Reinhold Environmental Ltd.

2009 APC Round Table & Expo Presentation

July 12-14, 2009, in The Woodlands, TX

RWE's Experience with Mercury Control in its Coal-fired PS

2009 APC/PCUG Conference
July 13 & 14
The Woodlands, Texas

Juergen Wirling

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RWE core business

Exploration and production of natural gas and oil

Lignite production and refining

Power generation from lignite

Power generation from renewables

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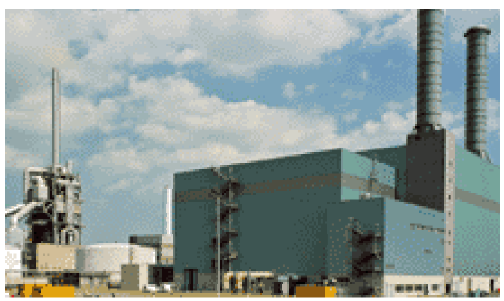
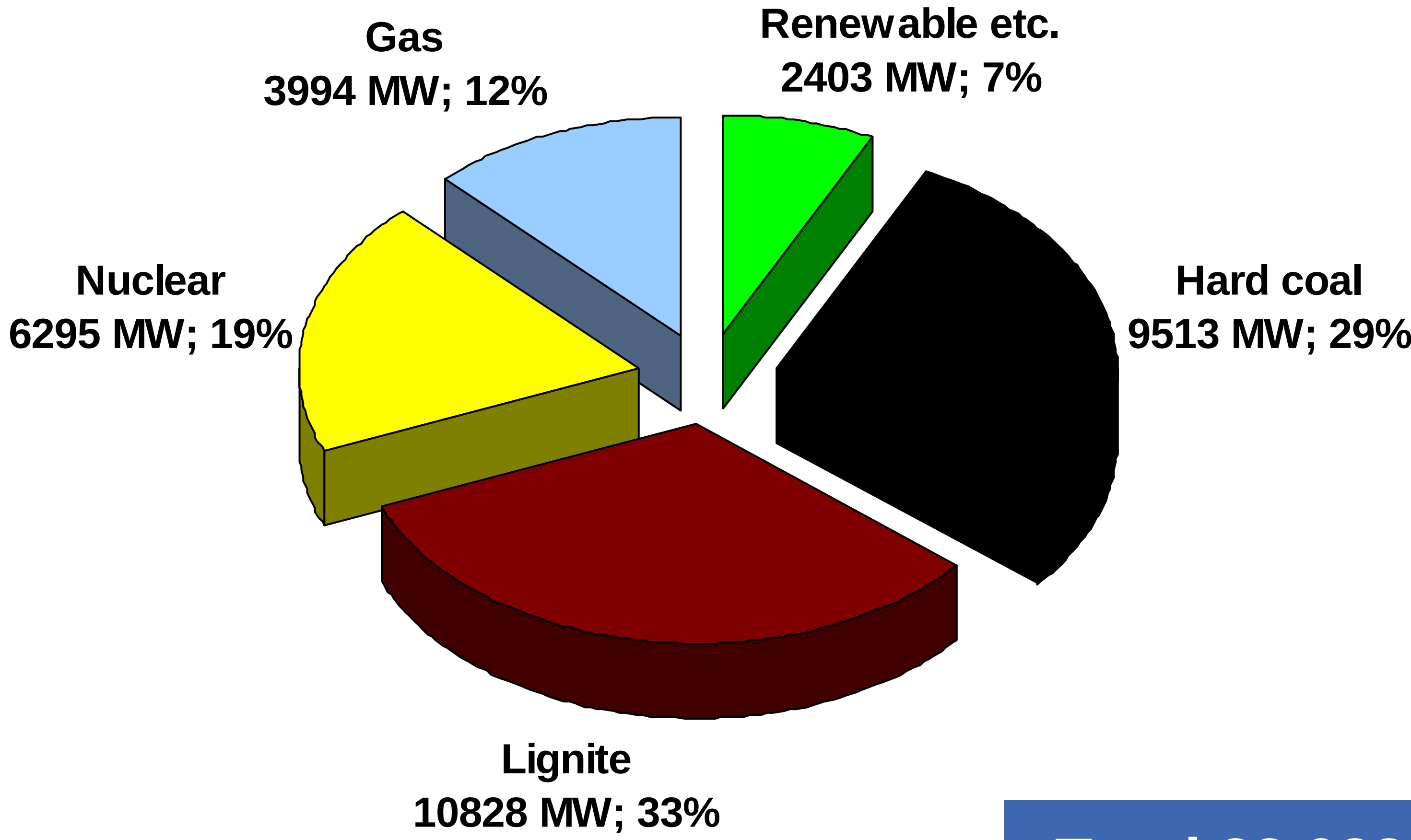
Power generation from hard coal



Gas-fired power generation

Power generation from nuclear energy

Power Plant Capacity of RWE by Primary Energy Source



Total 33,033 MW

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Energy source Lignite

Typical Values of Rhenisch Raw Lignite

Moisture:	**54.0 % wt**	**(52,7 %)**
Ash:	**2.5 % wt**	**(7,0 %)**
Volatiles:	**23.5 % wt**	**(21,9 %)**
Fixed carbon:	**20.0 % wt**	**(18,4 %)**
Lower heating value:	**10.1 MJ/kg**	**(9.2 MJ/kg)**
Sulphur (S):	**0.20 % wt**	
Mercury (Hg):	**0.08 mg Hg/kg, dry**	
Chloride (Cl):	**286 mg/kg, dry**	

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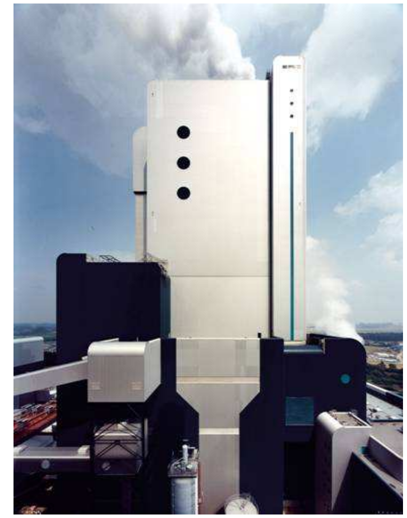
Lignite and Hard Coal-fired Power Plants



Lignite PS (10,828 MW)

5 plants (35 units) + 3 mine-mouth plants

Hard Coal-fired PS (9,513 MW)

5 plants with 7 units

Emission Limits of German Guideline 13th Federal Immission Control Ordinance *(BImSchV)* PS > 300 MW as of Dec. 2003

