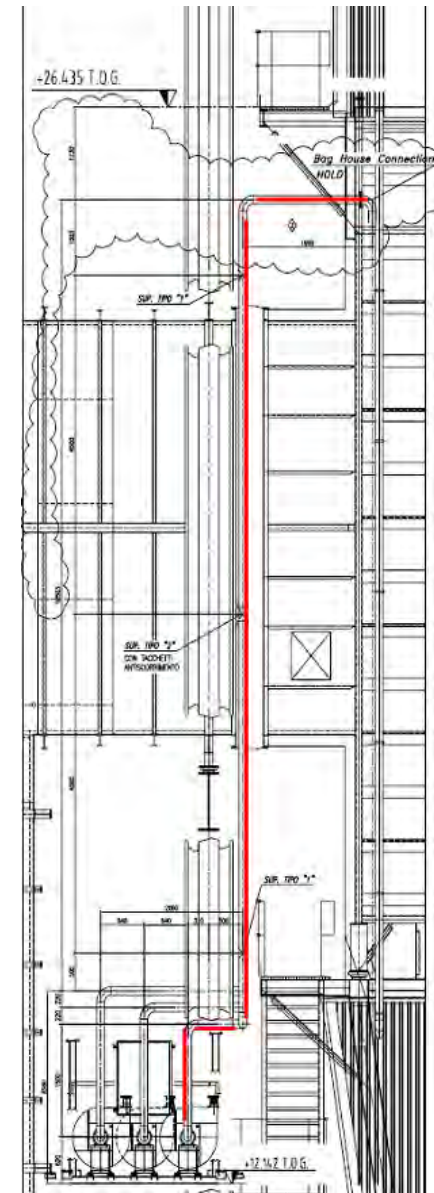
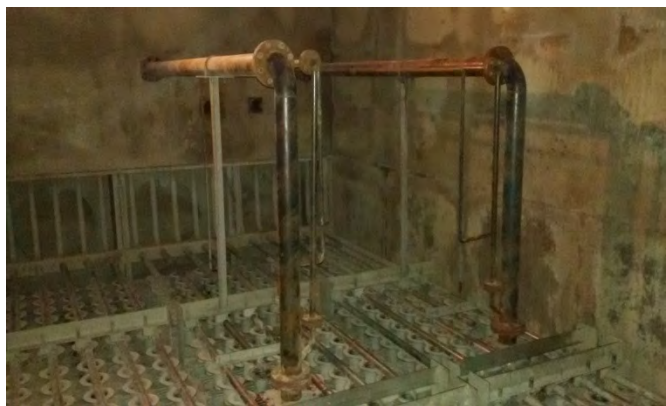
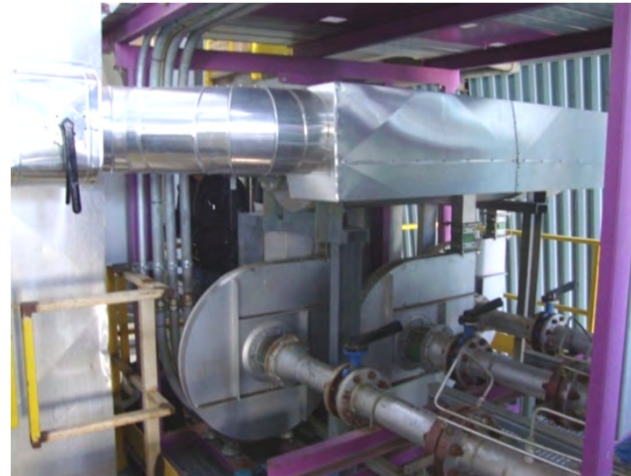
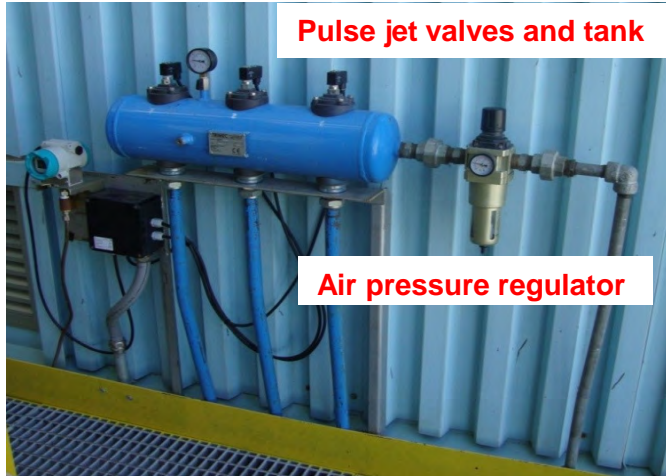
Pulse jet cleaning valves

Raw gas pressure

Test Filter Bags inside the full scale FF



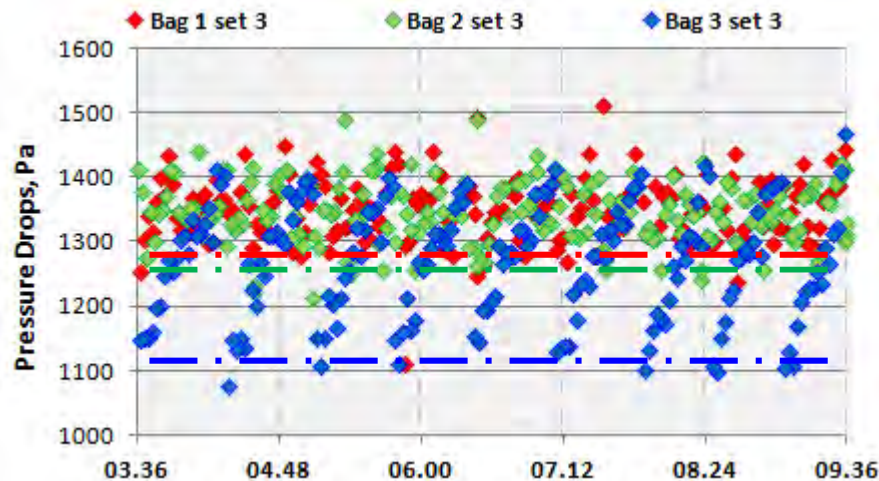
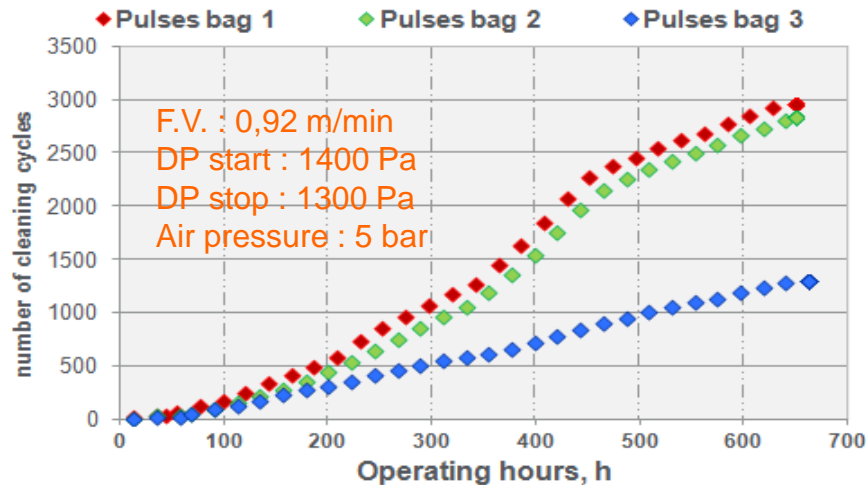
Evonik FTR



FTR - Test results



Bag 1:	PTFE felt + PTFE Membrane	NEW
Bag 2:	PPS felt + PTFE Membrane	NEW
Bag 3:	PPS+(PPS 2,2 dtex+P84 1,7 dtex) reference	NEW



