

Air Pollution Control Systems for Power Stations and Waste to Energy plants

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Content

1. introduction
2. State of the art for APC-system for WtE- and Power Plants
3. SO₃-Removal
4. Fabric filter as a key component in APC-Systems, examples



■ Performance of ete.a

- basic and detail engineering
- project management
- project steering
- concept development / optimizations
- studies



■ Business units of ete.a

- energy engineering
- environmental technology
- project management

References

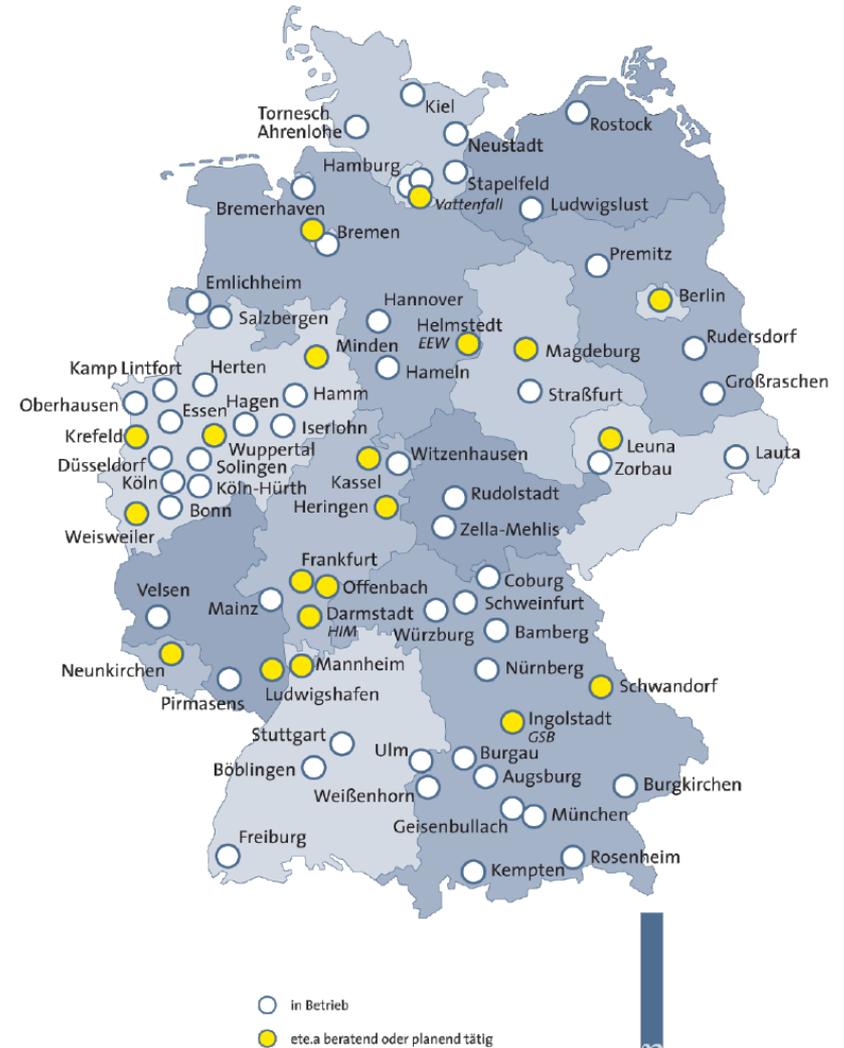
Market share on WtE plants in Germany more than 25 %

Power Plants:

- Vattenfall
- e.on



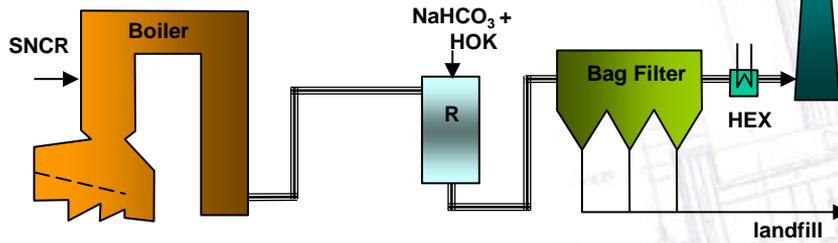
Thermische Abfallbehandlungsanlagen in Deutschland



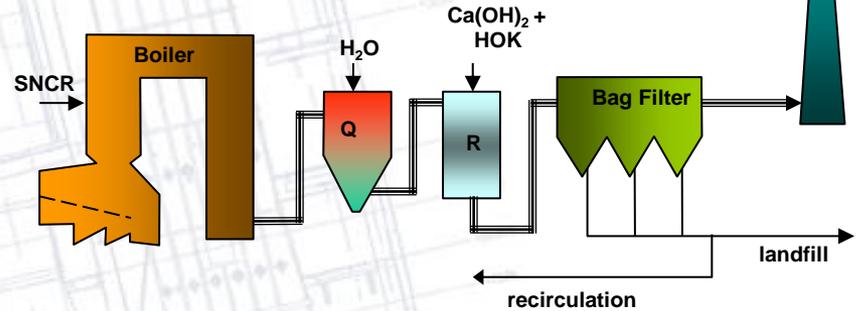
Quellen: www.itad.de kartonmuelton.de
Köln-Güterstraße

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Ingenieurgesellschaft für Energie- und
Umweltengineering & Beratung mbH