Mercury (Hg)
Daily average: 30 µg/m³ Half-hourly average: 50 µg/m³

Sulfur (SOx)
Daily average: 200 mg/m³ Half-hourly average: 400 mg/m³

(+ 85 % min separation efficiency of the desulphurization unit)

Nitrogen (NOx)
Daily average: 200 mg/m³ Half-hourly average: 400 mg/m³
(100 mg/m³ ab 2012)

Dust
Daily average: 20 mg/m³ Half-hourly average: 40 mg/m³

Oxygen
6 vol. %

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Emission Limits in case of Co-combustion of Residues

<u>Mixture limit regulation</u>
according to the 17th Federal Immission Control Ordinance
→ prescriptive limits < 13th Federal Immission Control Ordinance

As an example for RWE's lignite-fired PS: Frimmersdorf and the Berrenrath mine-mouth PS

Hg emissions in case of co-combustion of paper sludge and sewage sludge

PS Frimmersdorf

Daily average value:	11 µg/m³	(instead of 30 µg/m³)
Half-hourly average value:	22 µg/m³	(instead of 50 µg/m³)

Mine-mouth plant Berrenrath

Daily average value:	22 µg/m³	(instead of 30 µg/m³)
Half-hourly average value:	44 µg/m³	(instead of 50 µg/m³)

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Mercury Control in RWE's Frimmersdorf Lignite-fired PS (Conventional PS)

Lignite-fired PS

Co-combustion of paper sludge

Net electric power output: 2,028 MW

13 units

Mercury control by desulphurization unit (wet scrubber)

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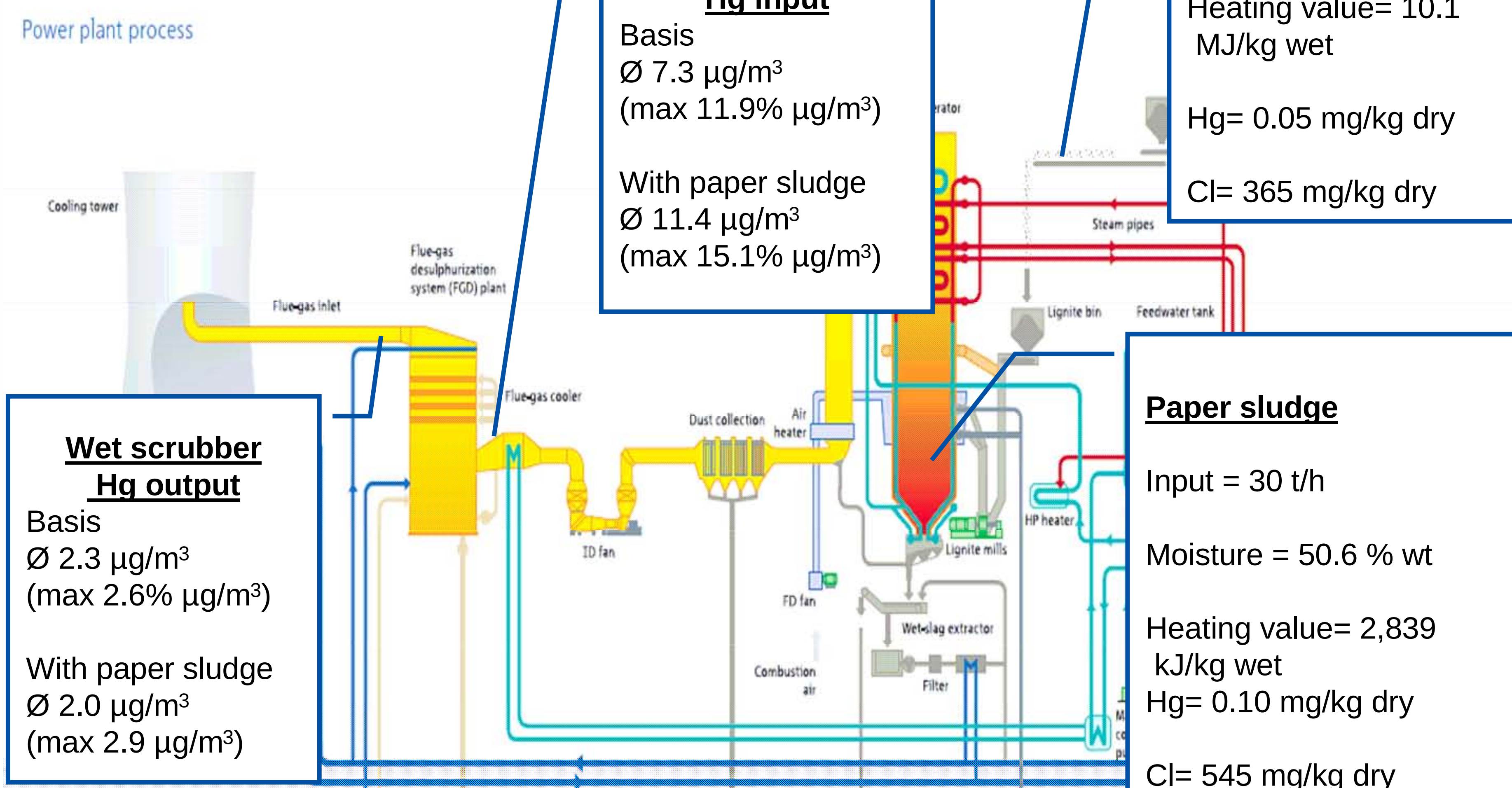
Mercury Control in RWE's Frimmersdorf Lignite-fired PS



Lignite

Input = 760 t/h

Moisture = 54 % wt

Heating value= 10.1 MJ/kg wet

Hg= 0.05 mg/kg dry

Cl= 365 mg/kg dry

Wet scrubber Hg input

Basis
Ø 7.3 µg/m³
(max 11.9% µg/m³)

With paper sludge
Ø 11.4 µg/m³
(max 15.1% µg/m³)

Wet scrubber Hg output

Basis
Ø 2.3 µg/m³
(max 2.6% µg/m³)

With paper sludge
Ø 2.0 µg/m³
(max 2.9 µg/m³)

Paper sludge

Input = 30 t/h

Moisture = 50.6 % wt

Heating value= 2,839 kJ/kg wet
Hg= 0.10 mg/kg dry

Cl= 545 mg/kg dry

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Mercury Balance of RWE's Frimmersdorf PS

