# WONDERBED-TECHNOLOGY

# Target & Development of the Wonderbed

Target

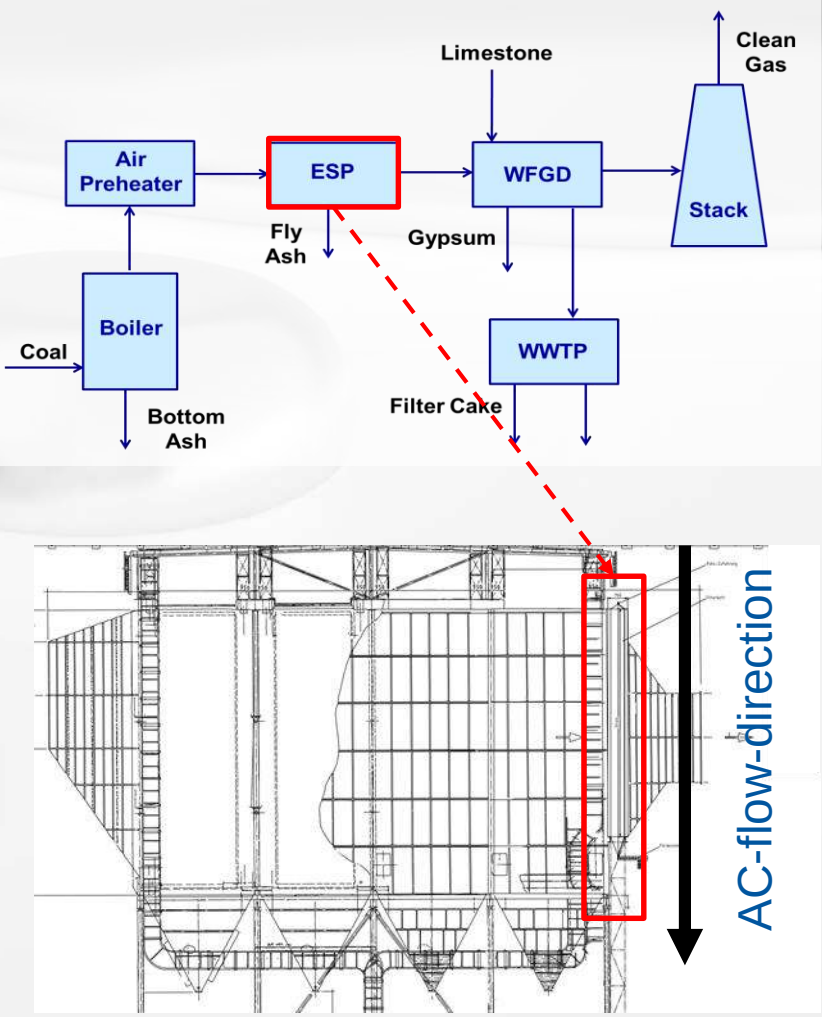
- Achieve future Hg-flue gas emission limits of <5 µg/m³ at lignite burning power plants
- Reduce operation costs of the Hg-removal treatment

Development

- Following the principle of fixed bed filters after waste incinerators
- A new concept with less pressure drop was developed
- Focus is set on catalytic Hg-oxidation
- Since 04/20 on-going research at plant Schkopau on a pilot plant
- Technic is now ready for full scale application

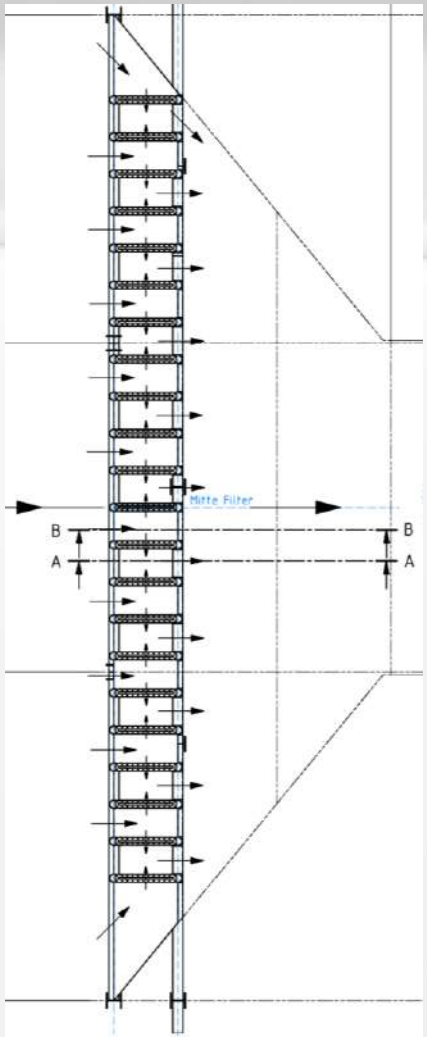
# Installation Location of the Wonderbed

- Downstream of the ESP
  - Integrated in the ESP outlet hood is foreseen
  - Flue gas temperature: 130 - 200 °C
  - Hg-concentration 10 – 50 µg/sm³
- Flue gas velocity in the ESP
  - 1,1 – 1,8 m/s
- Achievement of the necessary adsorption surface by a specific design of the "Wonderbed"



# Design of the Wonderbed

- Adjustment of the number and size of the individual filter beds
- Reinforcement of the existing steel support structures
- Size of the Wonderbed surface and flow velocity of the flue gas can be individually adjusted:
  - Pressure loss between 2 and 5 mbar
  - Hg-oxidation rate: up to 90 %
  - Hg sink for oxidized species: FGD
  - More than 99 % of the additional dust can be separate in the wet FGD