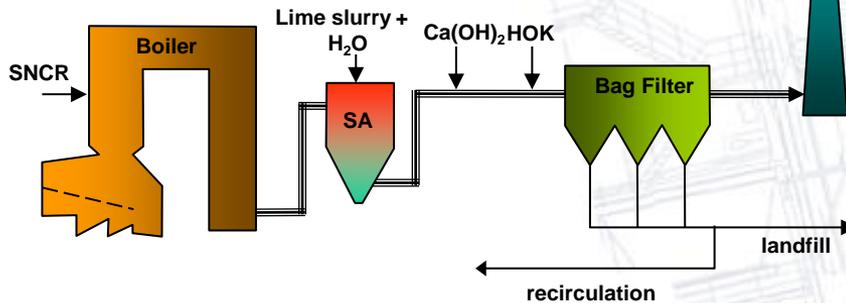
Dry Absorption



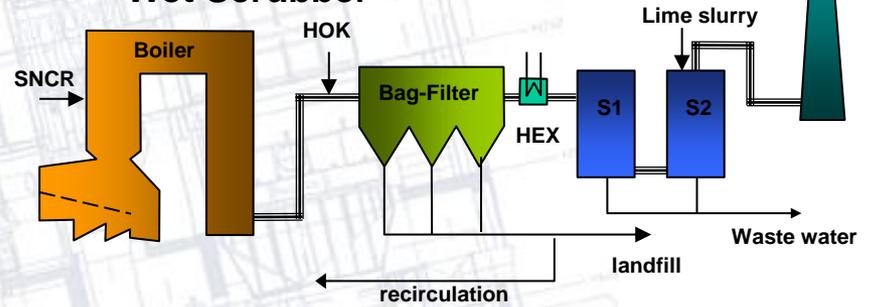
Conditioned Dry Absorption



Spray Absorption



Wet Scrubber

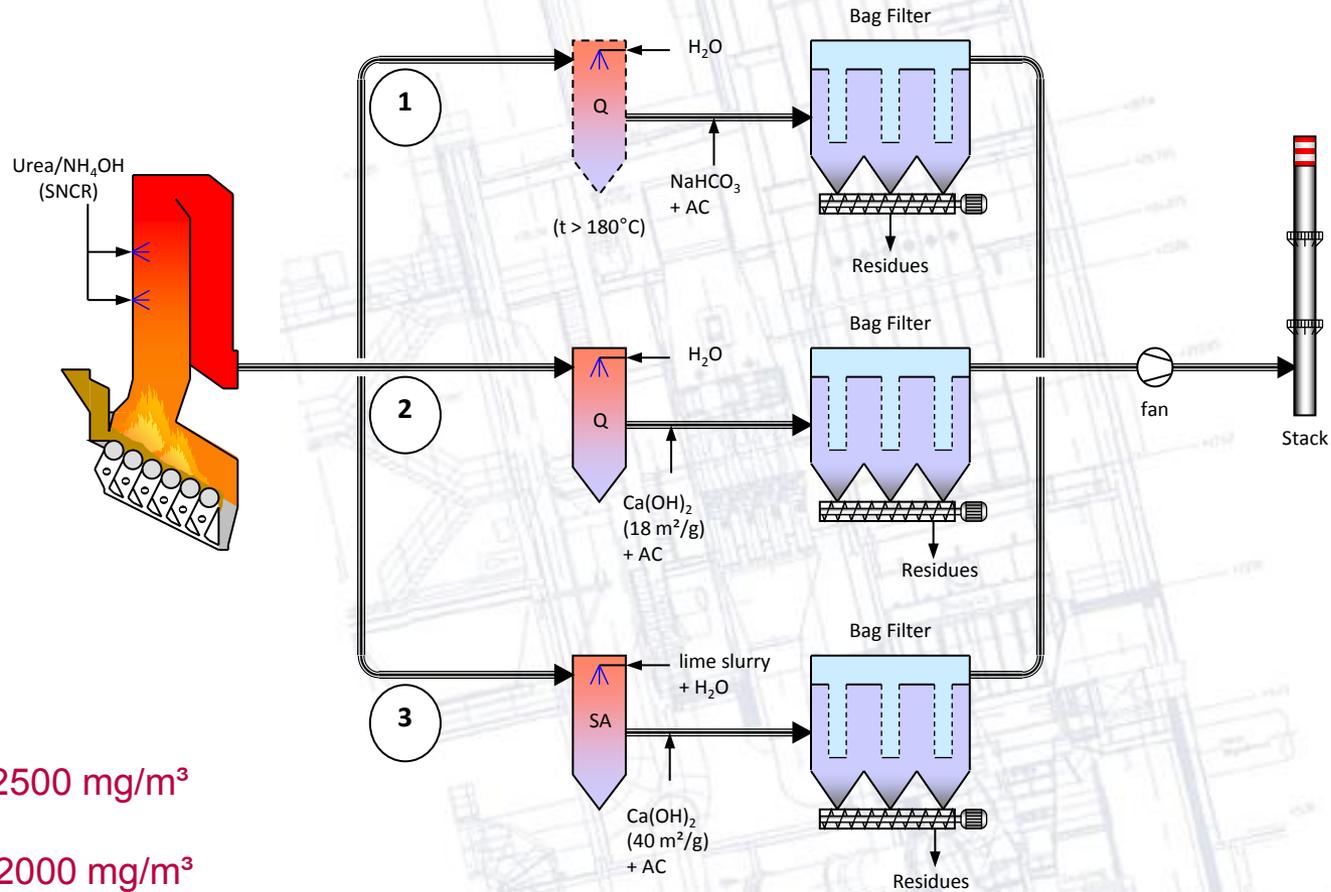


Q = quench
R = reactor

SA = spray absorber
S1/S2 = scrubber
HEX = heat exchanger

Source: fisia-babcock

Operation range of single stage dry absorption systems



$\text{HCl} \leq 2500 \text{ mg/m}^3$

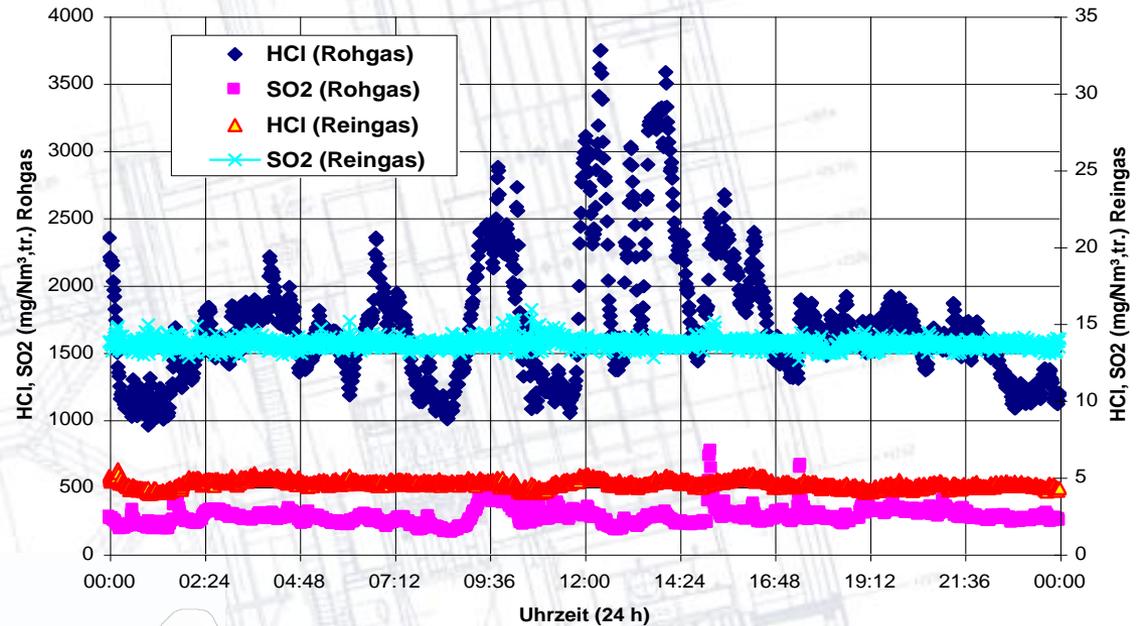
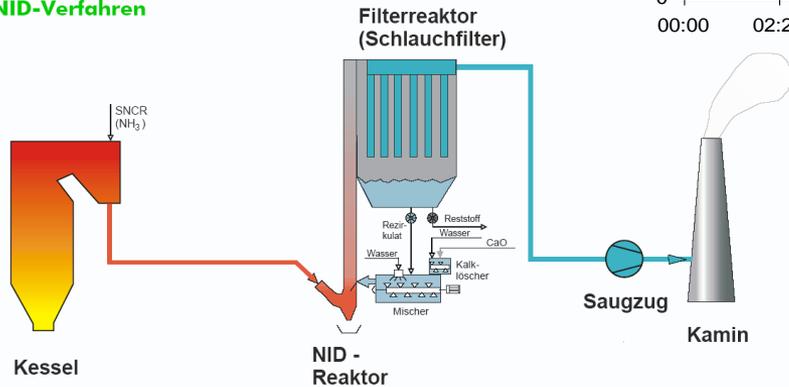
$\text{SO}_2 \leq 2000 \text{ mg/m}^3$

$\text{NO}_x \leq 100 \text{ mg/m}^3$ (emission figures)