		Reference	Paper sludge co-combustion
Input	Lignite	98.2 mass %	88.1 mass %
	Paper sludge	-	10.4 mass %
	Lime	1.8 mass %	1.5 mass %
Output	Waste gas	12.5 mass %	13.5 mass %
	Ash dry / wet, sludge	69.9 mass %	66.8 mass %
	Gypsum	17.6 mass %	19.7 mass %
Separation efficiency		87.5 %	86.5 %

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Co-combustion of Paper Sludge in RWE's Frimmersdorf Power Plant – Yearly Information for the Public

Continuous measurement

Hg limit value: 11 µg/m³

…erbrennung im Kraftwerk Frimmers…

…keit

Continuous measurement

Hg emissions: 3 µg/m³

Kontinuierlich gemessene Emissionen in 2006

Komponenten	Emissionsgrenzwert Blöcke P und Q	Emission Papierschla… Block P	
Staub	20 mg/m³	5,0 mg/m³	
Schwefeldioxid	185 mg/m³	100,2 mg/m³	
Stickoxid	200 mg/m³	190,7 mg/m³	185,5 mg/m³
Kohlenmonoxid	228 mg/m³	87,1 mg/m³	101,6 mg/m³
Quecksilber	0,011 mg/m³	0,003 mg/m³	–

brennbare Stoffe) in den Blockanlagen P und Q mitverbrannt wird. Hieraus ergibt sich die Pflicht, nach § 18 der 17. BImSchV die Öffentlichkeit jährlich über die Emissionen der Anlagen zu unterrichten. Nachfolgend werden die im Jahr 2006 gemessenen Emissionskonzentrationen bei der Mitverbren-…

Durch Einzelmessungen bestimmte Emissionen in 2006

Single measurement

Hg limit value: 22 µg/m³

Single measurement

Hg emissions: 3 µg/m³

…ten	Emission… Blöc…		…ung …d Q
	0,…		…g/m³
…b+Cr+Co+ Ni+V+Sn	…		…g/m³
…o+Cr+BaP	…		…g/m³
…rane	0…		…g/m³
…rstoff HF			…g/m³
…rstoff HCl	19,4 mg/m³	2,1 mg/m³	1,4 mg/m³
Gesamtkohlenstoff	8,4 mg/m³	<0,4 mg/m³	<0,4 mg/m³
Quecksilber	0,022 mg/m³	-	0,003 mg/m³

Sollten Sie weitere Informationen wünschen, wenden Sie sich bitte an Guido Steffen, Telefon: 0201 1241266

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Mercury Control in RWE's Berrenrath Lignite-fired PS (Mine-mouth Plant)

Lignite-fired PS

Co-combustion of sewage sludge

2 x 275 $MW_{thermal}$

Mercury control by addition of HOK

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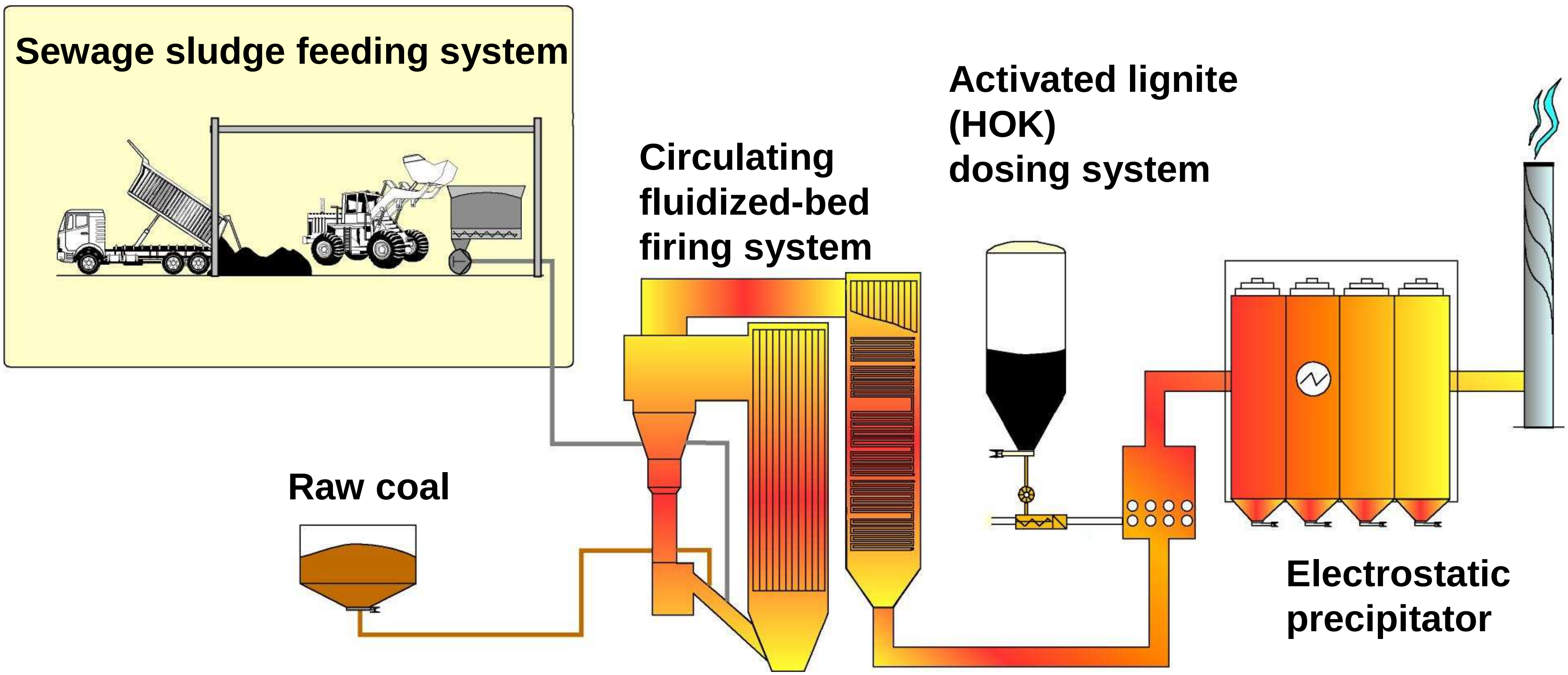
Sewage Sludge Co-combustion in an Industrial Power Plant



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Environmental Protection with Activated Lignite (HOK)

- Use in waste gas cleaning and waste water treatment
- High-quality and at the same time low-priced mass sorbent
- Lignite from RWE's own opencast mines near Cologne (Germany)
  - ⇒ constant quality with low ash content, etc.
  - ⇒ security of supply