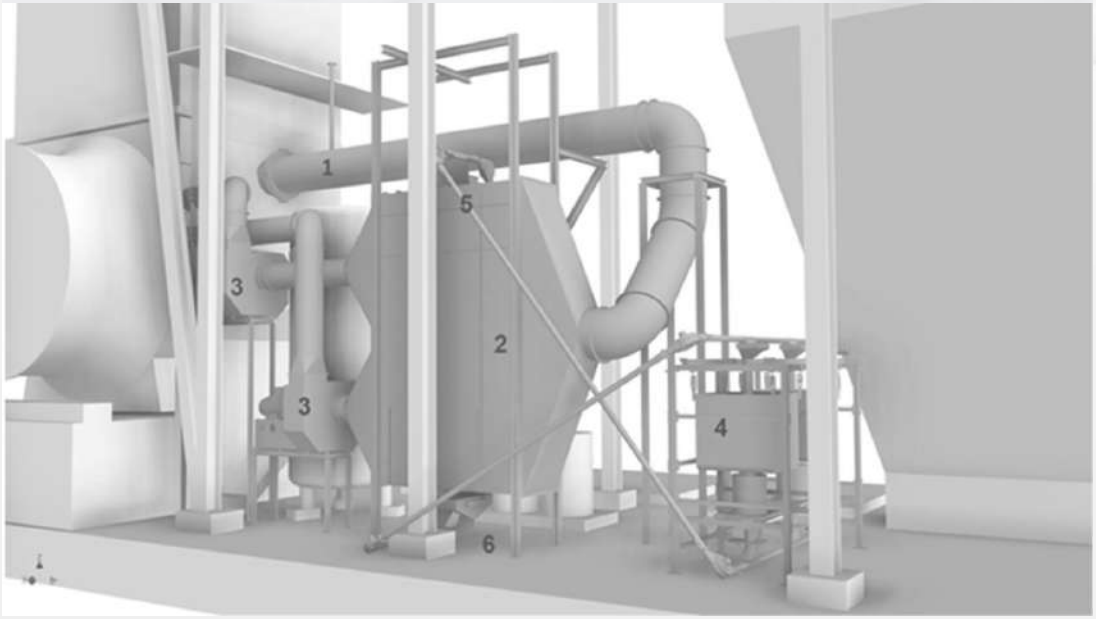
# Experiences with Microbed Pilot Plants

- Up to 500 m³/h flue gas
- Adjustable filter bed volume (< 2 l)
- Sorbent material manually changed

  → for quick material-selection

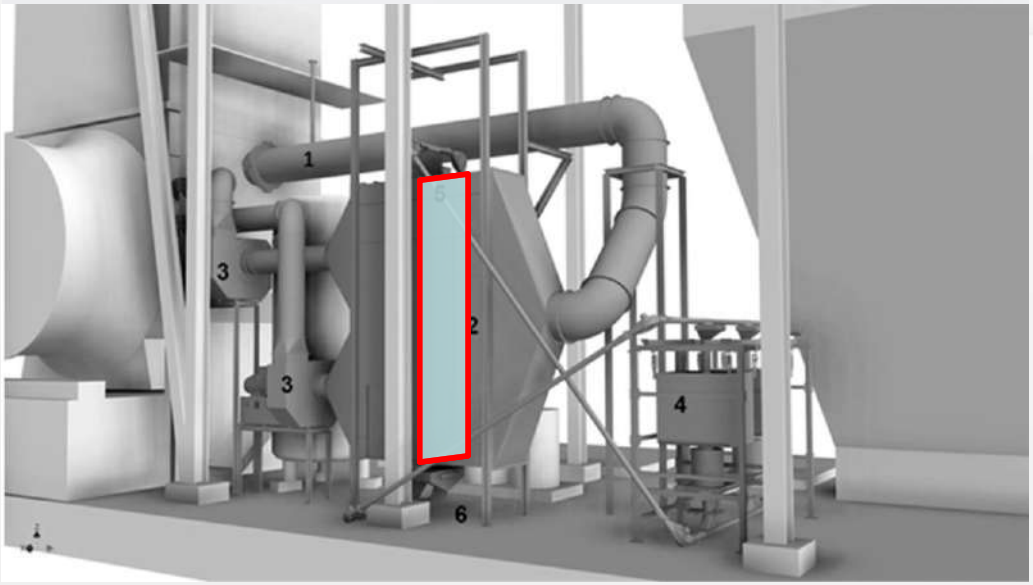
# Experience with Pilot Plant

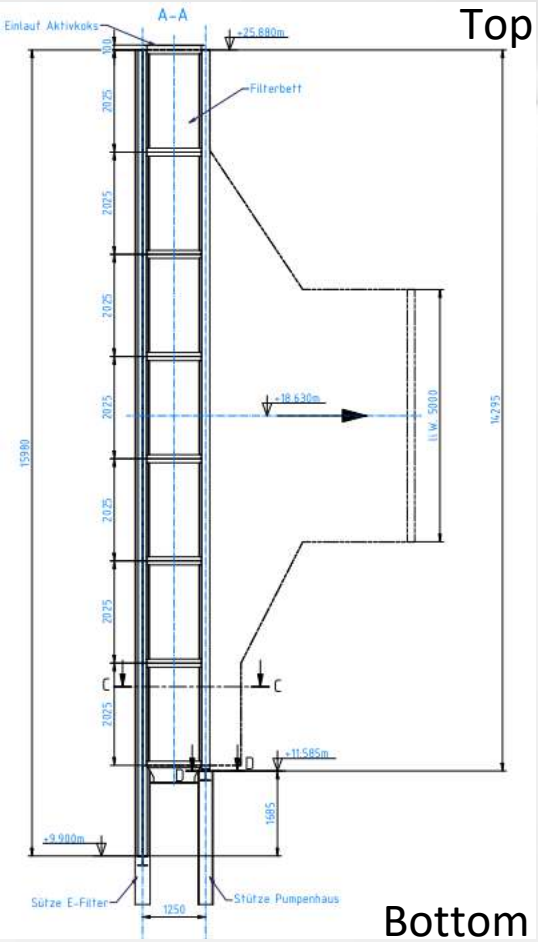
- More than 8 months of operating experience
  - Up to 40.000 m³/h
  - 30 different sorbent materials tested
  - Small upscaling factor to a full-scale plant