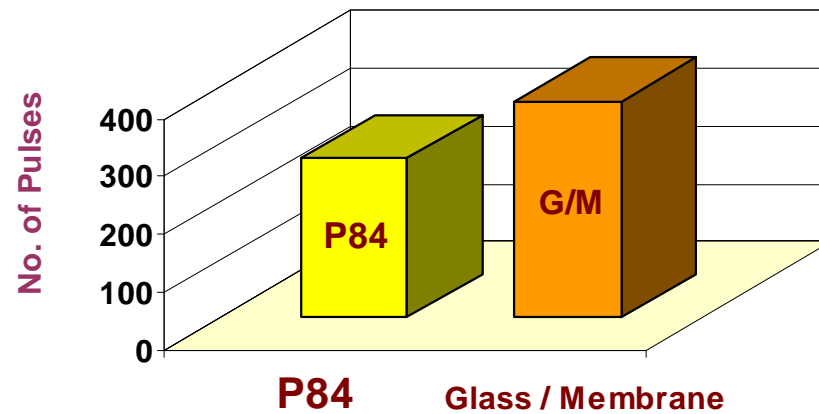
Specific weight		Bag 1	Bag 2	Bag 3
As Received	g/m ²	1013	635	952
Cleaned	g/m ²	990		
Washed	g/m ²	959	586	749
Air permeability				
As Received	l/dm ² @200 Pa	9	13	16
Cleaned	l/dm ² @200 Pa	10	21	44
Washed	l/dm ² @200 Pa	14	49	109
Breaking load				
longitudinal	N	852	877	1379
cross	N	747	1816	1689
Elongation				
longitudinal	%	11,5	26,5	26
cross	%	19	25	36

Higher residual pressure loss for membrane bags
Lower pulsing rates for the P84 based bags

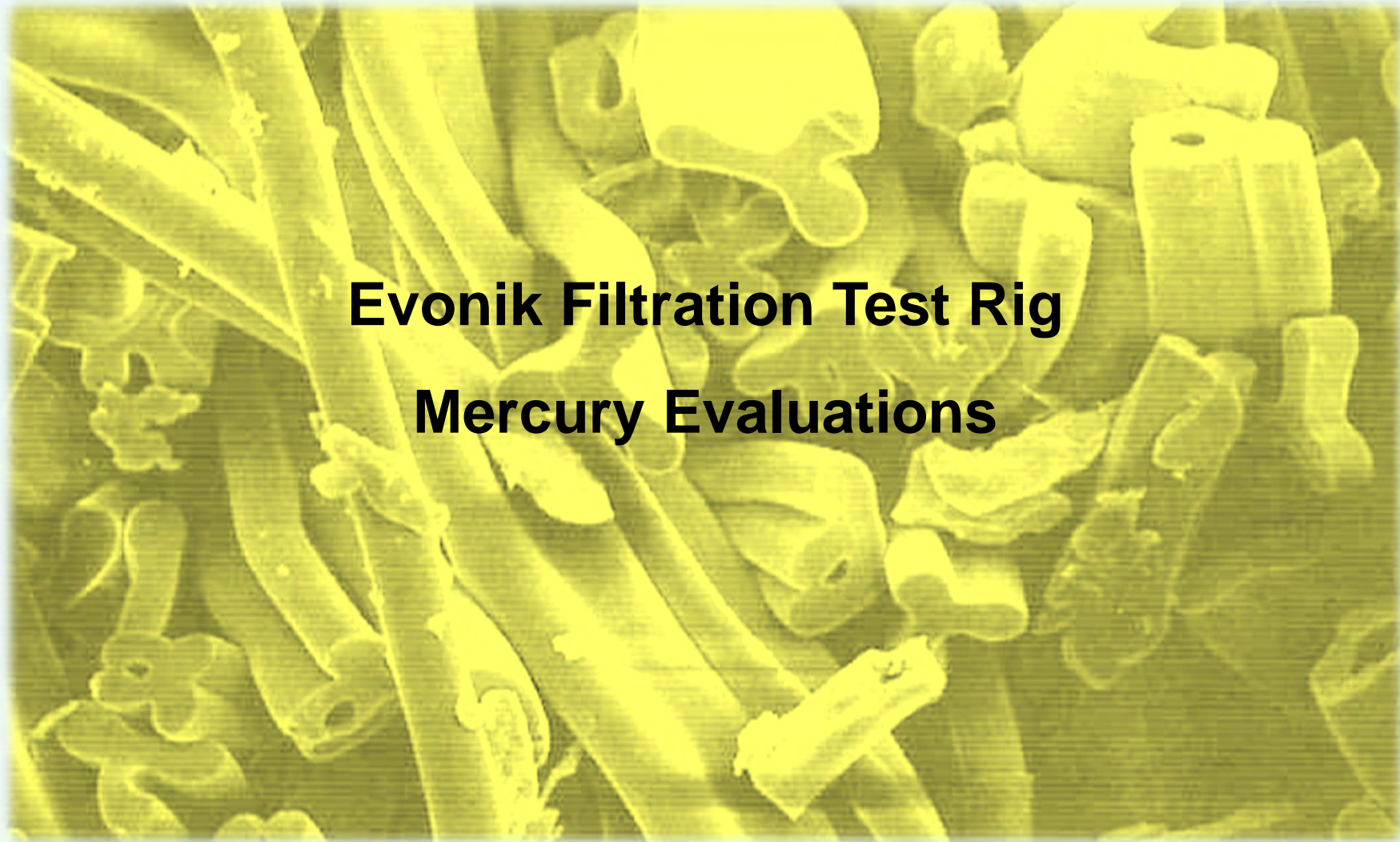
FTR – P84 versus G/M



No. of Pulses - ENEL Test 2 - DP Cleaning
1.4 - 1.3 kPa, Filtration Velocity 1.1 m/min, 40 days values



APC – Wastewater Round Table



Evonik Filtration Test Rig Mercury Evaluations

Mercury control - CFBs

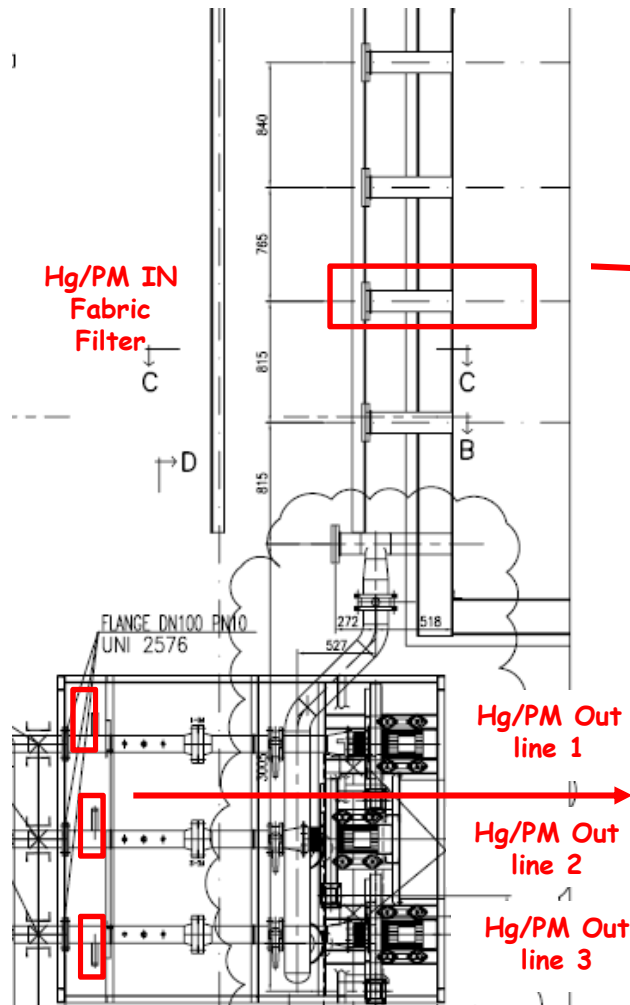


➤ Activated Carbon Injection (ACI)

