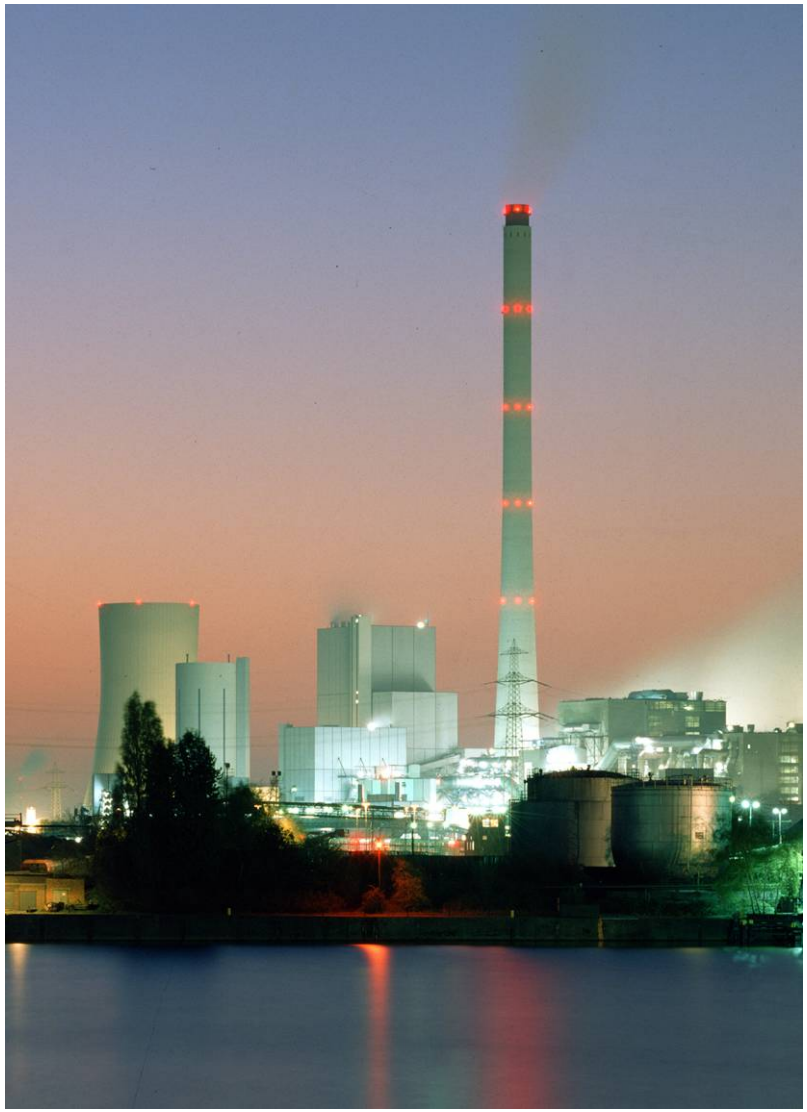
Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Mercury Control By Activated Carbon Within The FGD And Selective Removal of Mercury Through Waste Water Treatment

Philip Elliott
July 15, 2008



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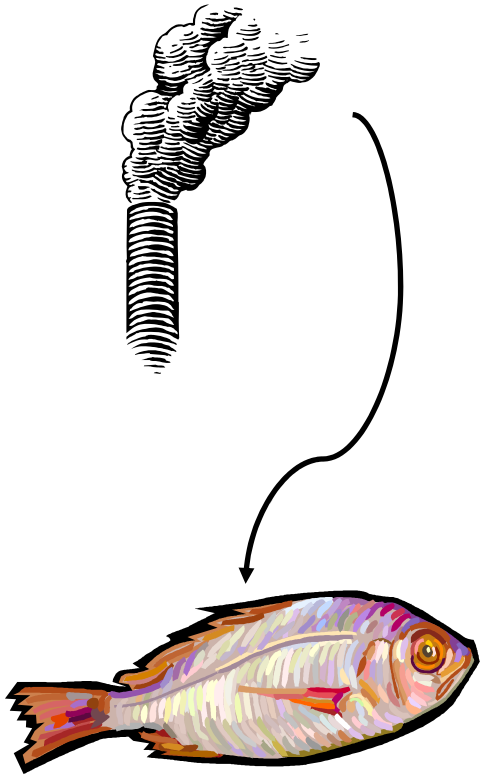
Mercury Control