# Upscaling of the Wonderbed

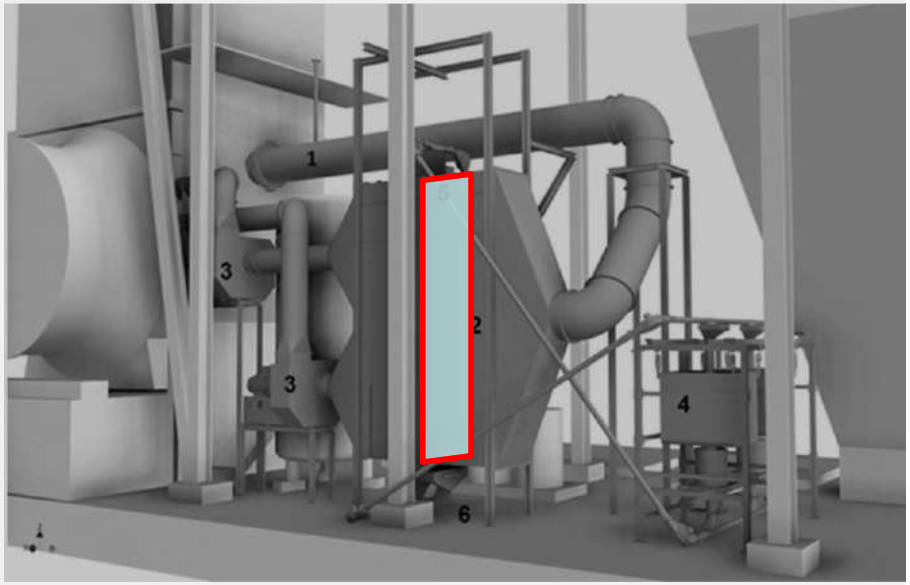
- Size and structure of each filter bed is comparable to the test plant
  - Typical upscaling factor 2 -3
- Installation in the ESP outlet hood is foreseen

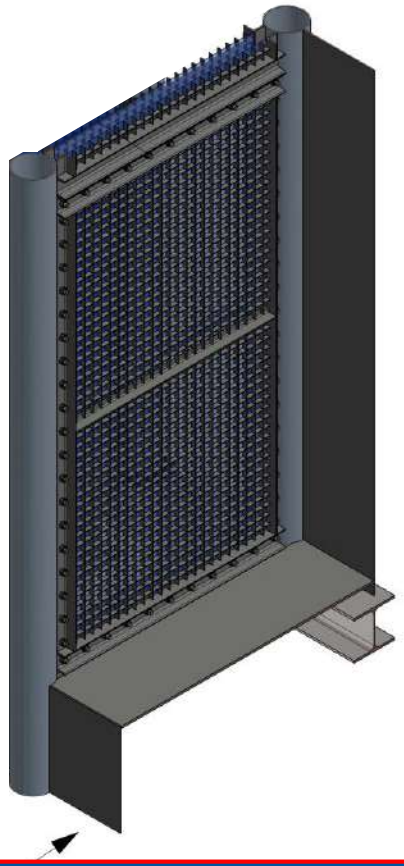


# Upscaling of the Wonderbed (II)

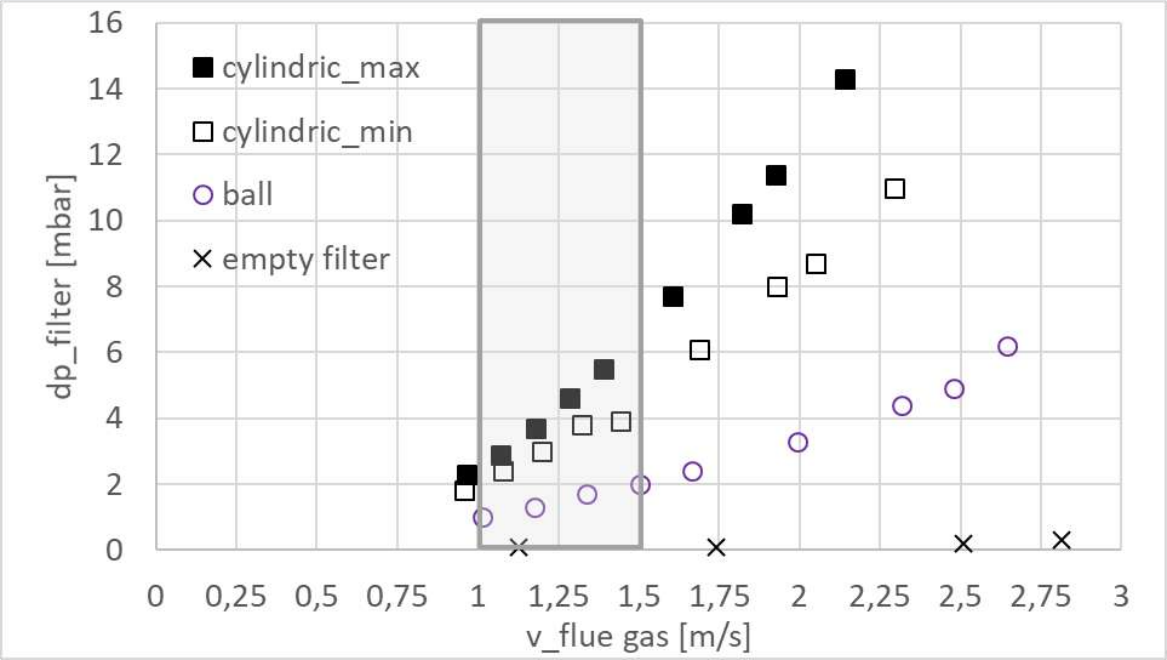
- Parallel operation of several "Wonderbeds" in the full-scale plant
- Measurement results of the pilot plant can be transferred easily to full scale plants