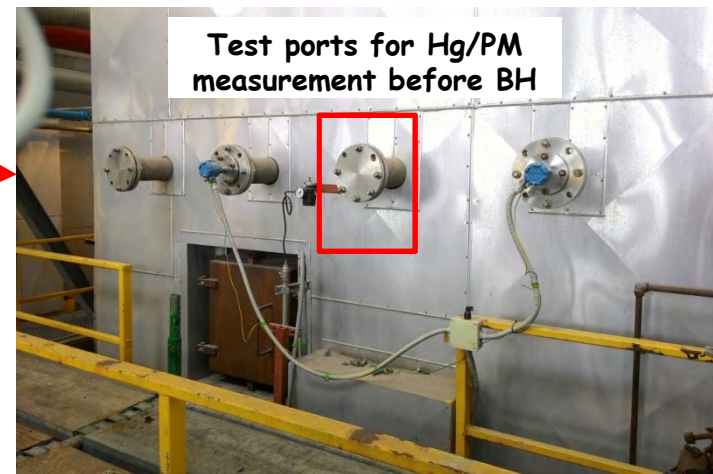
- ❖ Hg and Hg²⁺ are entrapped in the AC pores
- ❖ Hg_p is removed as a solid
- ❖ Required: AC with high surface and high pore areas
- ❖ ESP, FF, Dry FGD (reactor + FF)
 - ❖ Hg / Hg²⁺ gas and vapour contact with AC
 - ❖ dust cake importance / critical
 - ❖ filter material – high surface area dust cake
 - ❖ Multilobal P84 fibres
 - ❖ Membrane type materials are not holding a dust cake continuously

Hg and PM sampling points

In order to evaluate PM and Hg removal efficiency of three different materials the following sampling points have been selected



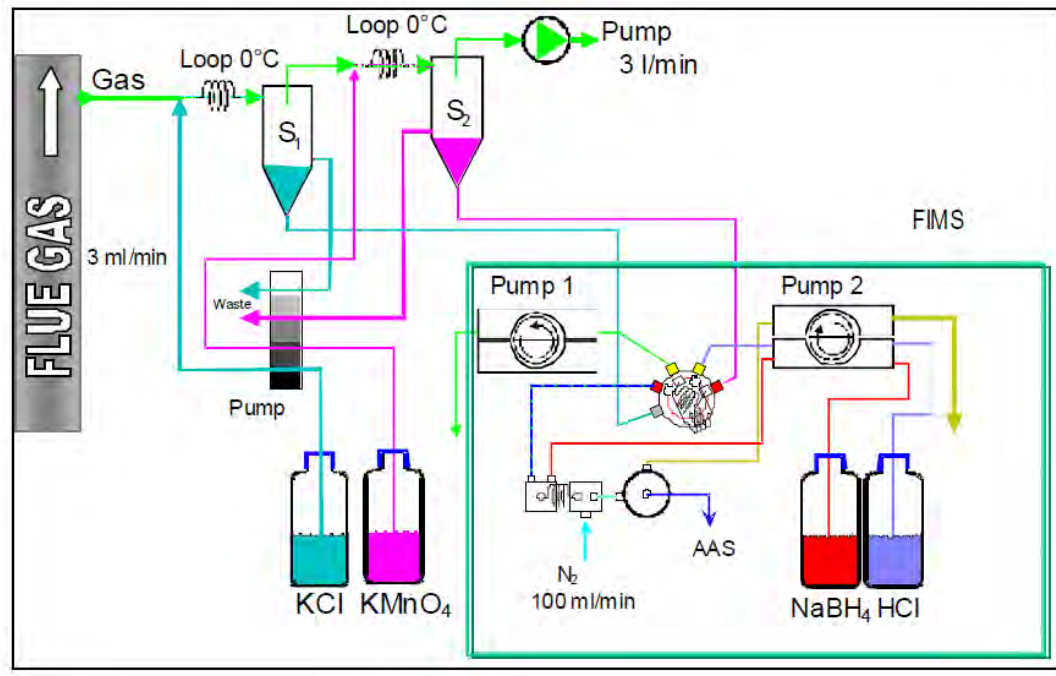
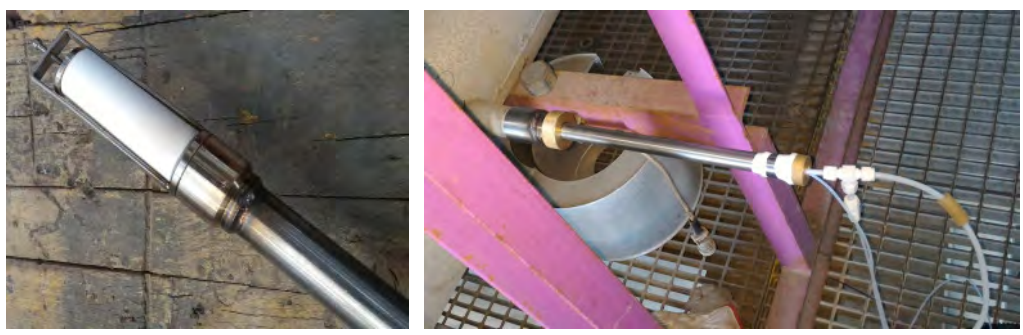
Sampling point upstream Fabric Filter



Sampling points downstream Test-rig



Hg measuring system and test probes



Hg measurement was based on an Ontario modified hydro method.

This system allows to monitor in real time both Hg⁰ and Hg²⁺.

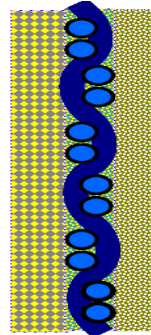
Hg test bags

P84/PPS, PPS & Glass / Membrane



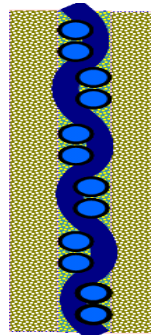
Bag 1

P84 surface
layer
(multilobed
fibres)



Bag 2

PPS surface
layer
(round fibres)



Bag 3

PTFE
Membrane
surface layer



Test conditions

- Bituminous coal
- ACR = 0.6 m/min
- No ACI

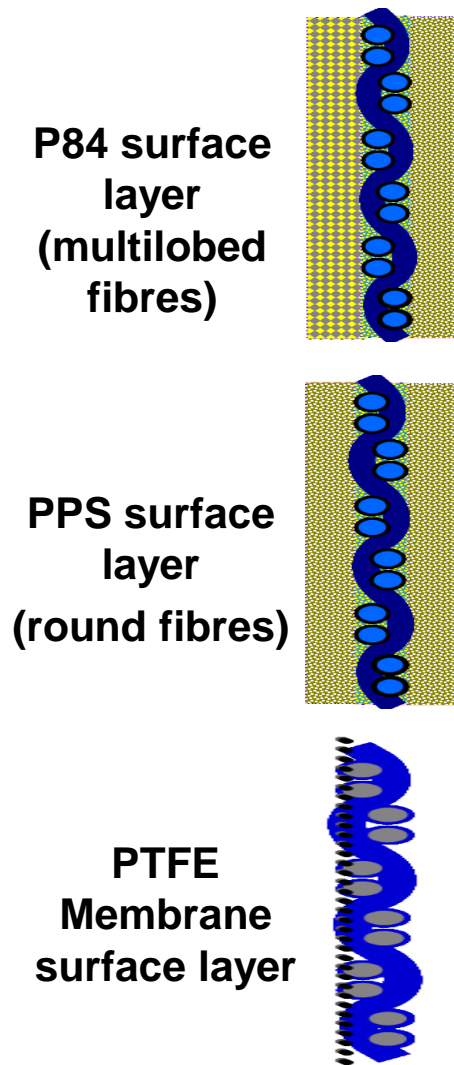
PM measurements



	PM at FF inlet	PM out line1	PM out line3		Efficiency line 1	Efficiency line 3
	mg/Nm3	mg/Nm3	mg/Nm3		%	%
21/07/2015	4857	3,93			99,92	
22/07/2015	4266	3,21	7,85		99,92	99,82
23/07/2015	4474	4,24	7,44		99,91	99,83

- ✓ No measurement are available for Bag 2 → no possibility to insert the probe because of interference with test-rig frame and instrumentation
- ✓ Bag 1 (P84) shows the lowest Hg emissions and the highest de-dusting efficiency