- Why Control Mercury
- Methods to Control Mercury
- PAC Injection
- Waste Water Treatment

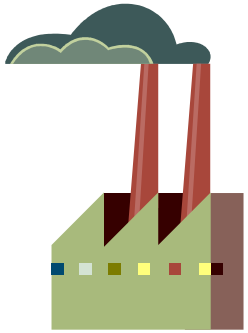
Why are We Concerned about Mercury?

- Water soluble mercury from power plant flue gas was entering the water sources, contaminating fish
- The key is that we must be able to prevent its reintroduction into water sources



Four Paths for the Mercury to Travel

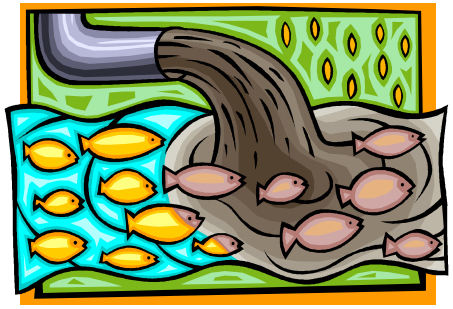
Flue Gas



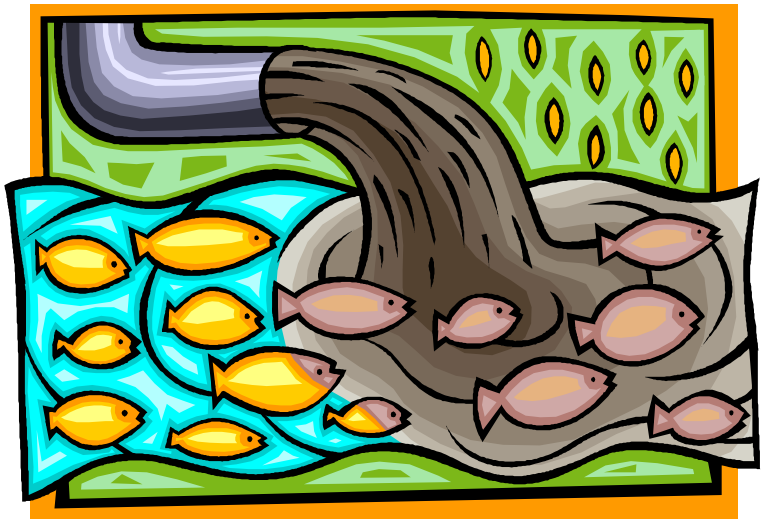
Gypsum

Ash

Waste Water



Where Can We Control It?



Different Mercury States

Three States of Mercury in Flue Gas

- Hg^{o} – elemental mercury (not water soluble)
- Hg^{2+} - ionic mercury (water soluble)
- Hg_P – particulate bound mercury (water soluble)

In Order to Capture the Mercury – it must be ionic or particulate bound mercury

Oxidized Mercury

How to Form Oxidized Mercury

- Combustion Process
- Injection Applications in Flue Gas
  - Bromine Injection
  - Chlorine Injection
- SCR Catalyst

How to Capture?