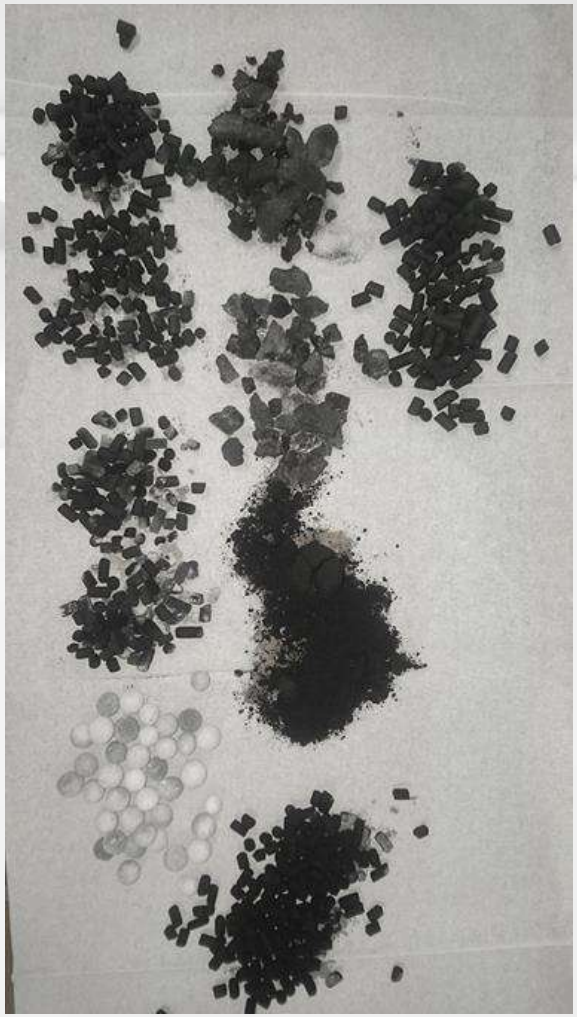


# Pressure Drop over the Wonderbed

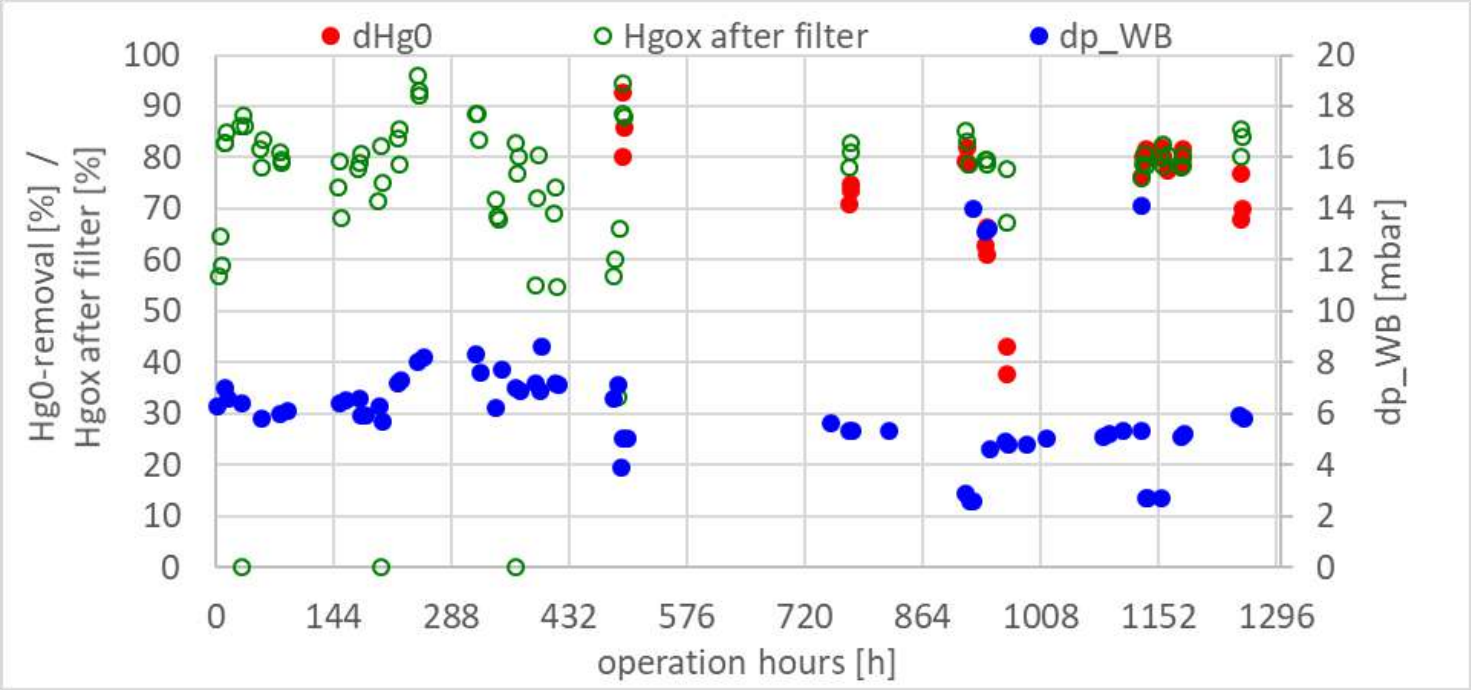
- Lowest pressure drop with ball-shaped materials (< 2 mbar )
- Cylindric pellets (4 x 10 mm) < 6 mbar