Experience with conditioned dry absorption systems

EBS-plant Romonta

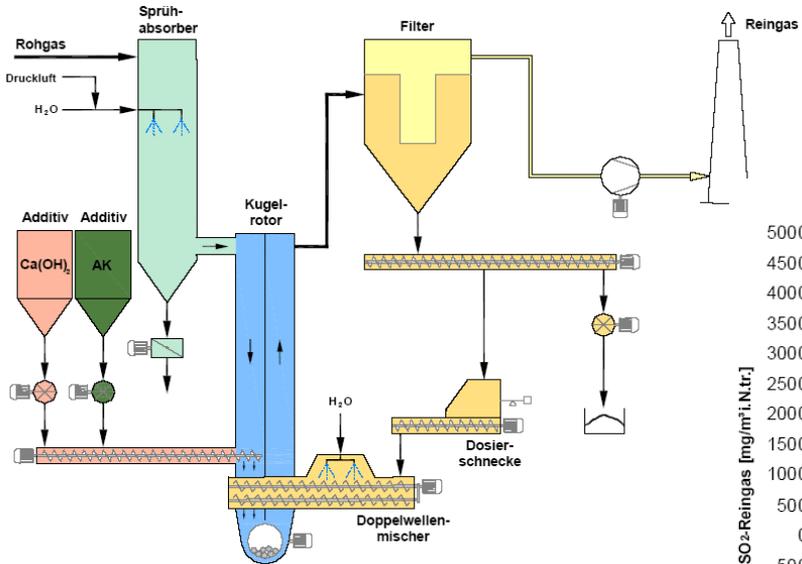
NID-Verfahren



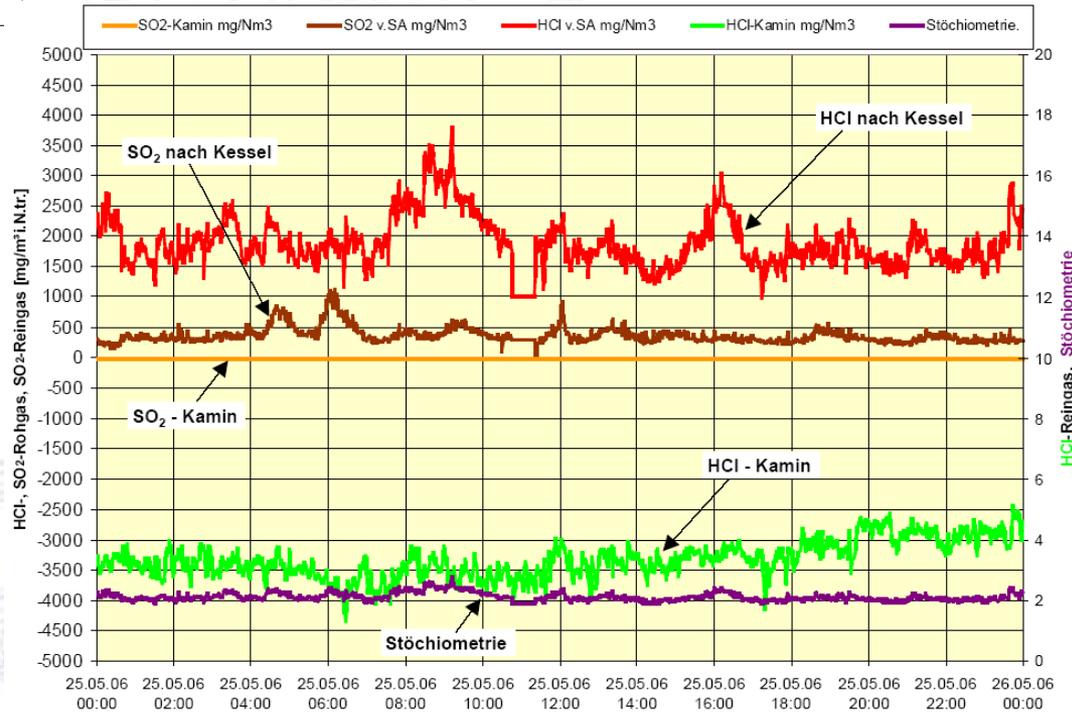
Quelle: ALSTOM Power

Experience with conditioned dry absorption systems

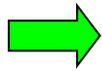
Wte-plant Ludwigshafen



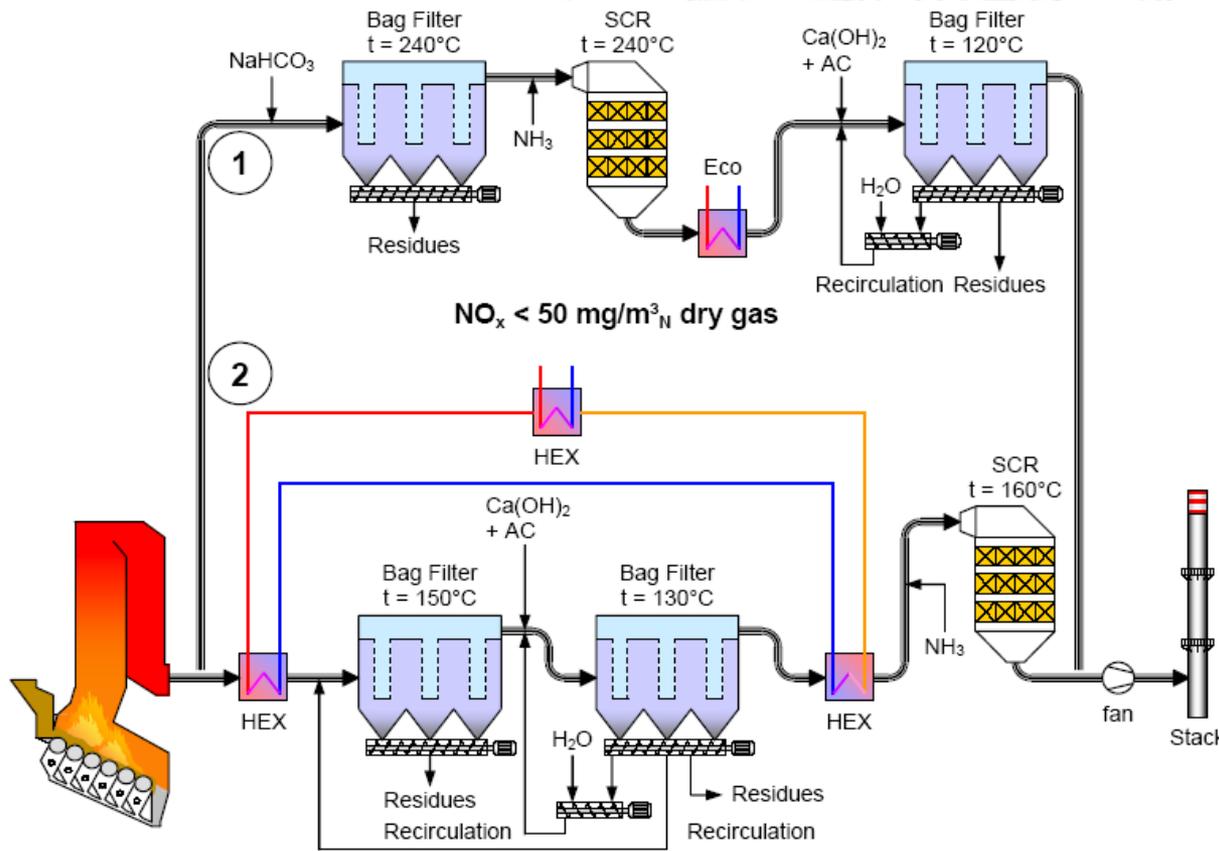
Quelle: Lühr-Filter



Operation range of multistage flue gas systems



If the HCl-raw gas concentrations as a permanent load is $> 2500 \text{ mg/m}^3$, a multistage system is necessary

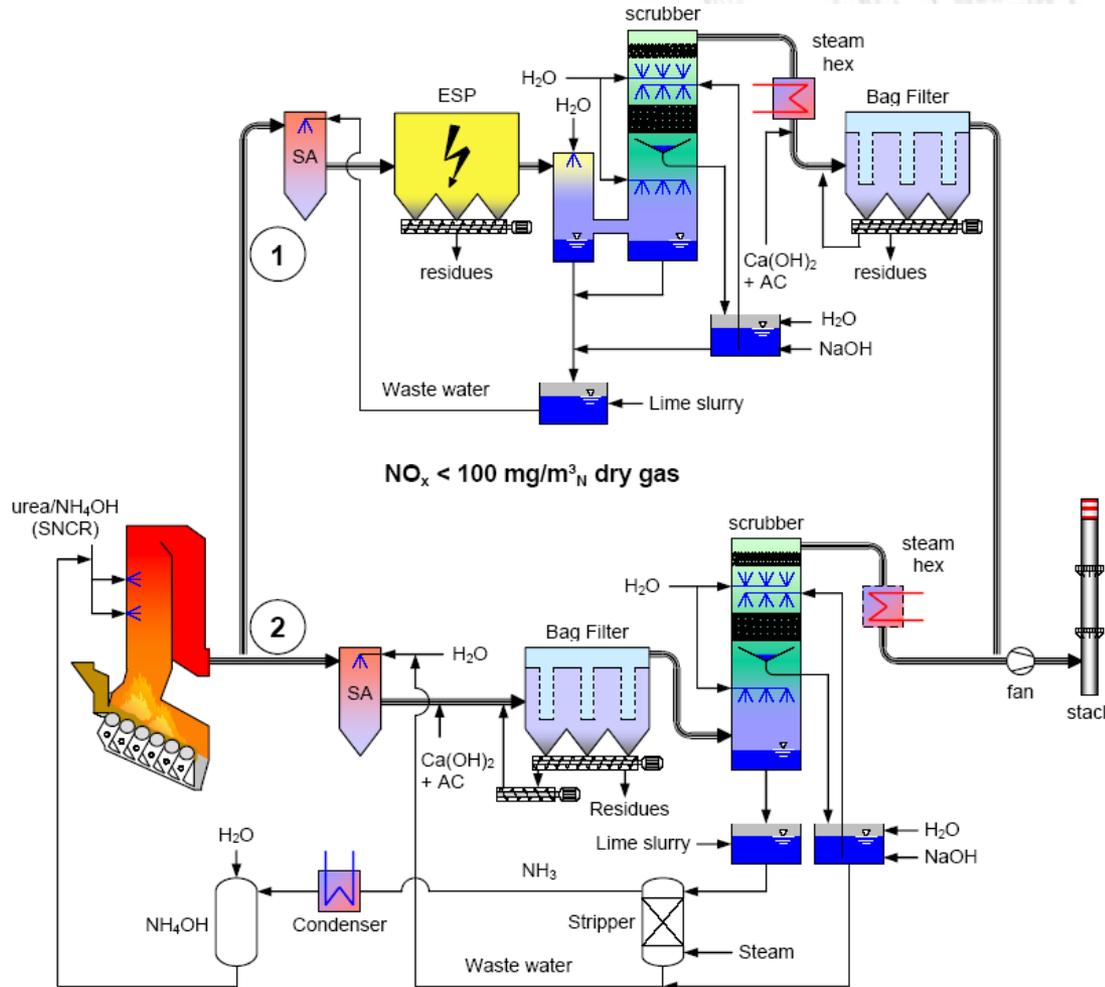


$HCl \geq 2500 \text{ mg/m}^3$

$SO_2 \geq 2000 \text{ mg/m}^3$

$NO_x \leq 50 \text{ mg/m}^3$
(emission figures)