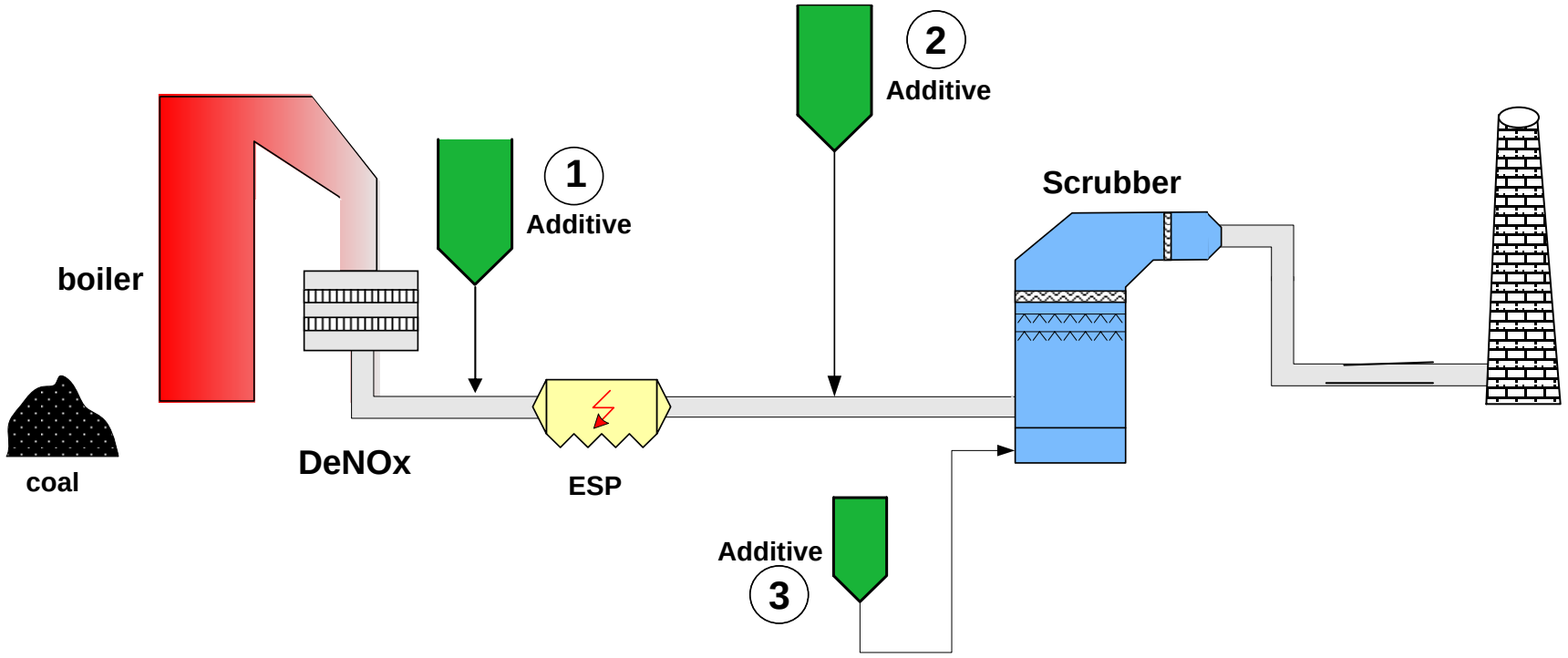
PAC Injection Prior to Particulate Control Device

- Injection of PAC to Combine with Oxidized Mercury
- Captured in Baghouse or Precipitator

Captured in Wet FGD

- Ionic/Particulate Mercury Captured in the Scrubber Slurry

Options for PAC Injection Points



PAC and Particulate Control Device

- Low Retention Time for PAC and Hg to Combine
- Higher Temperatures for Reaction to Occur
- Greater Amount of PAC Required
- Mercury in Fly Ash
- Potential Extensive Capital Costs

PAC Prior/In Wet FGD

- Limited Extra Capital
- Higher Retention Time for Reaction to Occur
- Lower Temperature
- Requires Less PAC
- Prevents the Reemission of Hg^{2+} to Hg^{0}
- Does Not Effect Gypsum or Ash Sales