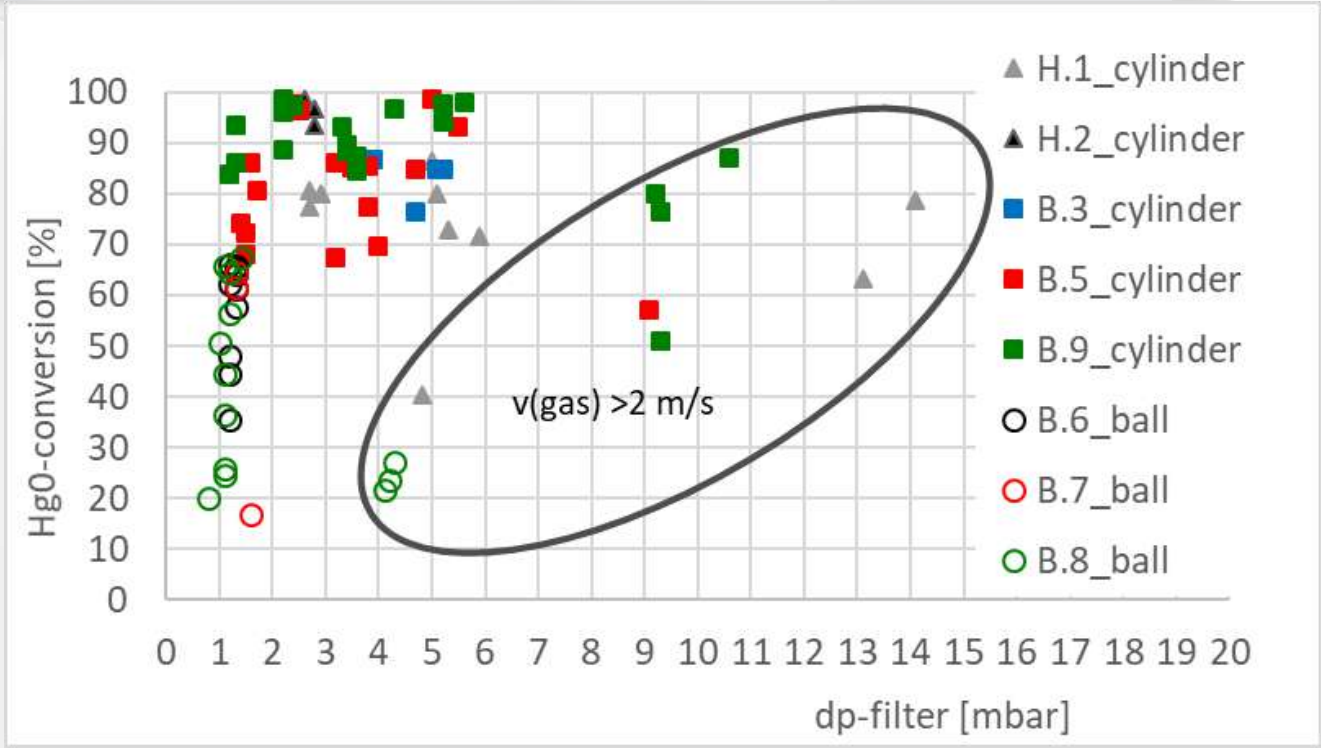
# $Hg^0$-removal

- > 80 % Hg0-removal with cylindric form
- Long-term lasting catalytic activity (> 1200 h), in comparison to a few seconds of activity time with ACI
- $Hg^{2+}$-removal in the FGD (with precipitation agents)



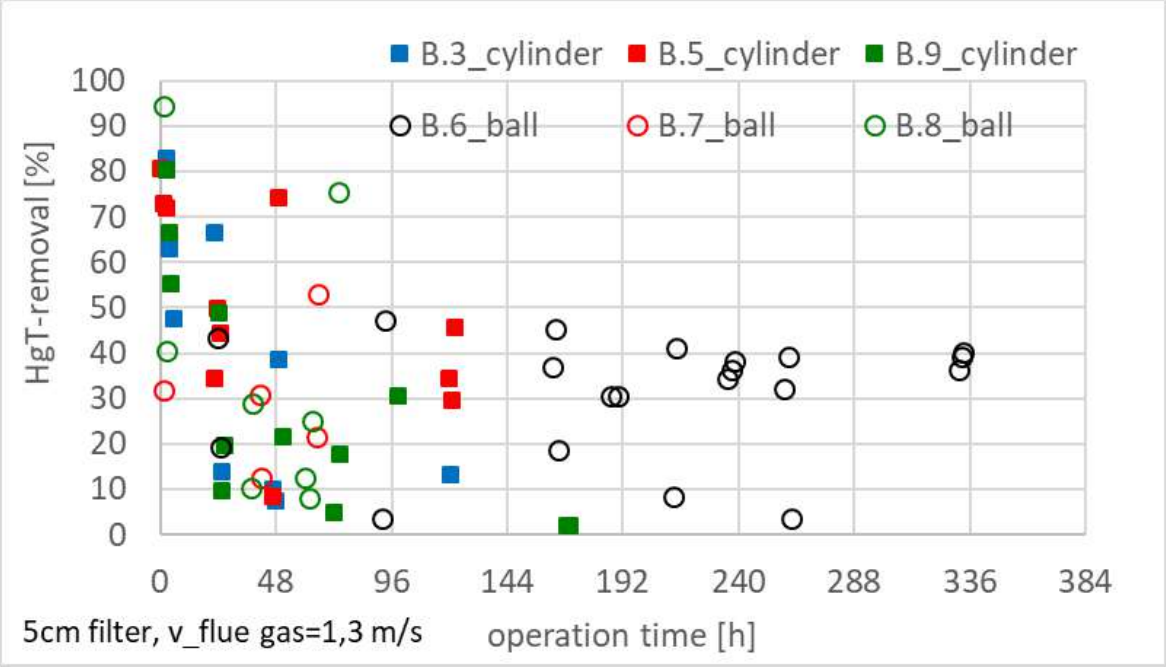
# $Hg^0$-removal (II)

- The higher dp, the higher Hg0-removal
- Thicker filter bed of ball-formed material can achieve higher Hg0-removal