Microscopically magnified activated lignite

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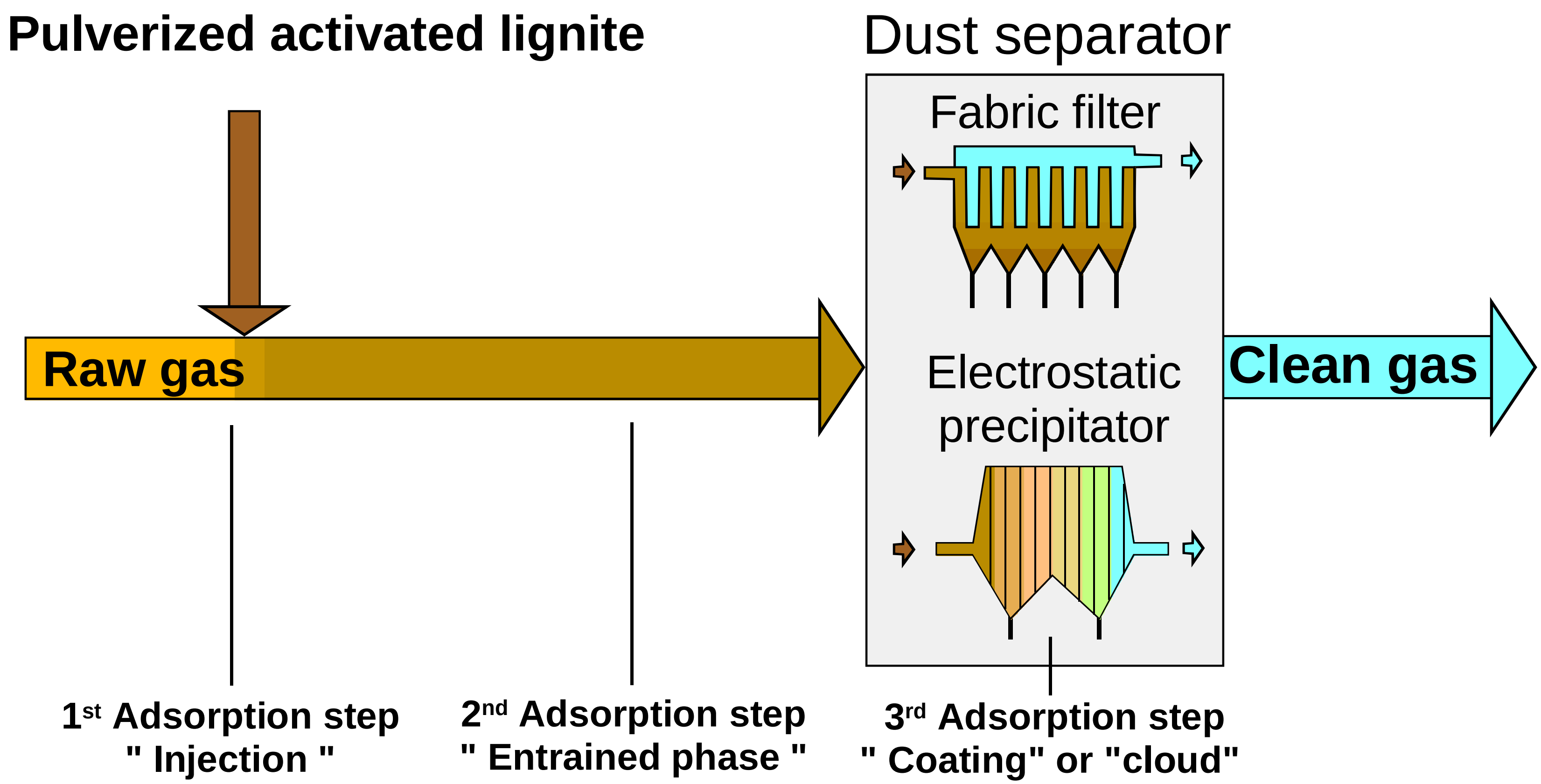
Entrained-Dust Cloud Process



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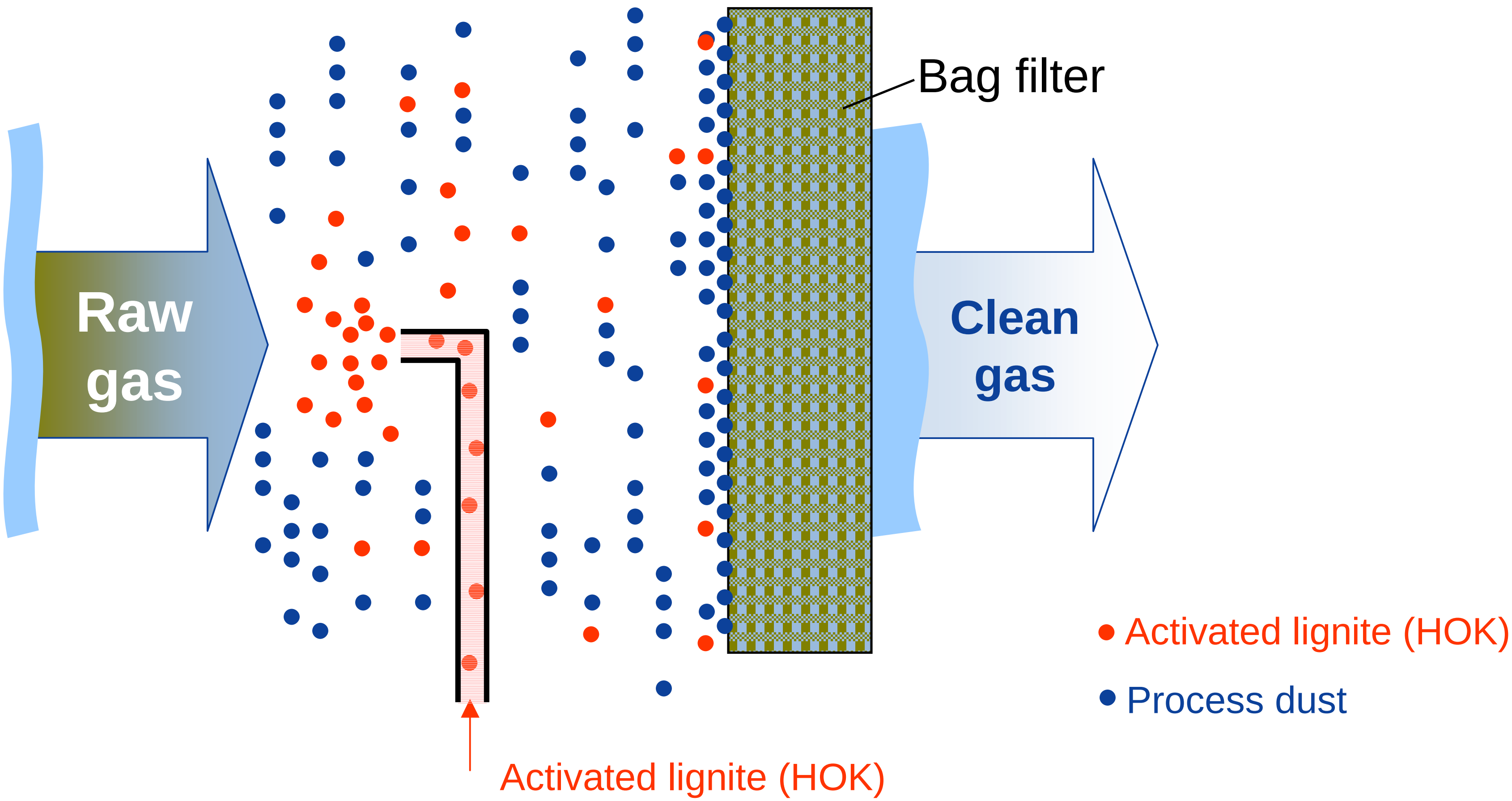
Pollutant Separation in the Filter Bed Process