Hg measurements – average results P84/PPS, PPS & Glass / Membrane

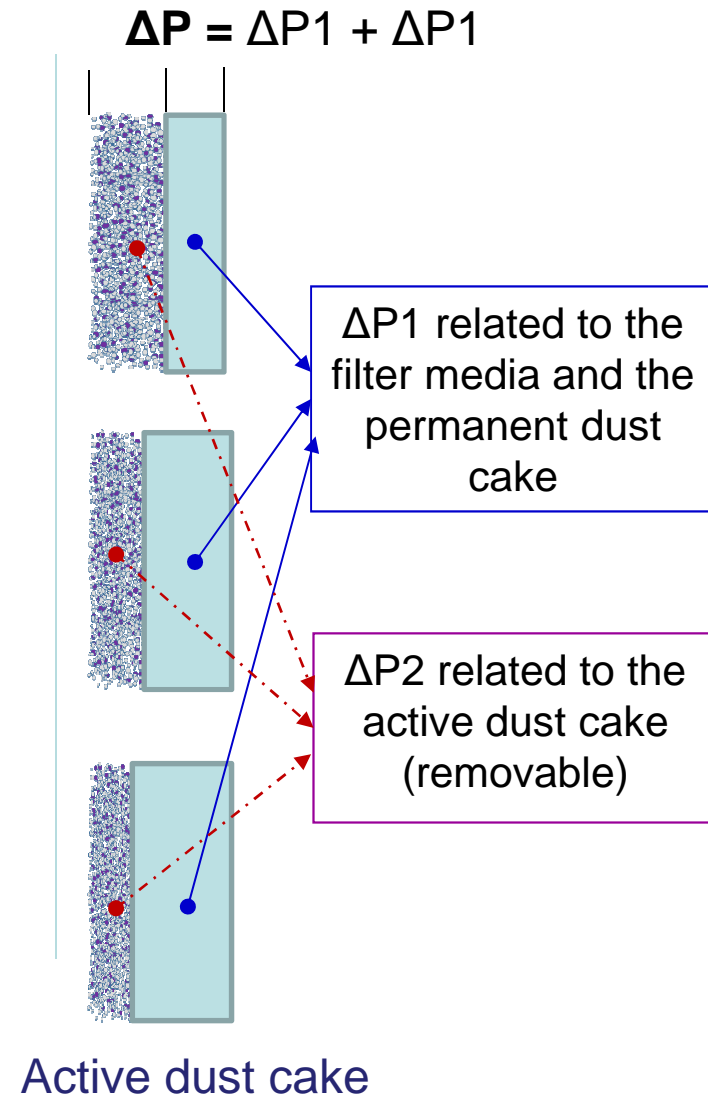


Efficiency

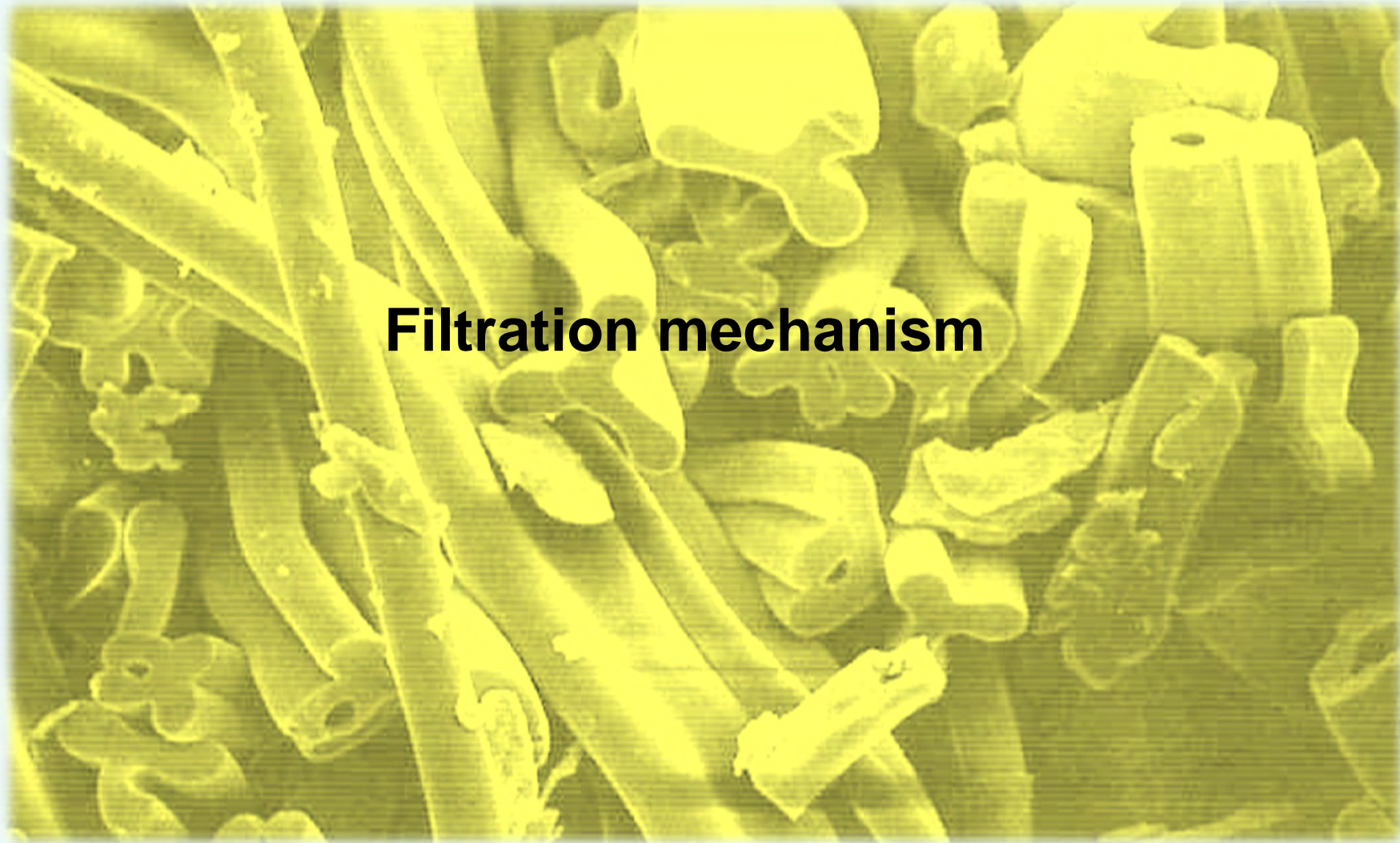
89.9%

83.5%

75.9%



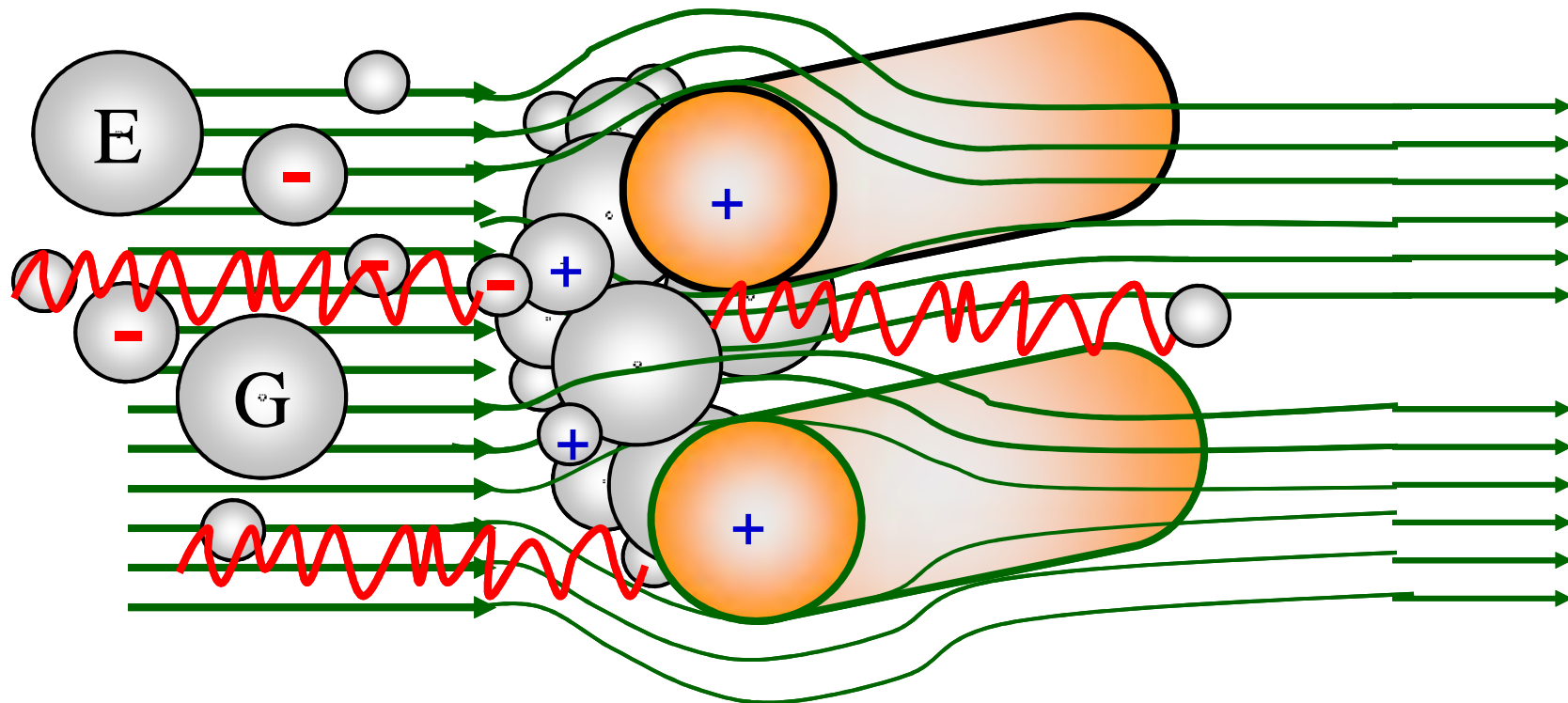
APC – Wastewater Round Table



Filtration mechanism

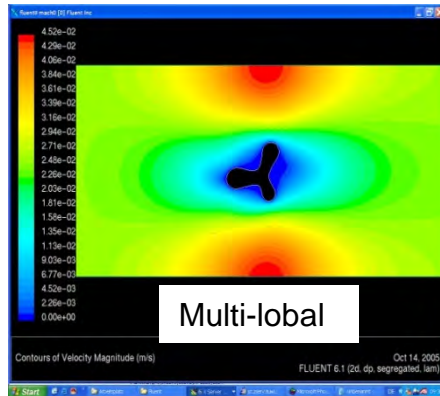
Filtration mechanisms

Sieving, impaction, agglomeration, electrostatic, cake filtration