Addition of PAC into Flue Gas Stream/Absorber Tower

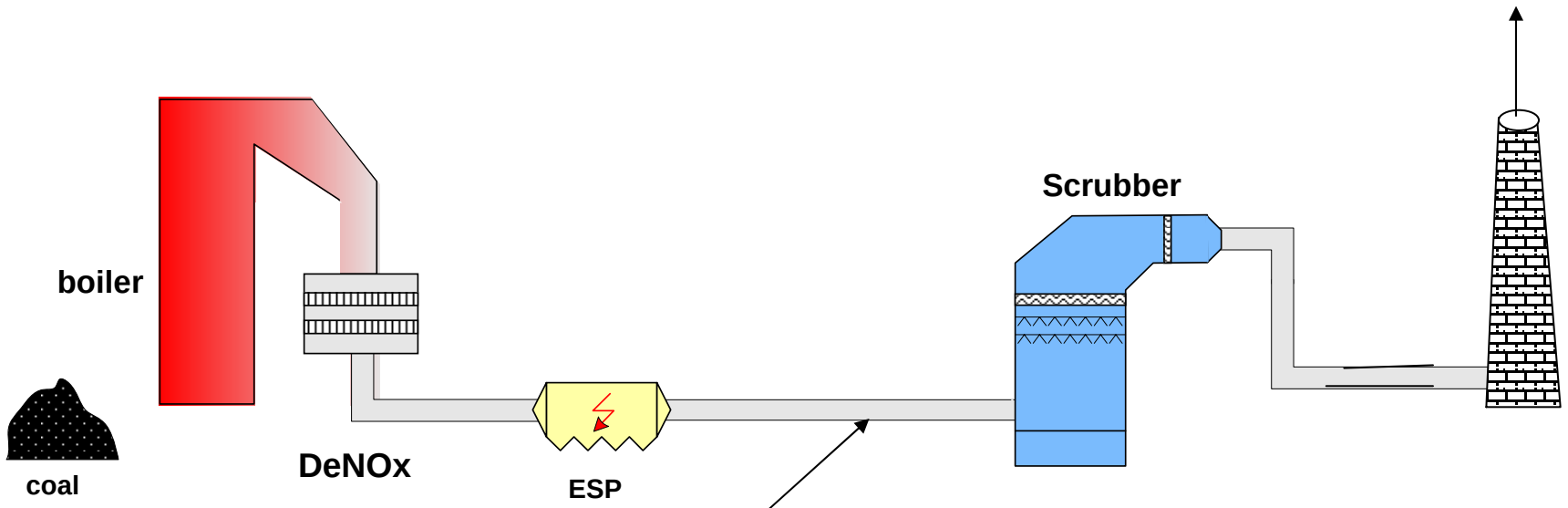
- PAC combines with the mercury in the flue gas
- The mercury is attaches to the PAC and does not reemit to the flue gas
- The mercury in the particulate and ionic form dissolve in the scrubber slurry
- The PAC is small enough to pass through the primary hydrocyclones and through to the waste water treatment system