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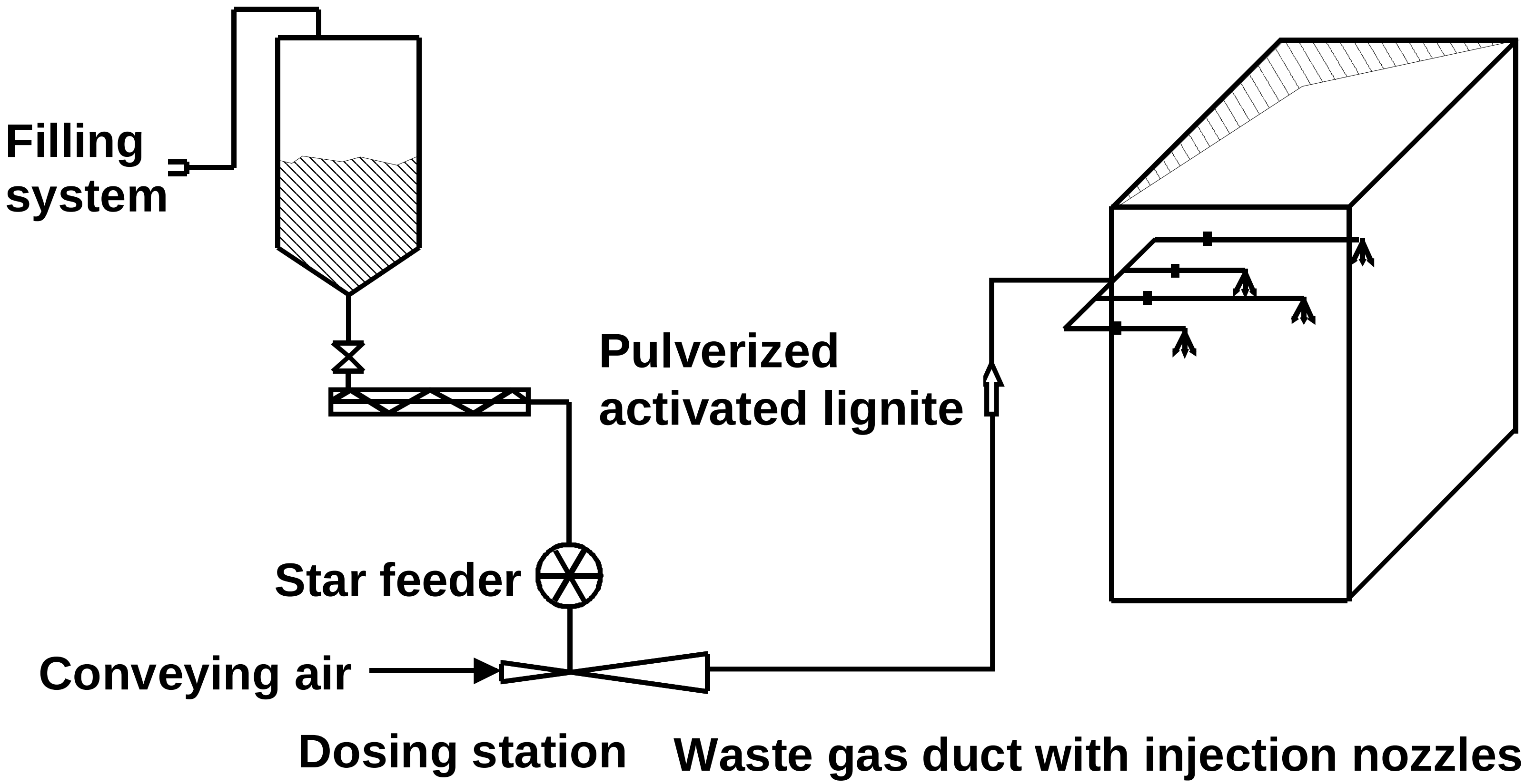
Activated Lignite Dosing System



Mercury Separation in RWE's Berrenrath Coal-fired PS

Waste gas duct with injection nozzle

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Mercury Separation in RWE's Berrenrath Coal-fired PS