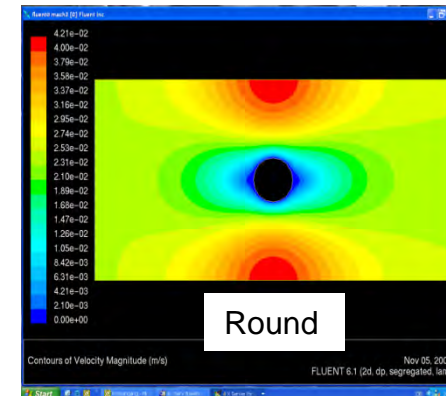


Pre-coating of filter bags to establish the dust cake

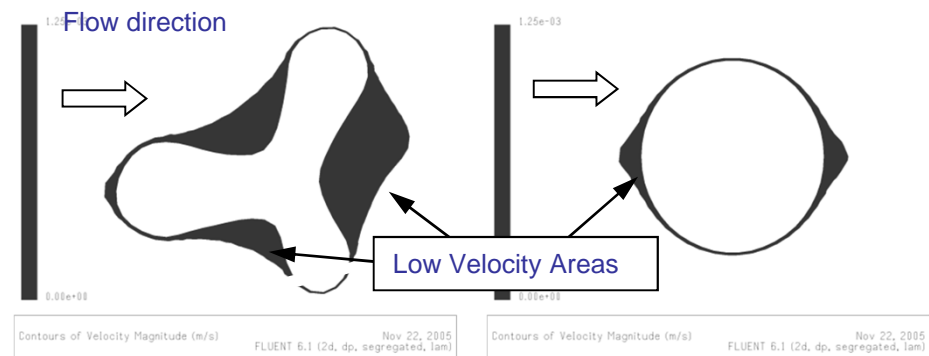
Dust cake formation - charging of fibres



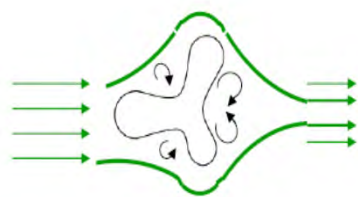
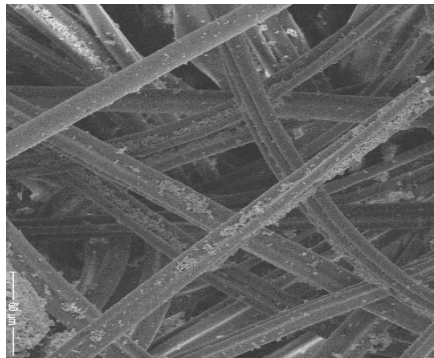
P84 multilobal fibres show larger areas with low flow velocities compared to round fibres.



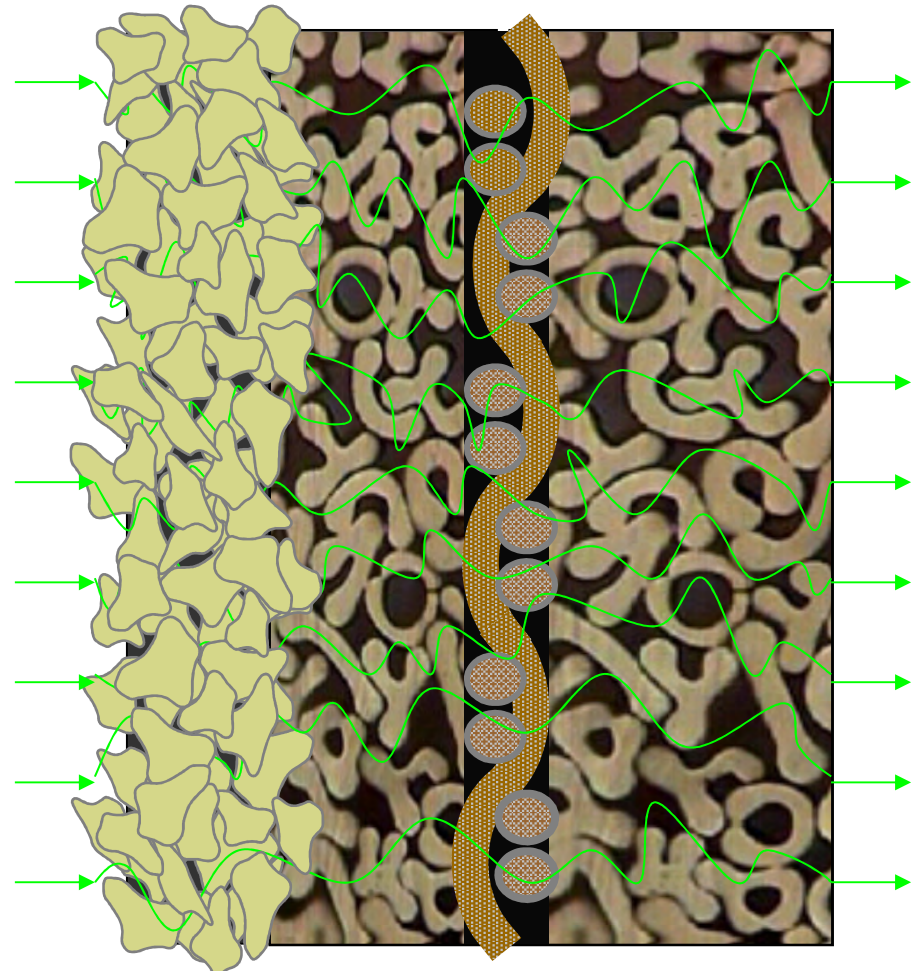
Charging of P84 multilobal and round fibres