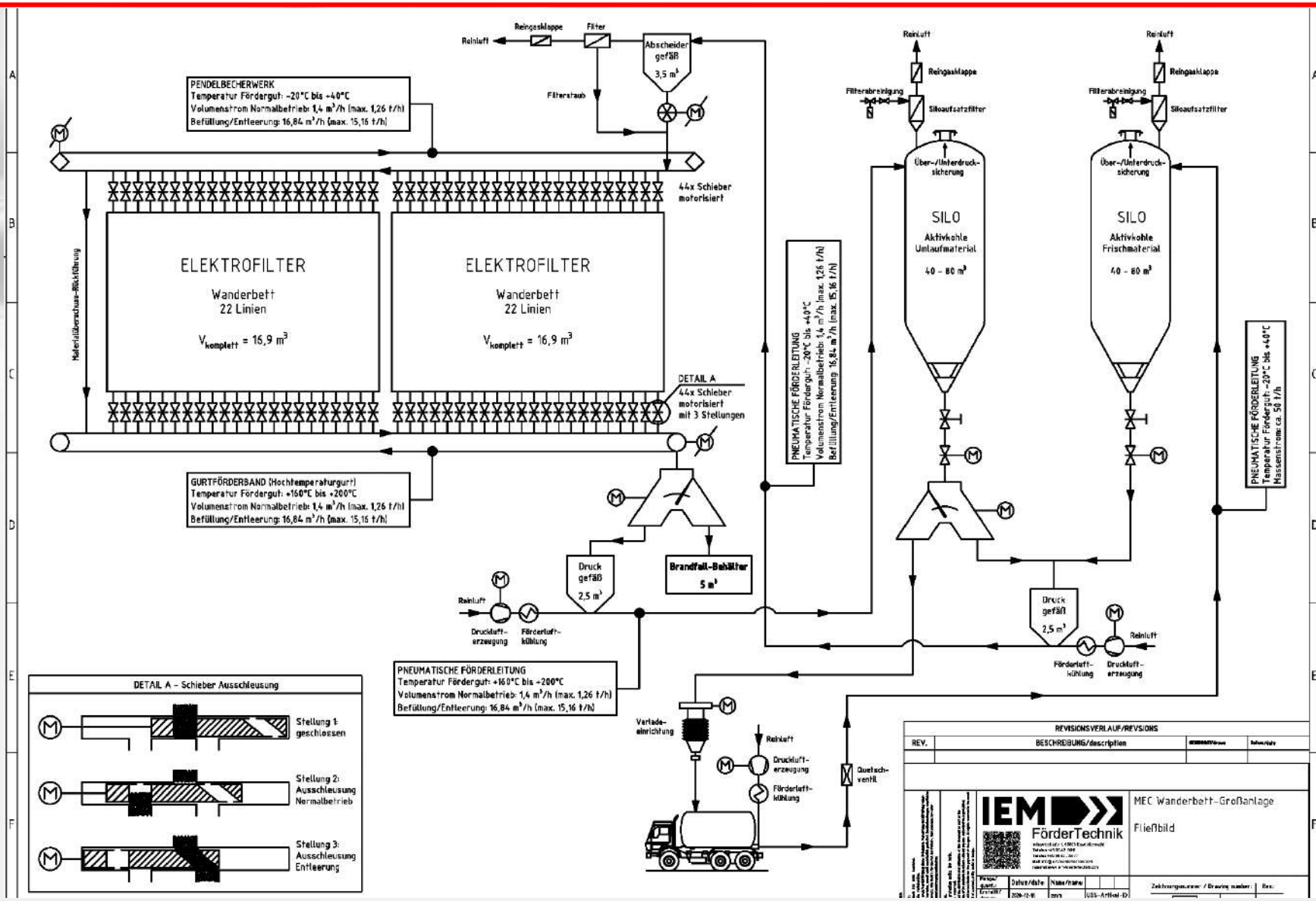



# $Hg^T$-removal

- Starts with 80-90% $Hg^T$-removal
- No Hg-diffusion into the inner particle surfaces
- Outer surfaces loose adsorption capacity quickly