Injection pipes into waste gas duct

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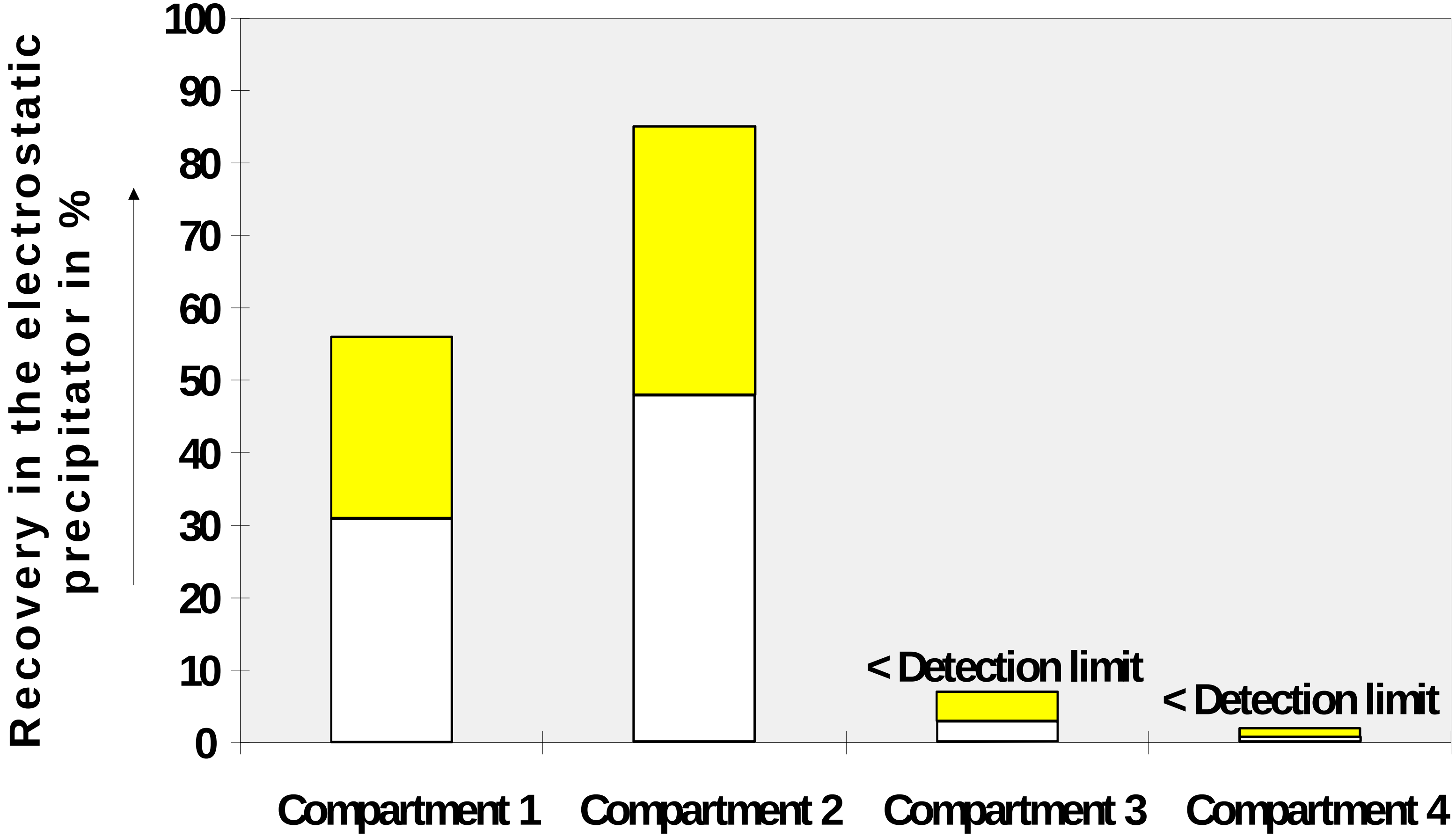
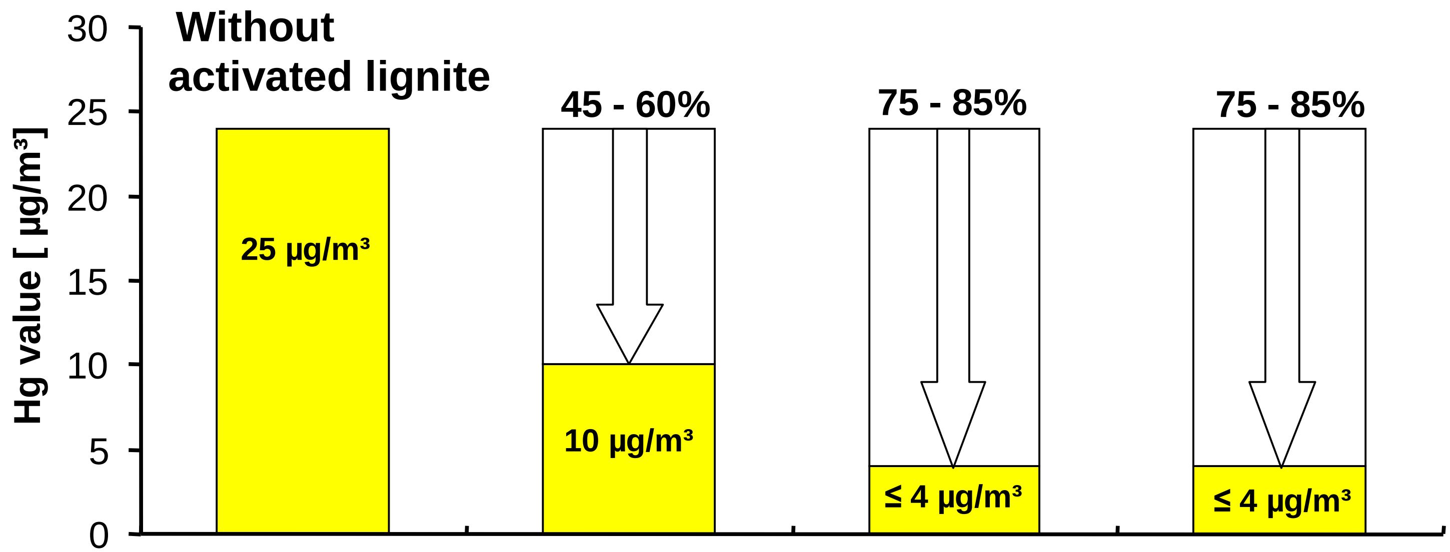
Activated Lignite Separation in the Electrostatic Precipitator