P84 - dust cake formation



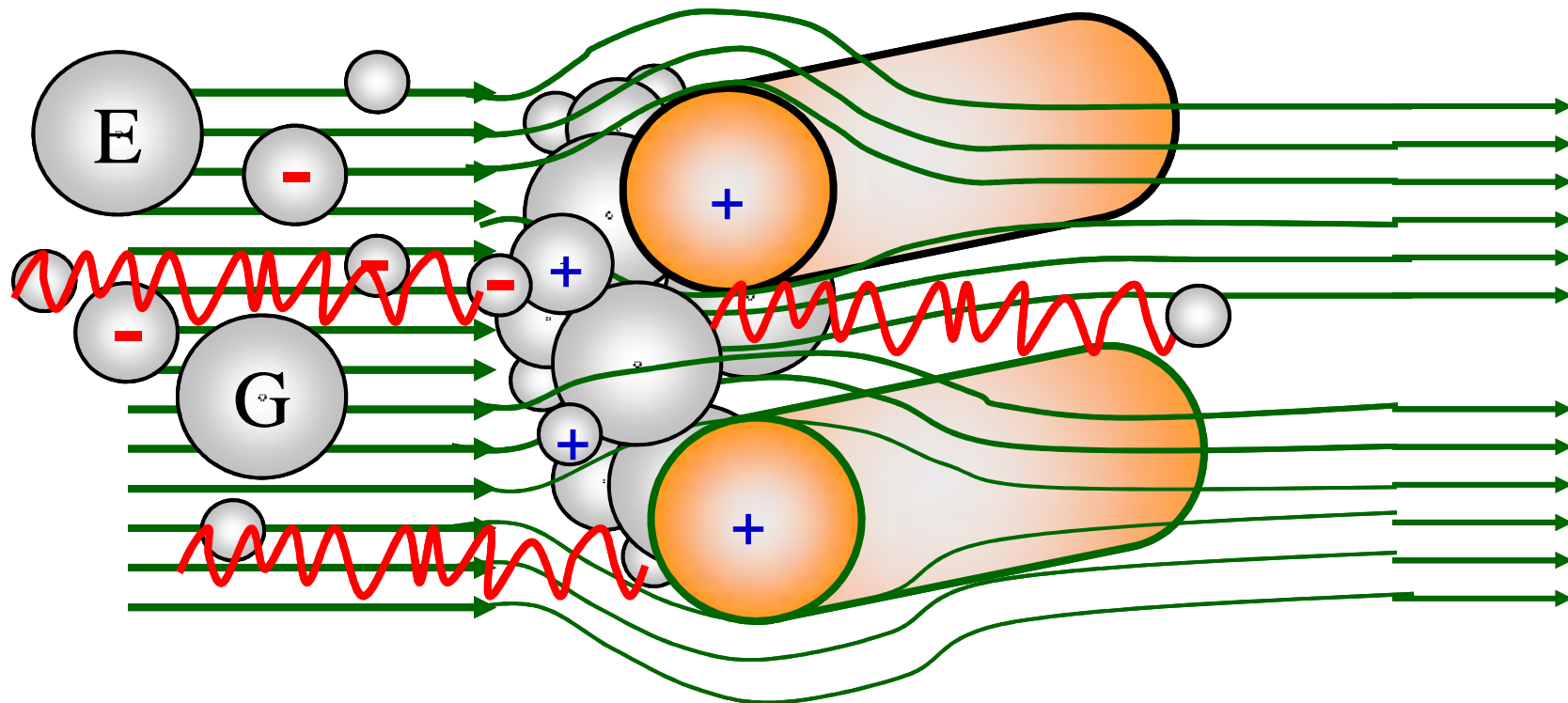
- **Flow lines - Little obstruction caused by the collected dust**
- **Permanent dust cake irregular and porous**