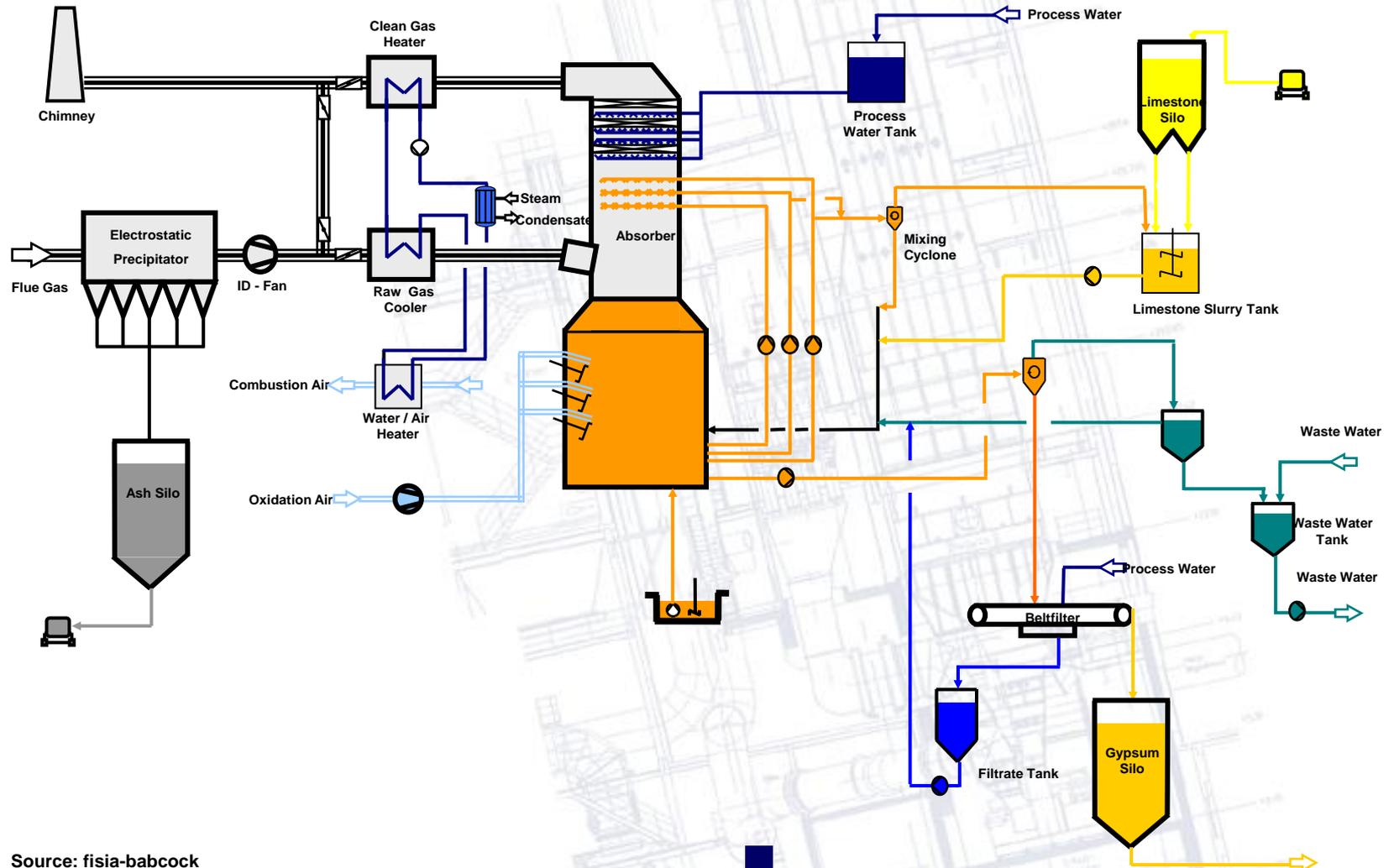
Operation range of multistage flue gas systems



HCl \geq 2500 mg/m³
SO₂ \geq 2000 mg/m³
NO_x \leq 100 mg/m³
(emission figure)

NO_x < 100 mg/m³ dry gas

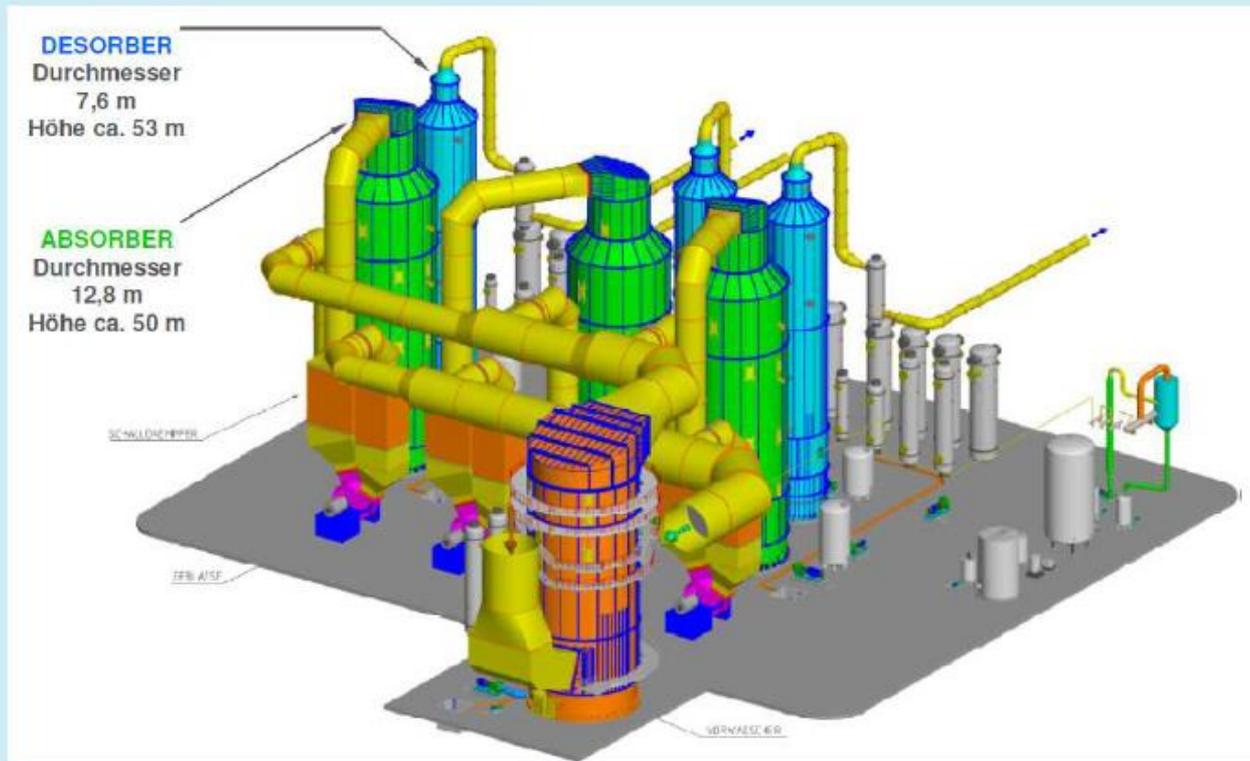
Single loop FGD with leakage free reheating



Source: fisia-babcock

New Generation of Power Stations - CO₂-Absorption

Anordnungsplan für eine Großanlage mit 800 MWel



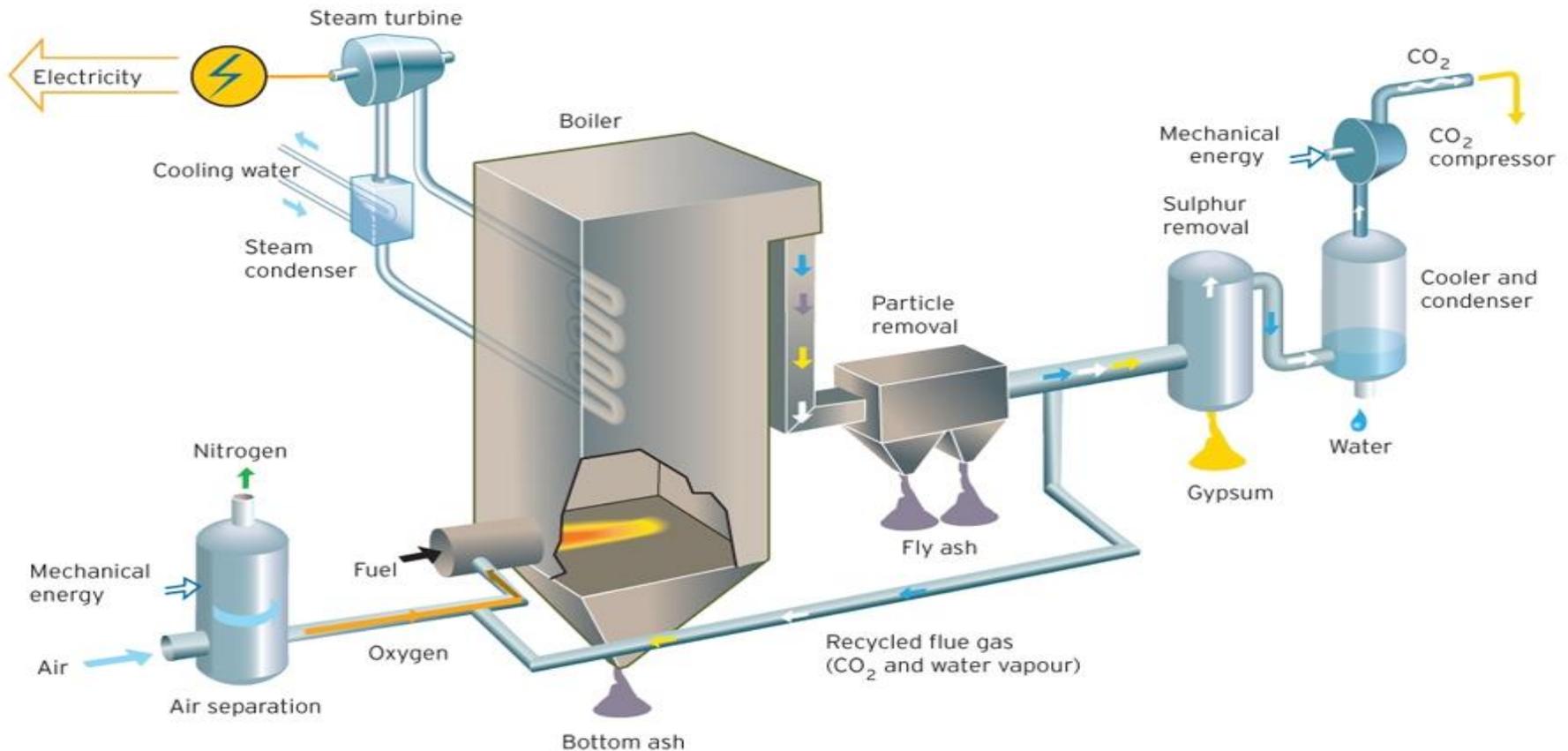
Dr. A. Heberle, Dipl. Ing. J. Klebes, Dipl. Ing. T. Buddenberg (Hitachi Power Europe GmbH)