Activated Lignite-based Hg Separation during Sewage Sludge Co-combustion



Activated lignite dosing

[kg/h]	**-**	**30**	**50**	**80**
[mg/m³]	**-**	**85**	**140**	**230**

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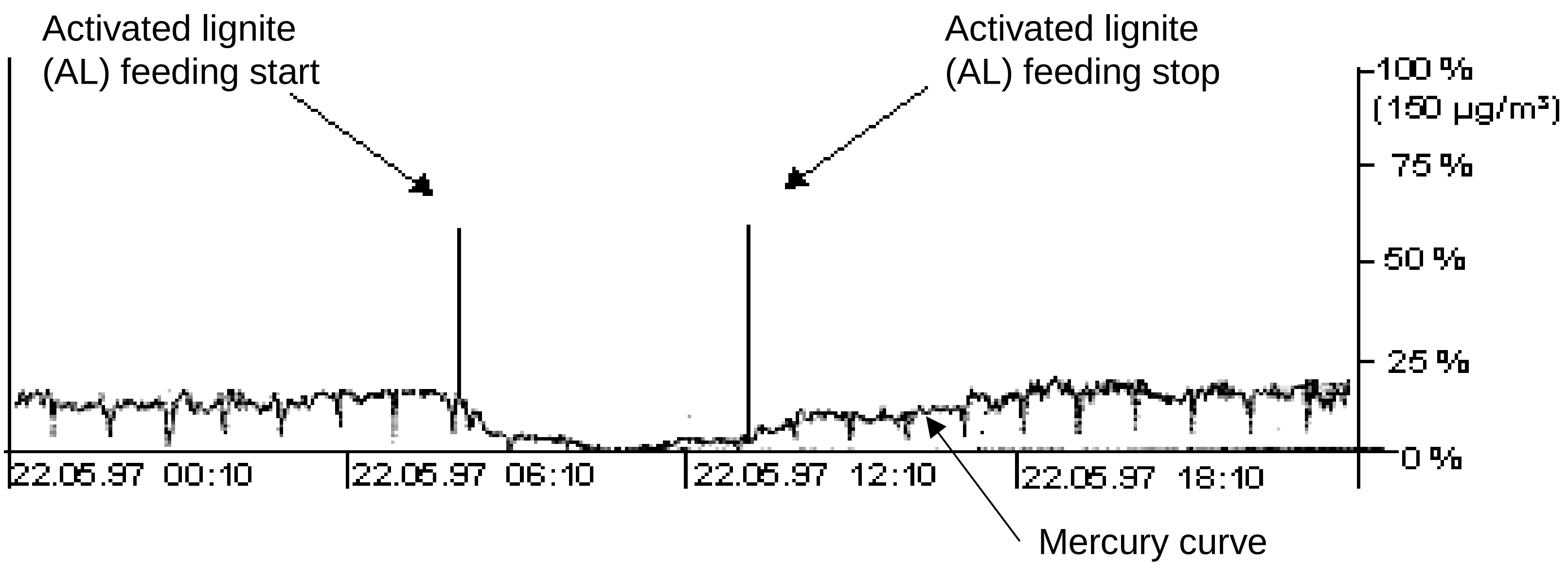
Hg Emissions Before and After Adding AL (Dosing Rate of 80 kg/h)



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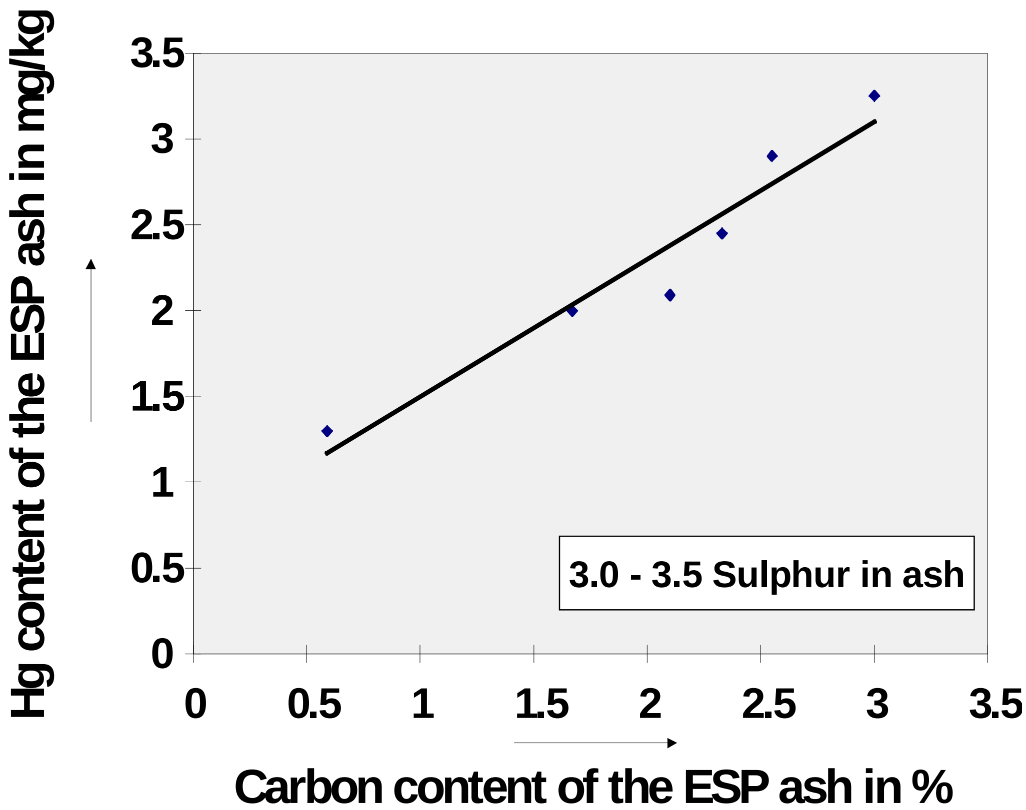
Hg Retention as a Function of the Carbon Content in the Mixed Ash