P84 dust cake formation on material filtration side

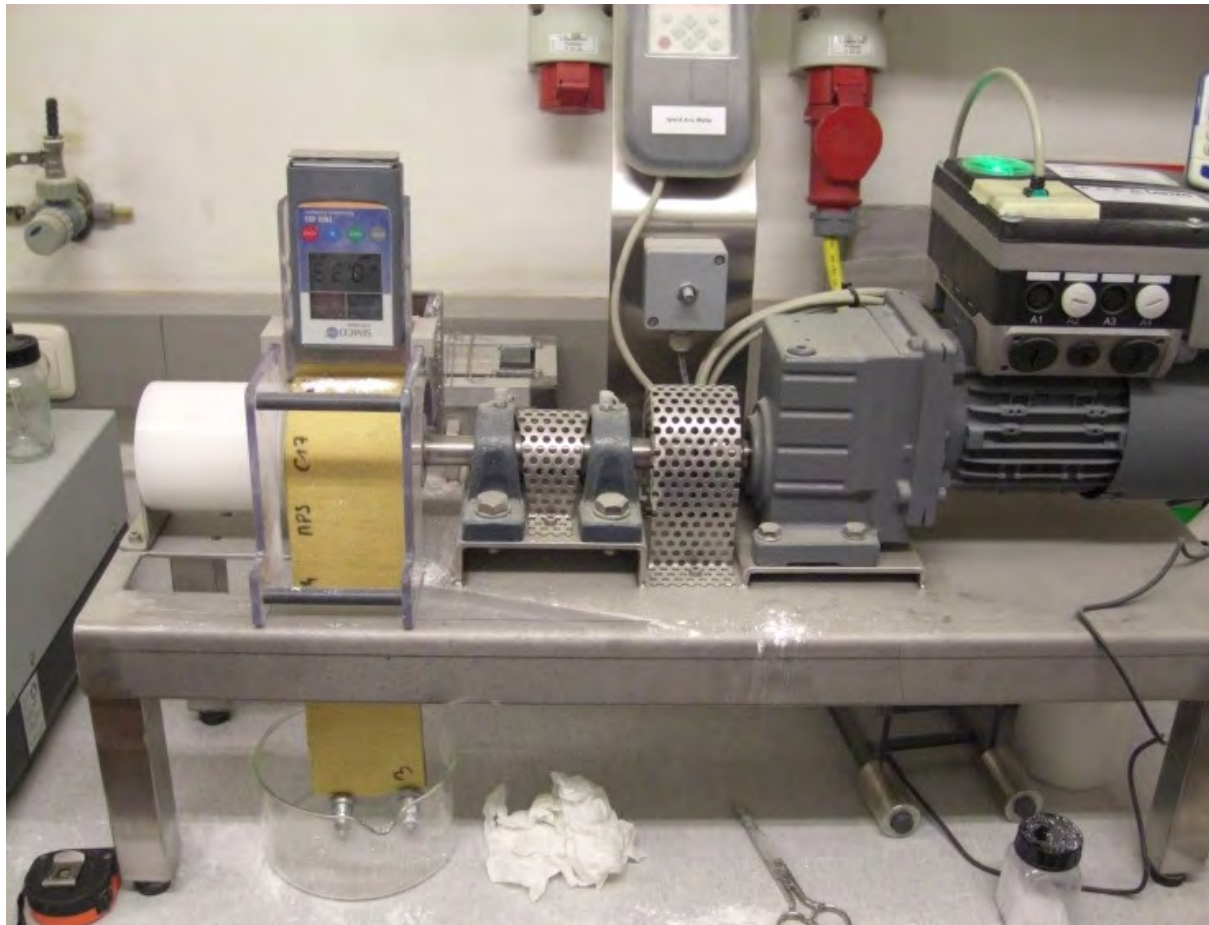
Electrostatic effect

Sieving, impaction, agglomeration, electrostatic, cake filtration



Pre-coating of filter bags to establish the dust cake

Charging of filter materials Triboelectric Test Rig



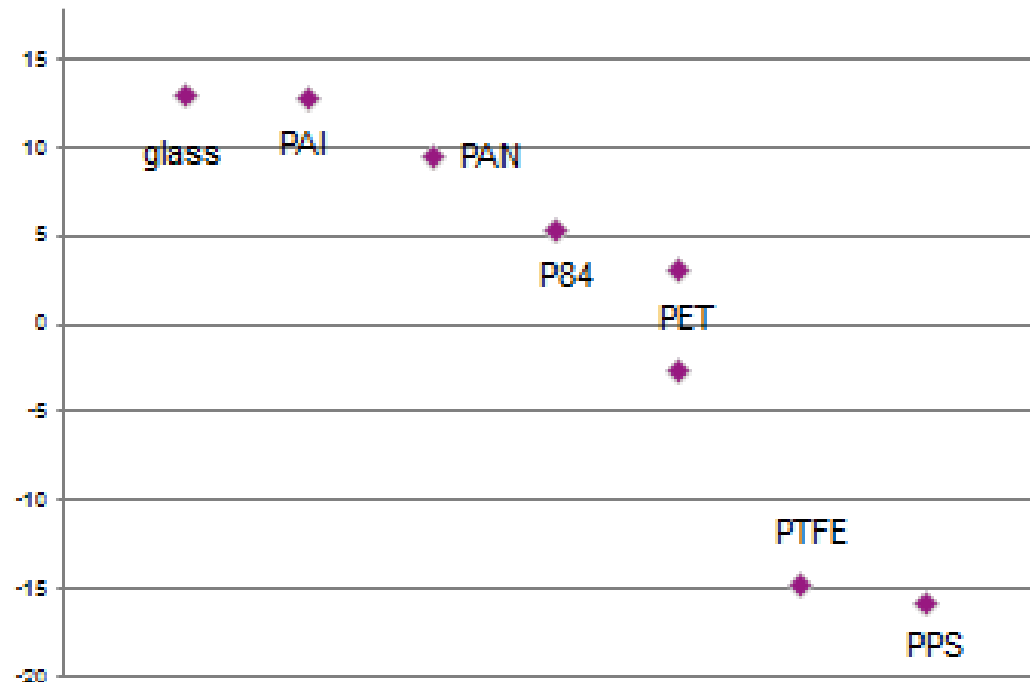
Tribo Test-Rig Charging Procedure

1. Mount a clean and dried sample on the PET reference wheel.
2. Zero the electrometer
3. Mount the balance weight (92g)
4. Turn on the motor switch for 5 minutes with a speed drive of 200rpm.
5. Slide the sample support frame after 5 minutes to the PA wheel (see below picture). Distance of the electrostatic field meter is always 25mm away from the sample.
6. Read the value of the electrostatic field meter

Electrostatic charging of filter materials



P84 charges (+) three times less in absolute value than PPS and PTFE (-)



24.05.2016 | Evonik Fibres GmbH



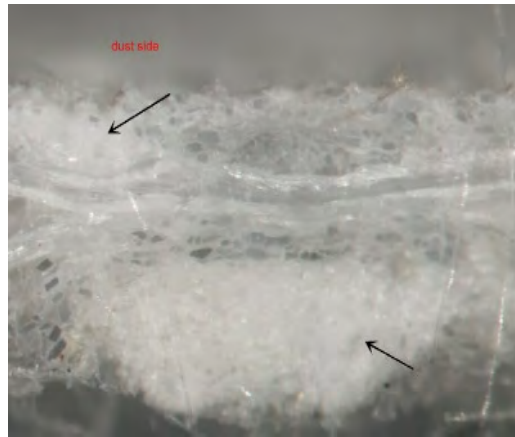
www.P84.com

Tribo-electric charging of filter media

PTFE



PPS



P84



- P84 acquires a week (+) charge (better isolator). This leads to the stability of the dust cake due to the weak repelling forces between the P84 polymer and the dust particles. The fibres are, thus, protected by the dust particles.
- PPS and PTFE acquire an opposite charge (-), three times higher in absolute value than P84, and interact with the dust particles in a different way: positive particles are forced to penetrate the felt cross section and the negative particles are repelled.
- The P84 surface fibres allow the formation of a rich and porous dust cake due to the multilobal fibre section and electrostatic properties.

APC – Wastewater Round Table



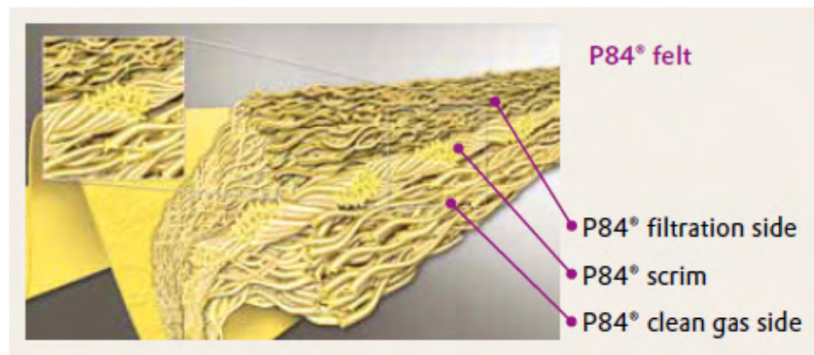
Dust Cake Implications

Benefits – P84 felt based dust cake



Increased filtration efficiency

- Operation at low pressure losses – due to the dust cake structure
- Lower suction fan power (bag house on timer control)
- Low cleaning / pulsing rates (bag house on DP control)
- dust charging capacity of multilobal fibres – longer time to reach the ΔP cleaning initiation value
- No dust penetration – due to dust cake stability
- Low particulate emissions due to the dust cake structure



Benefits – P84 based dust cake



Chemistry

➤ The bag house acts as a fixed bed reactor

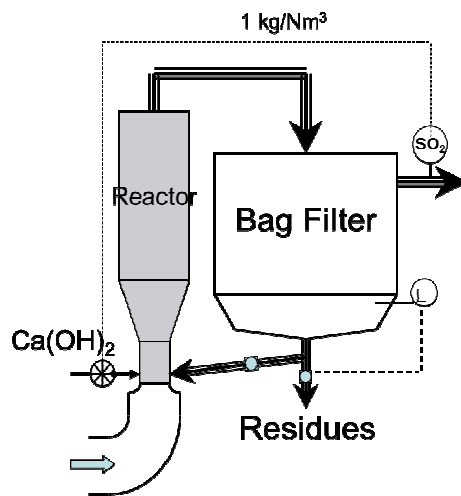
➤ Protection of the fibres against acid degradation – the alkaline components present in the dust cake neutralise naturally the acidic components present in the flue gas while the gas passes through the dust cake

➤ Secondary reaction in case of dry / semi-dry FGD systems – same as above but with the addition of activated carbon and of reagents lime or sodium based