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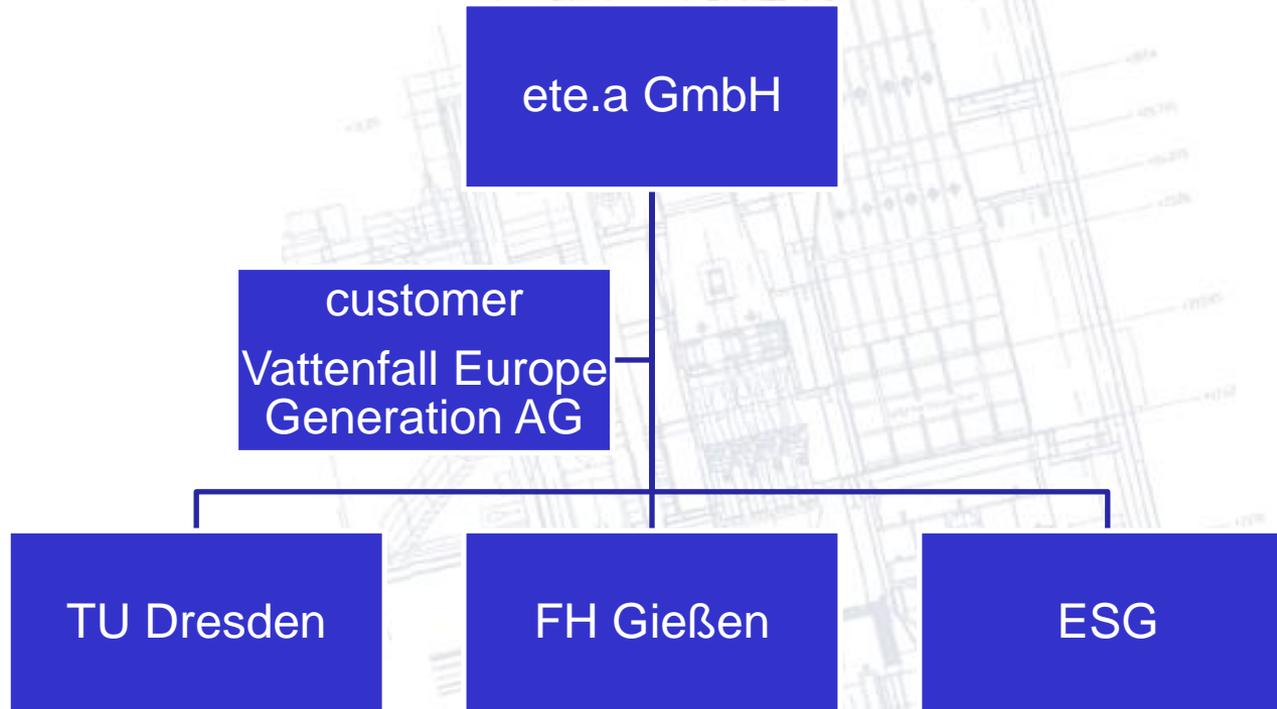
Source: Hitachi Power Europe GmbH

New Generation of APC-Systems for Power Stations

Oxyfuel (O_2/CO_2 recycle) combustion capture



R&D project to investigate SO₃-removal



Aim / Motivation of the project

- Quantify the principle removal of SO_3 , with limestone on a fabric filter
- Estimate the SO_3 -removal efficiency of fly ash
- Quantify the influence of the mass balance limestone to flyash (distribution of sorbents)