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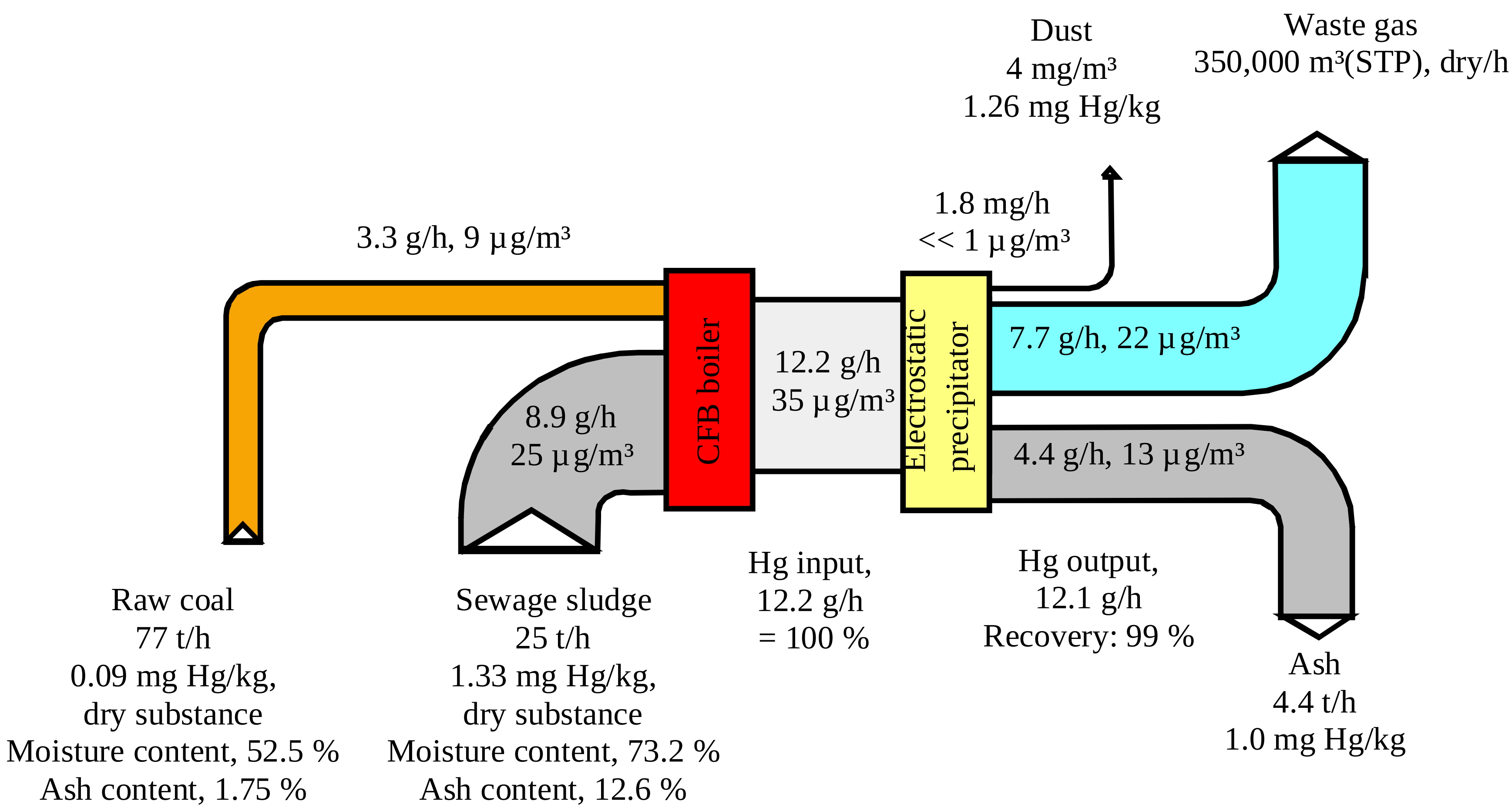
Hg Balance in the Case of Sewage Sludge Co-combustion Without AL Additon



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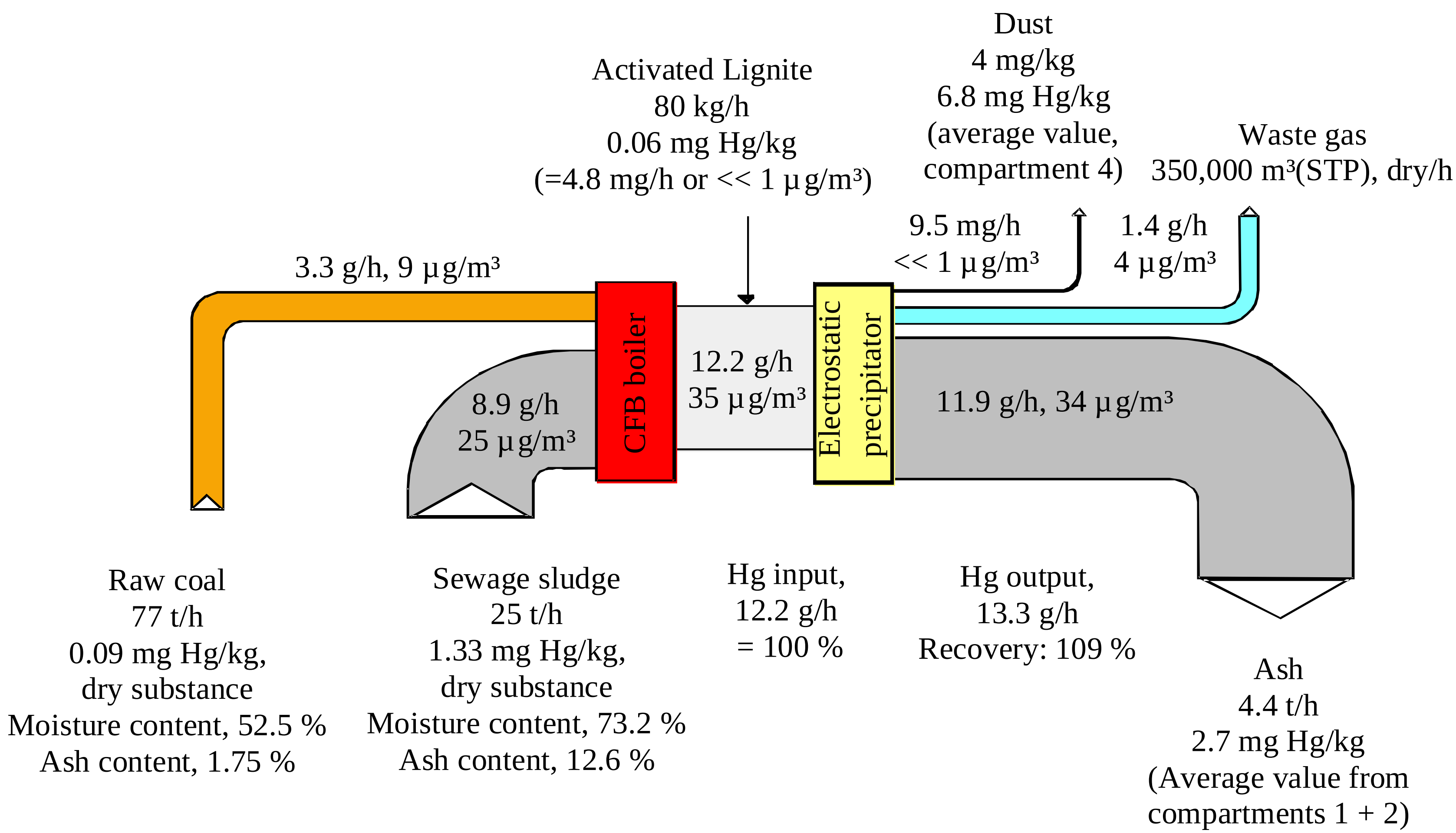
Hg Balance in the Case of Sewage Sludge Co-combustion With AL Additon



Mercury Control in RWE's Coal-fired PS

Conclusion

Power plant (plant with wet FGD)

- Efficient separation below the Hg limit value

Mine-mouth PS (plant with dry FGD)

- In case of co-combustion of Hg-contaminated residues additional control units necessary
- High separation efficiency for Hg with HOK at low operating cost
- Simple and low-priced retrofitting of existing plants
- In case of tighter emission requirements, the HOK technology is transferable to conventional PS.

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Thank you very much for your attention

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