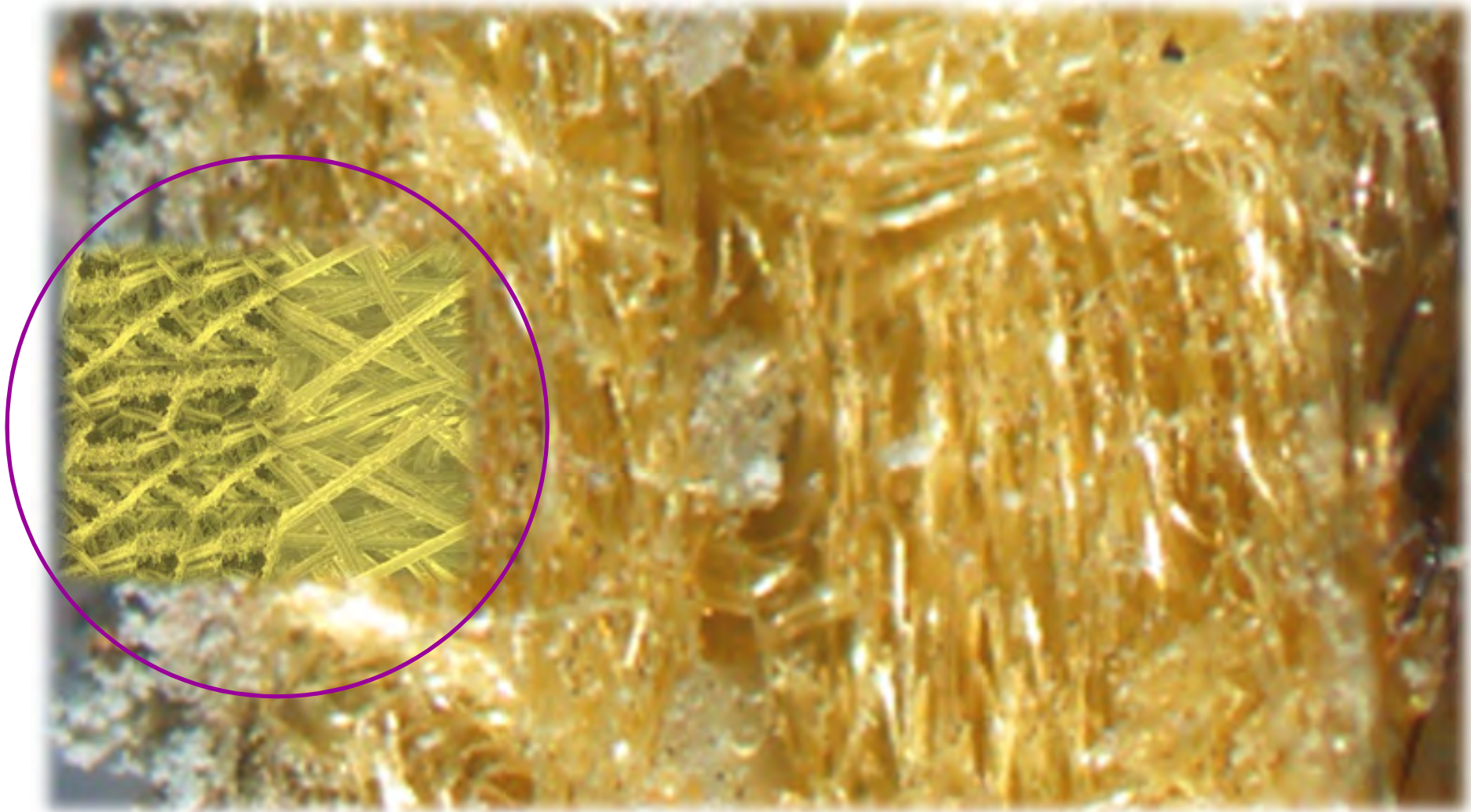
❖ Absorption of HCl, SO_x and HF

❖ Adsorption of dioxins, furans, Hg

➤ For the same ΔP a multilobal felt holds a larger dust cake ensuring more surface contact with the gas molecules and more effective chemical reactions



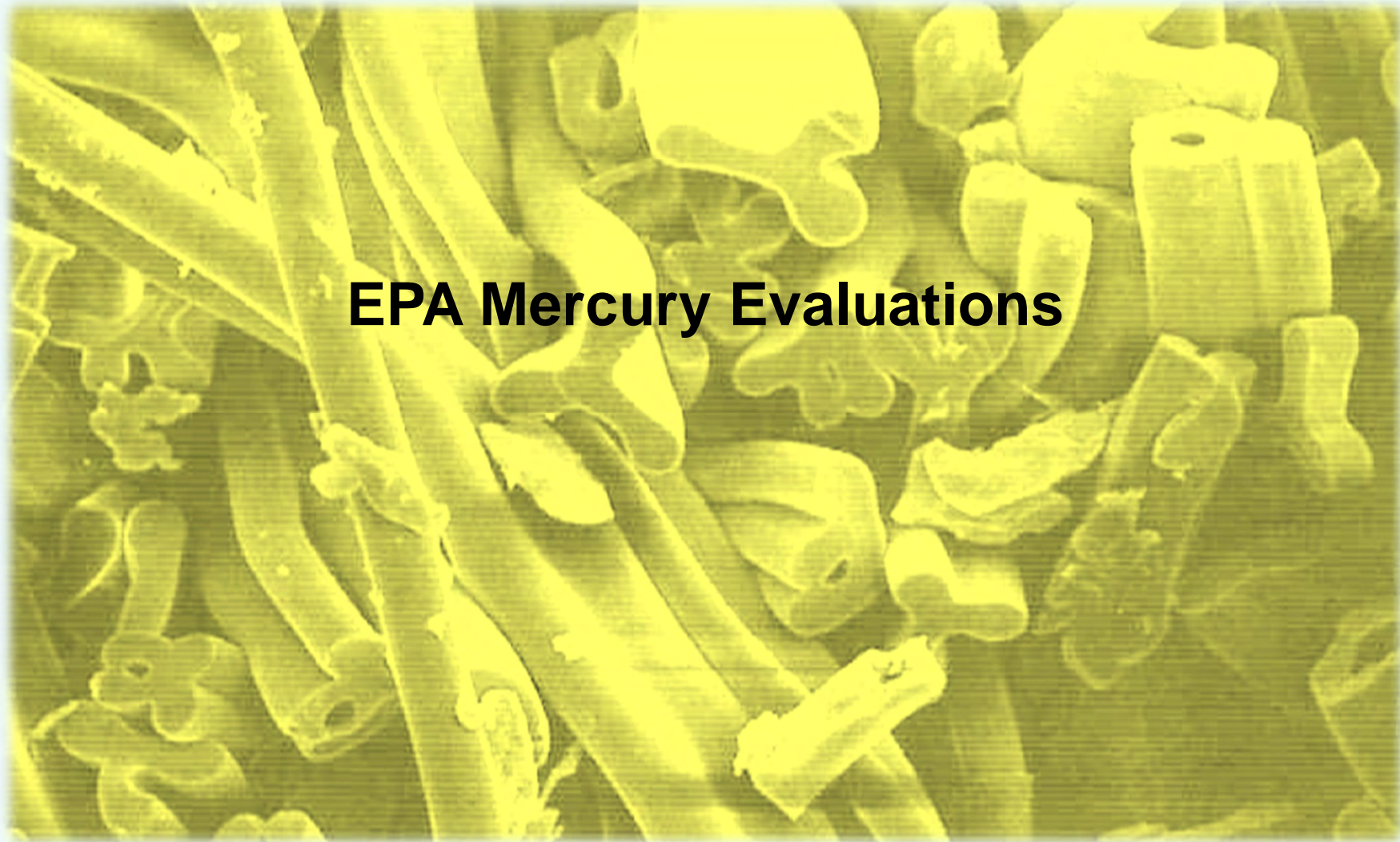
Dust cake Hg control P84 needle felt



P84

www.P84.com

APC – Wastewater Round Table



EPA Mercury Evaluations

Mercury capture – emission control technology



Post-combustion Control Strategy	Post-combustion Emission Control Device Configuration	Average Mercury Capture by Control Configuration		
		Coal Burned in Pulverized-coal-fired Boiler Unit		
		Bituminous Coal	Subbituminous Coal	Lignite
PM Control Only	CS-ESP	36 %	3%	0 %
	HS-ESP	9 %	6 %	not tested
	FF	90 %	72 %	not tested
	PS	not tested	9 %	not tested
PM Control and Spray Dryer Adsorber	SDA+CS-ESP	not tested	35 %	not tested
	SDA+FF	98 %	24 %	0 %
	SDA+FF+SCR	98 %	not tested	not tested
PM Control and Wet FGD System ^(a)	PS+FGD	12 %	0 %	33%
	CS-ESP+FGD	75 %	29 %	44 %
	HS-ESP+FGD	49 %	29 %	not tested
	FF+FGD	98 %	not tested	not tested

CS-ESP = cold-side electrostatic precipitator
 HS-ESP = hot-side electrostatic precipitator
 FF = fabric filter
 PS = particle scrubber
 SDA = spray dryer absorber system

(a) Estimated capture across both control devices

(Courtesy of EPA)



EVONIK
INDUSTRIES