Oxyfuel-combustion

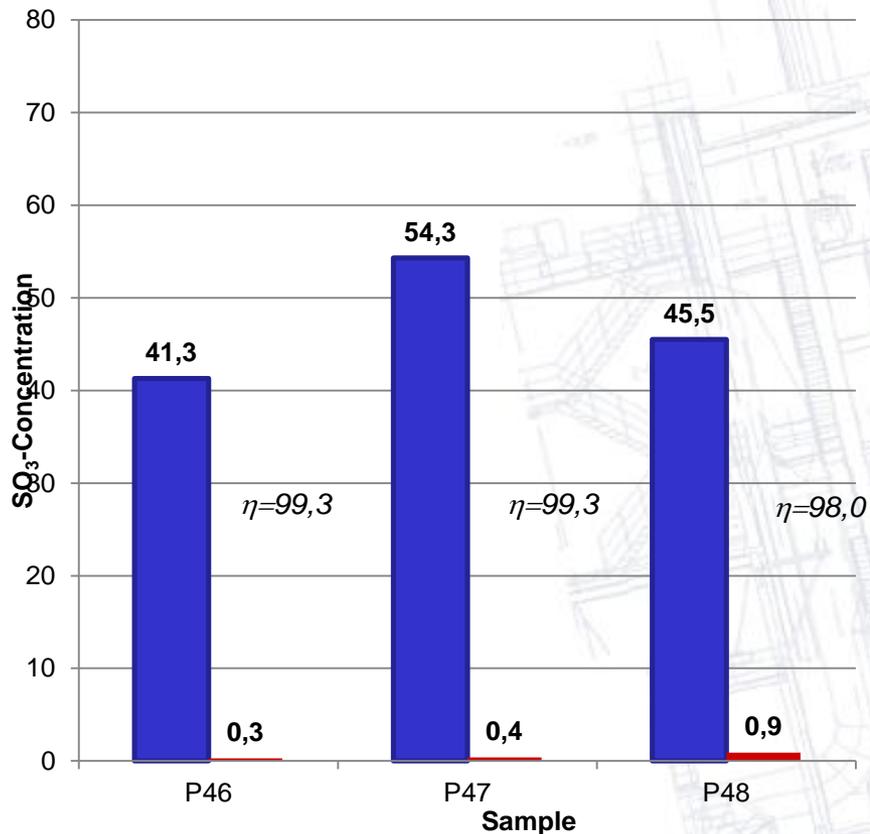
cyclon



fabric filter

SO₃-removal with limestone on a fabric filter

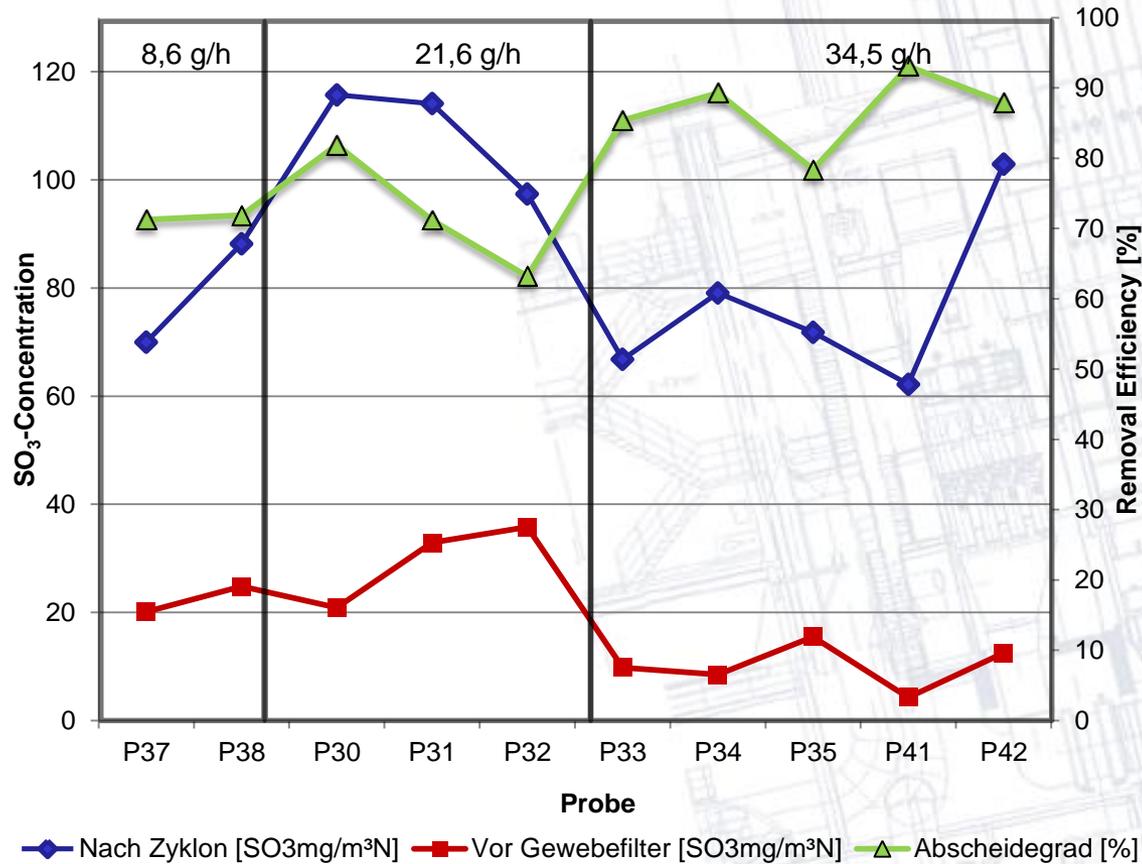
- SO₃-inlet average value 47,0 mg/m³
- SO₃-outlet average value 0,5 mg/m³
- average efficiency 98,9 %



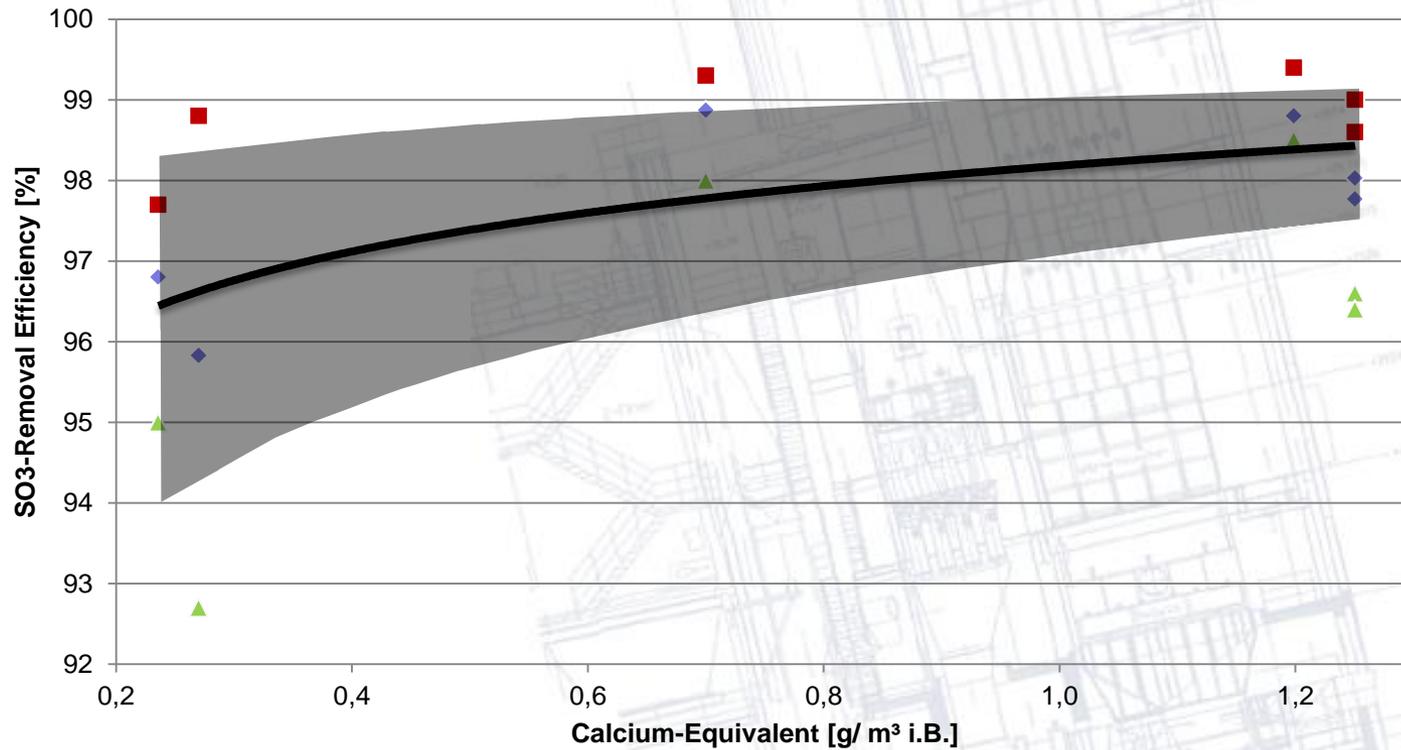
■ Nach Zyklon [SO₃mg/m³N]

■ Nach Gewebefilter [SO₃mg/m³N]

Influence of the SO₃-efficiency at the gaseous phase on fly ash



SO₃-removal efficiency depend on the calcium-equivalent



◆ Mittelwert des Abscheidegrades

■ Maximalwert des Abscheidegrades

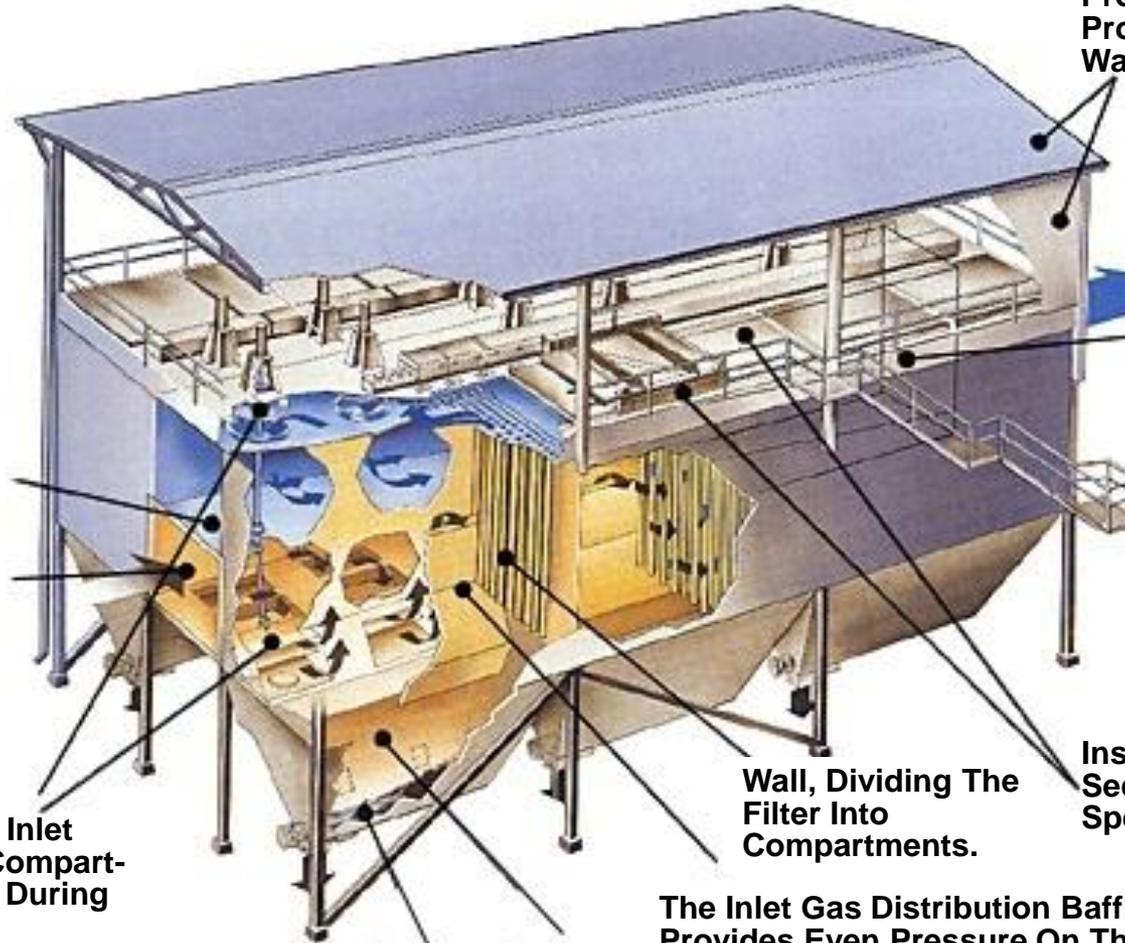
▲ Minimalwert des Abscheidesgrades

Design of a typical fabric filter, e.g. Typ ALSTOM, Optipuls LKP

Synthetic Fiber Bags
Up To 8 Meters Long.