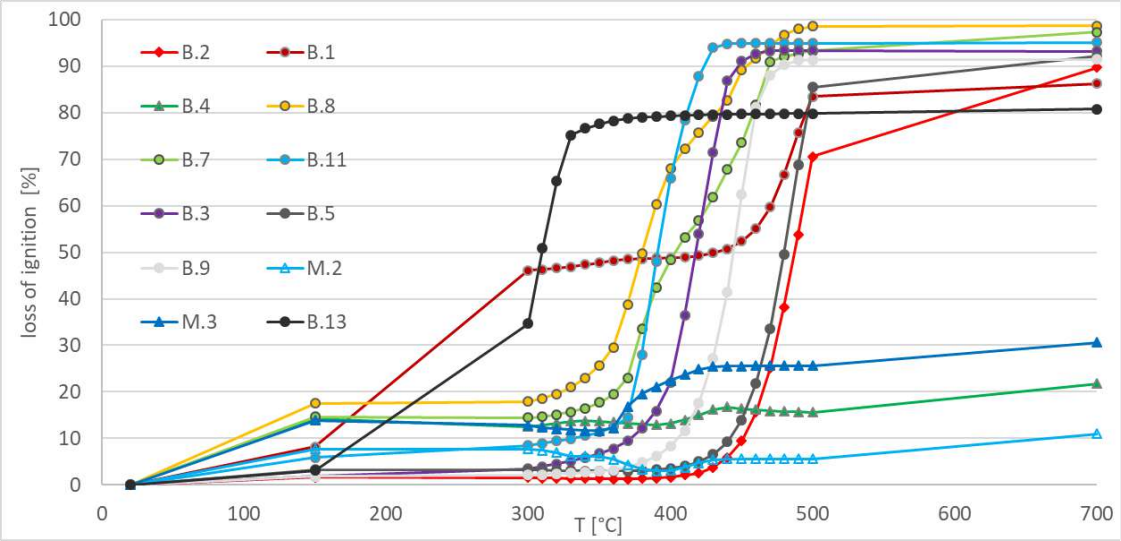


# Upscaling Process Flow Chart (typical)



# Upscaling Safety Concept

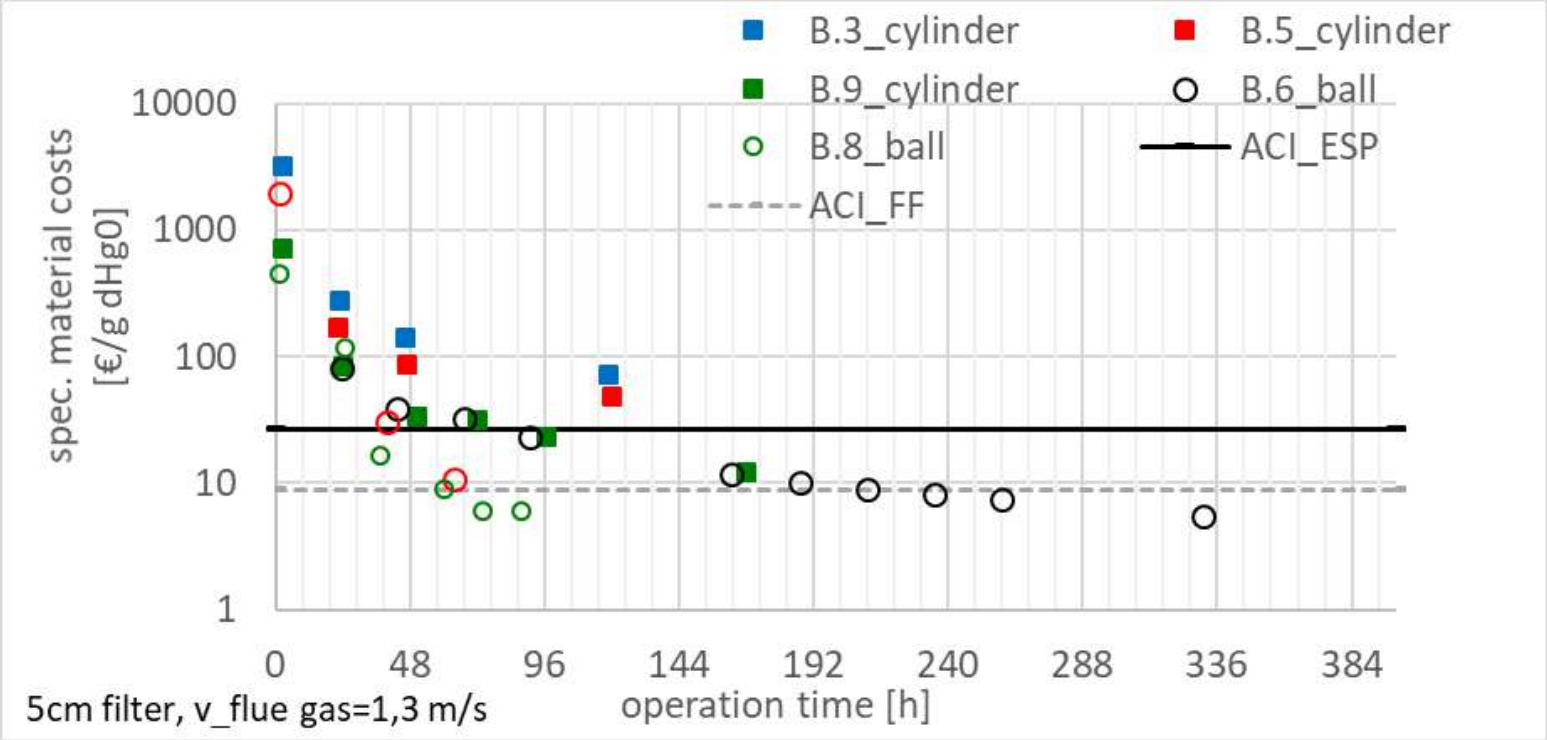
- Temperature sensors at the inlet and outlet (of each the Wonderbed-line)
- IR-sensor at the outlet (of each Wonderbed-line)
- Belt conveyer equipped with water extinguishing sprinkler system




- Central $N_2$ emergency tank (inertization with $N_2$)
- Fresh-AC-silo and circulation-silo can be inerted
- Sorbent selection
  - Ignition temperatures above 300 ° C

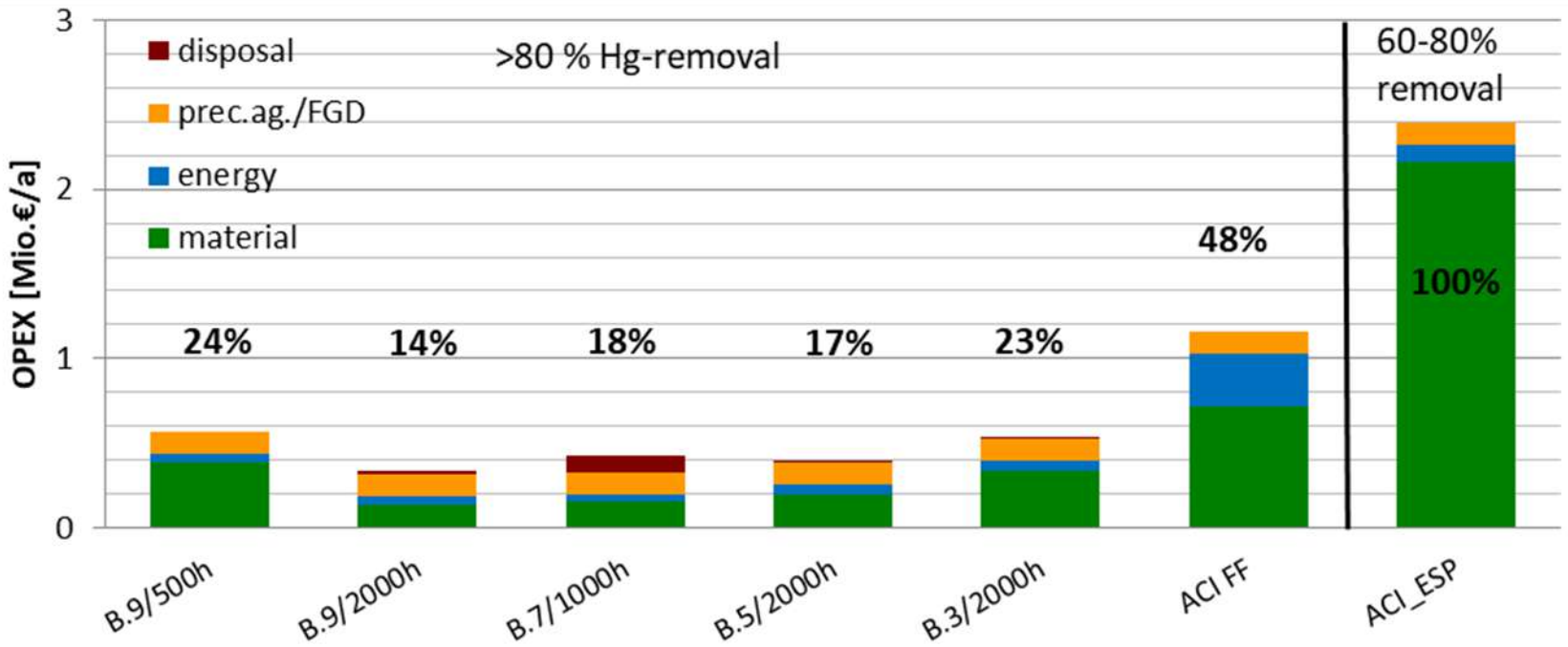
# Adsorbent Costs for $Hg^0$-Removal

- After 4d of catalytic operation Wonderbed is more economic than ACI regarding sorbens costs
- Just direct adsorbent costs (no pressure drop, energy, precipitants, disposal etc.)