Sloped Partition Wall
Between The Inlet and
Outlet Plenum

Shut-Off Dampers In The Inlet
And Outlet Of The Filter Compartments
Which Are Closed During
Service.



The Service Area Can Be
Provided With Full Weather
Protection - Including
Walls And Roof.

Clean Gas
Outlet

Inspection Cover Above Bag
Section. Easily Removed By
Special Service Trolley.

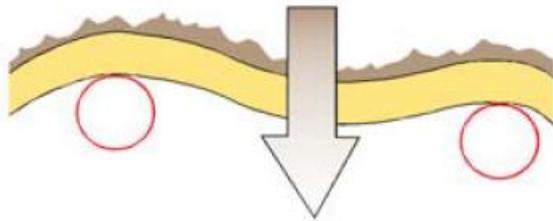
Wall, Dividing The
Filter Into
Compartments.

The Inlet Gas Distribution Baffle
Provides Even Pressure On The Bags.

Dust Hopper

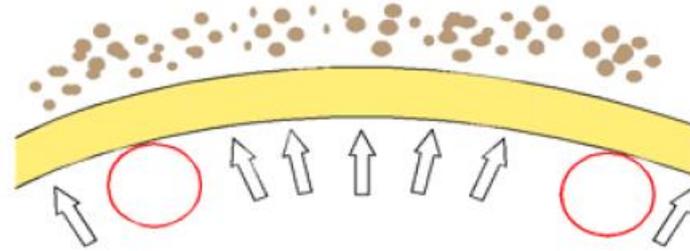
Conveyor

Characteristics of Fabric Filter/ Dry Absorption



flue gas

Filtration



Pressurised air

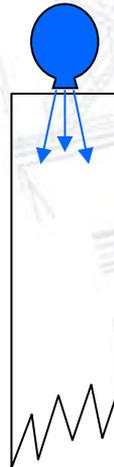
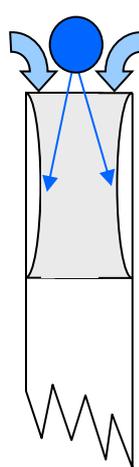
Cleaning

Cleaning with a venturi

Secondary air

6 – 7times more than
primary air

- slowly puls
- short bag length (~ 3 m)



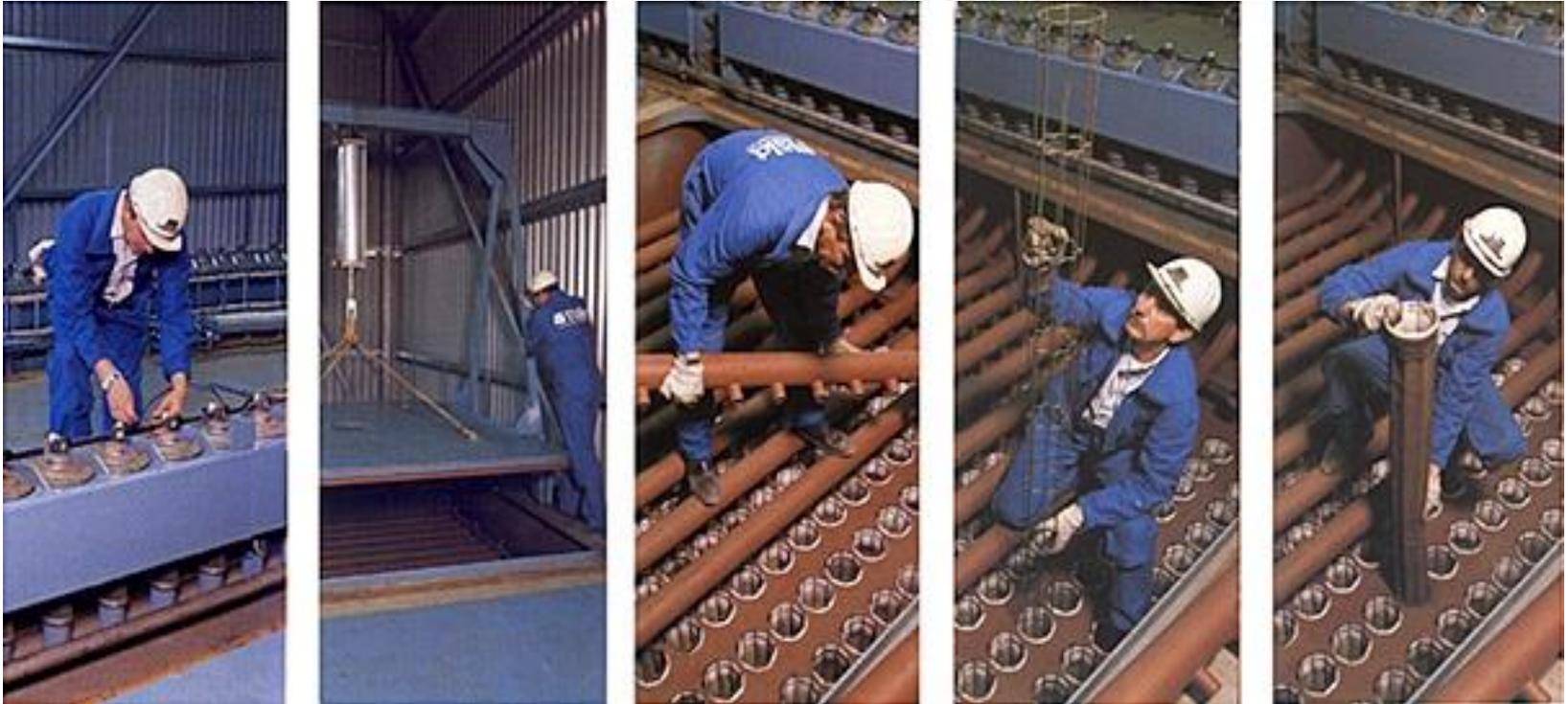
Low pressure
200 kPa

Direct Cleaning

Primary air expanded direct
in the filter bag – Secondary
air only app. 1-2times of the
Primary air

- short und rapid puls
- „deep“ puls
for long filter bags
(up to 8 m)

Characteristics of Fabric Filter/ Dry Absorption



Characteristics of Fabric Filter/ Dry Absorption

The main criteria for the design of a fabric filter are:

- **Air to Cloth Ratio**

$$v_F = \frac{V_{i.B.} [m^3/h]}{A_F [m^2]} = \text{Filterflächenbelastung} [m^3/m^2h]$$

- **Pressure drop of the fabric filter**

- for pure dust removal app. 8 – 12 mbar
- for the combination dust removal and sorption app. 12 – 20 mbar. The maximum design pressure are mostly 25 – 35 mbar

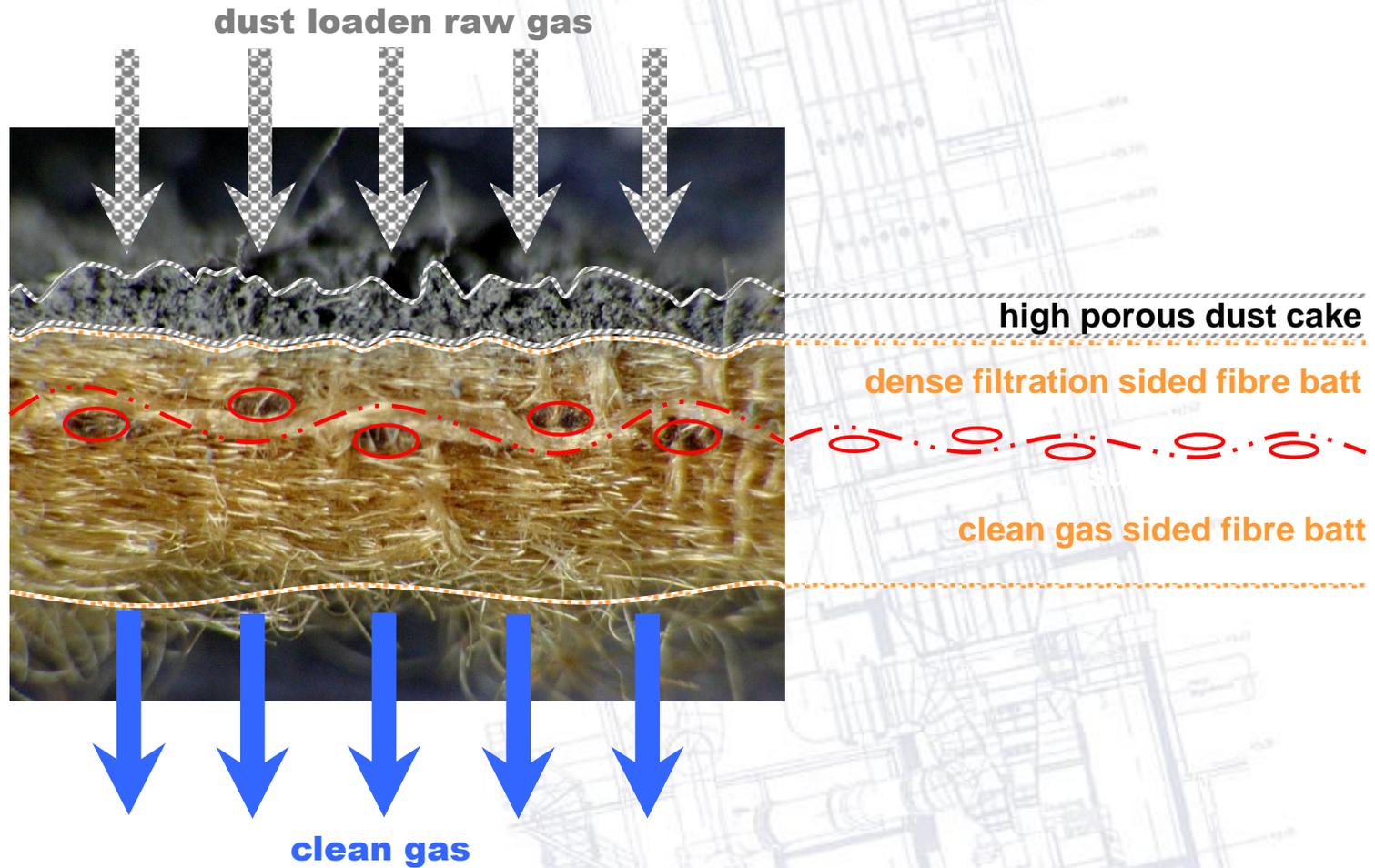
Characteristics of Fabric Filter/ Dry Absorption

The main criteria for the design of a fabric filter are:

- **Filter media**

- **Resistance (temperature, chemical, mechanical)**
- **condition of filtration (dust behaviour, removal efficiency,...)**
- **costs**

Surface oriented filtration



Quelle: Fa. Gutsche, Fulda

Optivel PI filter media construction (PPS basis)



Needlefelt cross-section new



Needlefelt cross-section 12 months CFB

- **Surface oriented filtration due to P84 in the fibre blend**
- **No dust penetration into the cross-section of the needlefelt**
- **Longer bag life, constant low pressure drop, energy saving**

Characteristics of Fabric Filter/ Dry Absorption

The main criteria for the design of a fabric filter are:

- Filtermedia
- consumption of pressurised air for filter cleaning
- flue gas distribution of the filter bags
- costs

examples

Liddell 4X500 MWe Coal Fired Power Station, Australia

ESP -> FF Conversion Retrofit

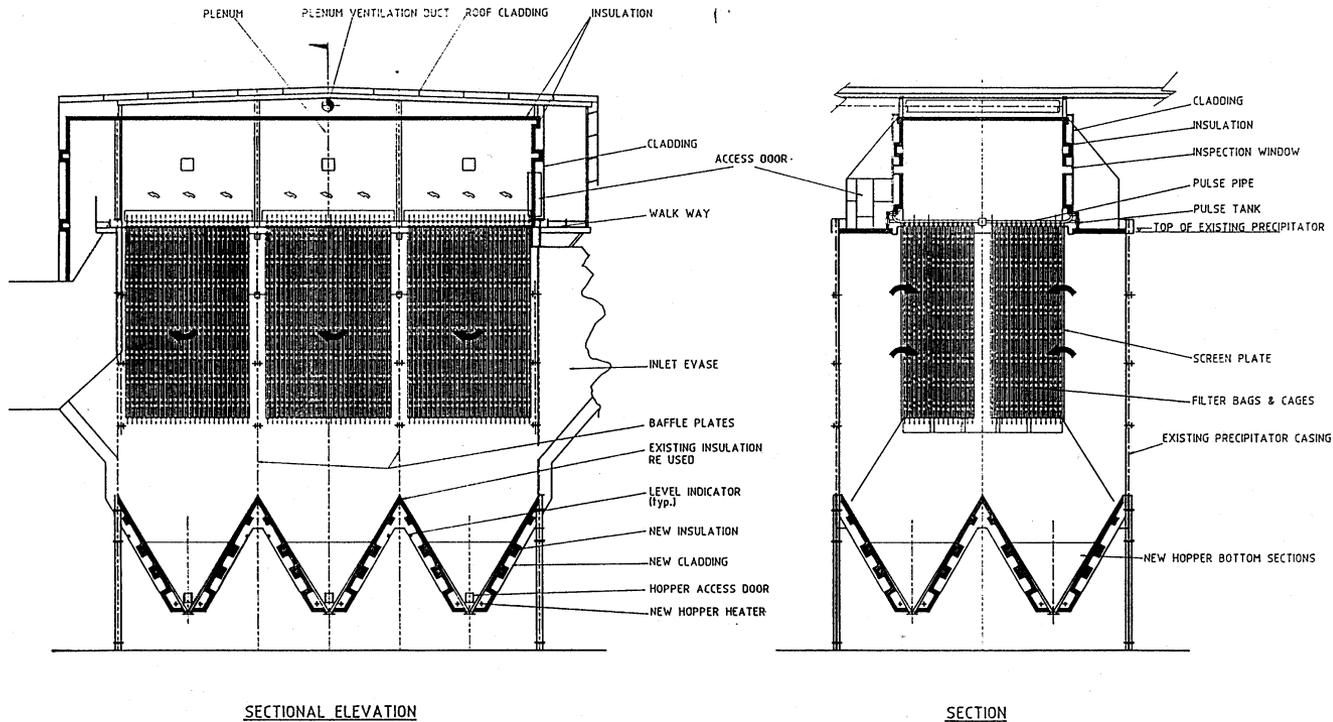
Unit Rating (MWe)	500
Boiler Type	Pulverized coal fired
Gas volume (m ³ /h)	3,384,000
Gas temperature (degC)	135
Start-up	1991
No. of Bags (pcs.)	14,664
Bag length (m)	8
Bag material	PPS/PPS (Ryton)
Inlet fly ash (g/Nm ³ _{wg})	40
A/C-ratio (m/h)	72
Guarantee value (mg/Nm ³ _{dg})	80
Guarantee DP across bags (kPa)	1.35

Quelle: ALSTOM, ECS P. Wieslander

examples

Liddell 4X500 MWe Coal Fired Power Station, Australia

ESP -> FF Conversion Retrofit



Quelle: ALSTOM, ECS P. Wieslander

examples

Liddell 4X500 MWe Coal Fired Power Station, Australia

ESP -> FF Conversion
Retrofit



Quelle: ALSTOM, ECS P. Wieslander

examples

Kogan Creek 750 MWe Coal Fired Power Station, Australia

- 750 MWe supercritical pulverized coal fired boiler in Queensland, Australia. Largest single generating unit in Australia.
- Boiler delivered by Babcock Hitachi in Japan
- Base load boiler
- Coal ash content approx. 25 - 28 %, coal S-content approx. 0.3 – 0.5 %
- Start-up fuel: Low S diesel oil (max 0.3 % S)
- Boiler commissioned May 2007

examples

**Kogan Creek 750 MWe Coal Fired
Power Station, Australia**



Quelle: ALSTOM, ECS P. Wieslander

examples

**Kogan Creek 750 MWe Coal Fired
Power Station, Australia**



Quelle: ALSTOM, ECS P. Wieslander

examples

Kogan Creek 750 MWe Coal Fired Power Station, Australia

- Plant layout: Boiler -> APH -> FF -> Fan -> Stack
- Design gas flow 958 m³/s @ 125 degC
- Inlet fly ash 39 g/Nm³_{wg} (performance coal), 48 g/ Nm³_{wg} (worst coal)
- FF size 2 x LKP-2x4x1020-8.0, filter area 52 224 m²
- FF design A/C-ratio 66 m/h N, 70.4 m/h N-1
- FF flange-to-flange pressure drop guarantee: 2 kPa (N-1)
- FF dust emission guarantee: 50 mg/Nm³_{dg}
- FF dust emission measured at 6 mg/Nm³_{dg} at actual gas flow 1053 m³/s, vs design 958 m³/s (+ 10 %)
- Bag material: PPS/PPS (Ryton/Ryton)
- Laboratory bag analysis performed August 2008 at approximately 9000 operating hours shows that the bags are in very good condition.

examples

Kogan Creek 750 MWe Coal Fired
Power Station, Australia



Quelle: ALSTOM, ECS P. Wieslander

examples

**Kogan Creek 750 MWe Coal Fired
Power Station, Australia**



Quelle: ALSTOM, ECS P. Wieslander

Thank you for your attention!

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