# Operation Costs ACI upstream ESP vs. Wonderbed

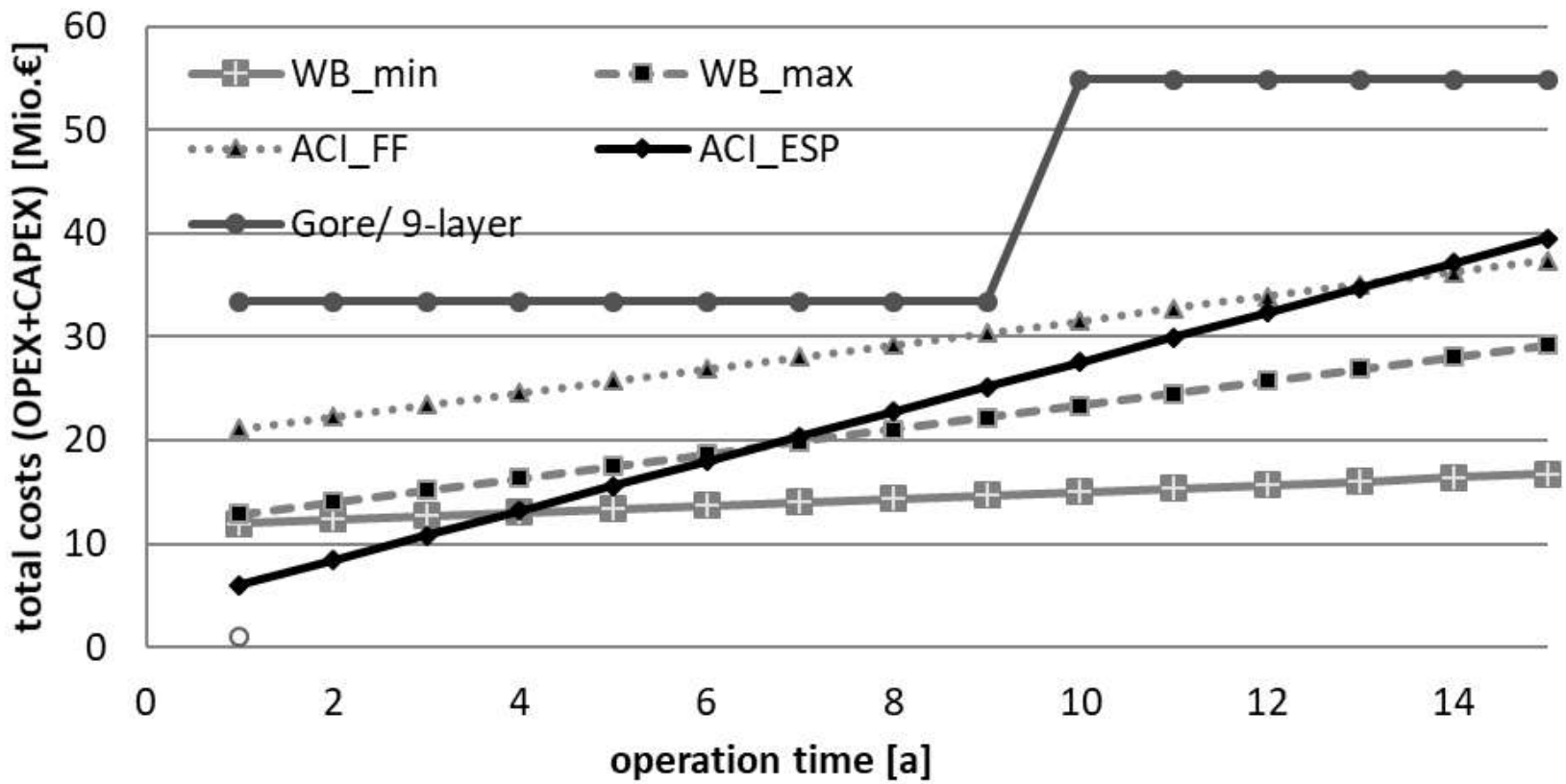
- Disposal of ACI ash is neglected yet, but can produce costs in the future
- Energy costs include fan power and pressure drop of ID-fan
- B.3-B.9 different operation scenarios and materials




operation time=7500 h/a; energy costs =40 €/MWel; Hg-conc. after ESP =23 µg/sm³.

# Operating Costs (Diagram)

- Costs for scenario of 2 boilers / 4 ESP / 1 FGD
- maintenance costs excluded




450 MWel, 7500 h/a; Energy costs=40 €/MW; Hg-conc.after ESP =23 µg/sm³.

# Why implement Wonderbed?

- Full-scale plant available for implementation in 2021
- Assembly during normal annual outages
- Total lead time for implementation of approx. 2-3 months
- Investment costs for a 200 MW unit are approx. 6 Mio. €
- In comparison with AC-dosing upstream ESP:
  - Saving up to 80 % of the AC-Costs
- In comparison with AC-dosing upstream FF:
  - Saving up to 65 % of the AC-Costs
  - Reduction of the pressure loss to approximately 2-4 mbar
- "Break-even" period for retrofitting of Wonderbed compared to ACI upstream ESP is around three years

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A common project of Steinmüller Engineering GmbH - IHI Group in cooperation with the MEC - Mercury Emission Control department of IEM FörderTechnik GmbH under the direction of Dr. Jan Schütze and Dr. Dorian Rasche

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**IEM Fördertechnik GmbH**
Industriestraße 1
D-95506 Kastl (Kemnath)

Dr. Jan Schütze
+49 171 271 3484
J.Schuetze@iem.eu
www.iem.eu

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**Steinmüller Engineering**
GmbH IHI Group Unternehmen
Fabrikstraße 5
D-51643 Gummersbach

Dr. Dorian Rasche
+49 (0) 226178950-413
dorian.rasche@steinmueller.com
www.steinmueller.com

Read more on our mercuryfree-blog**: iem.eu/mec-blog**