Mercury Concentration Mass Balance

0.8 µg/m³ Hg^{2+}

1.0 µg/m³ Hg^{0}

1.8 µg/m³ Total

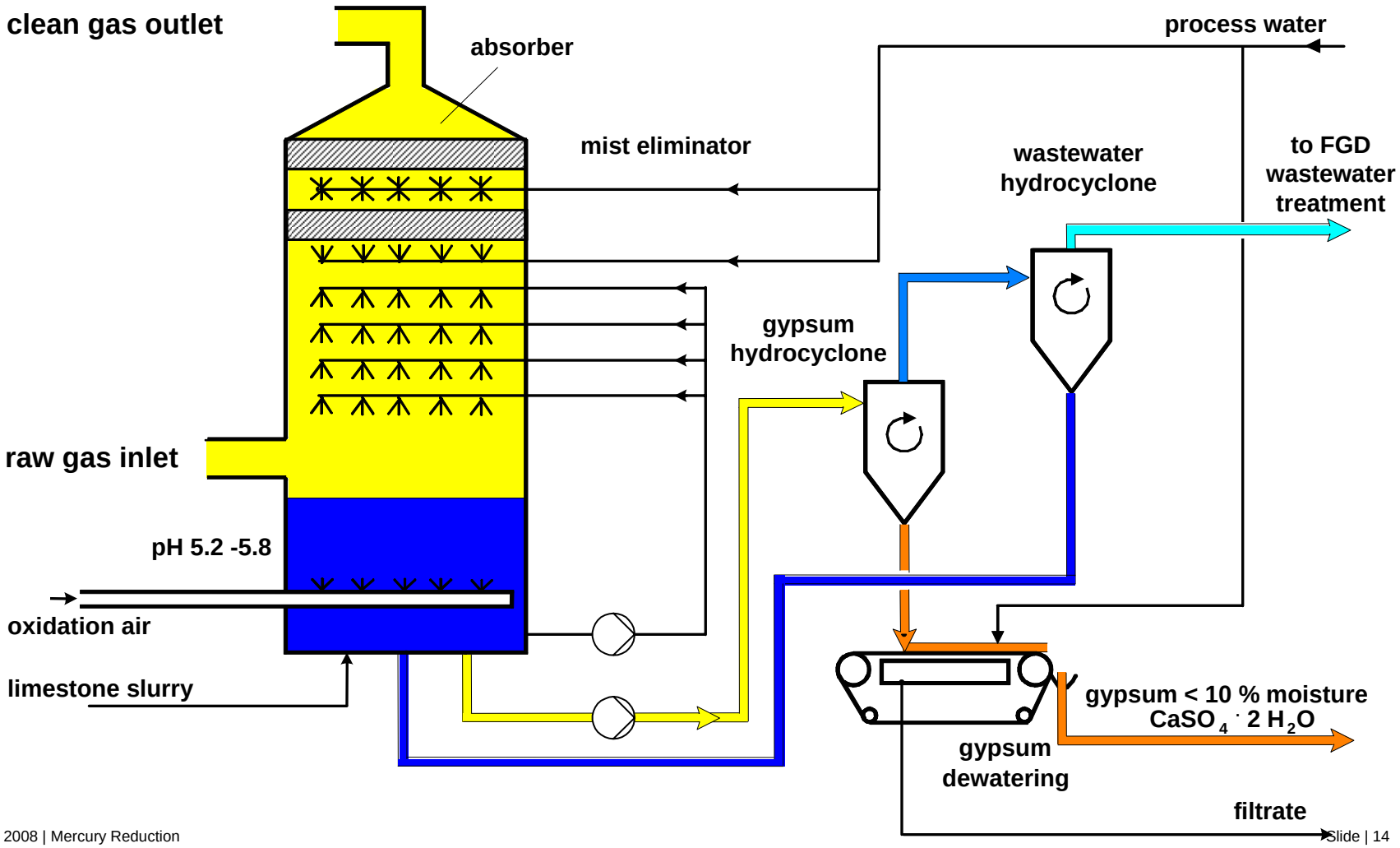


25.7 µg/m³ Hg^{2+}

1.3 µg/m³ Hg^{0}

27.0 µg/m³ Total

Scrubber to Waste Water Treatment

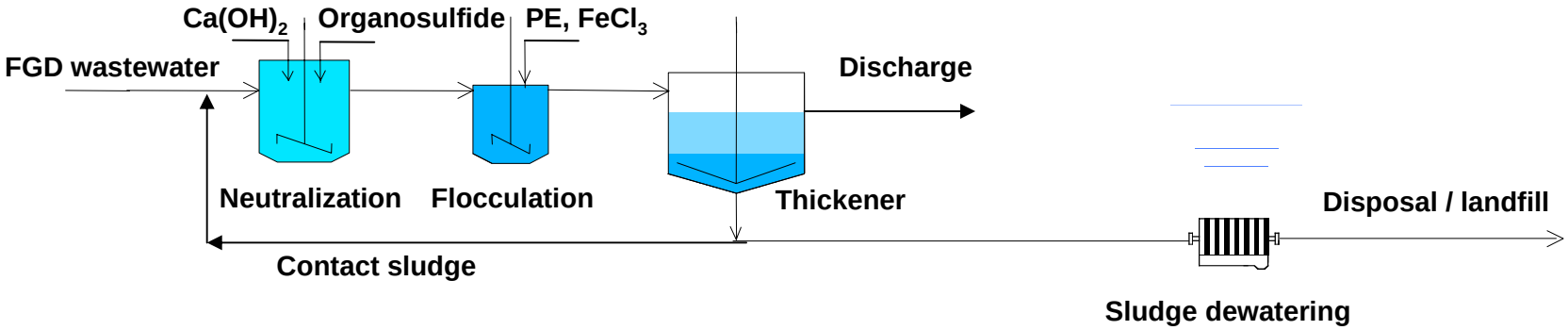


Evonik's Patented FGD Wastewater Treatment Process

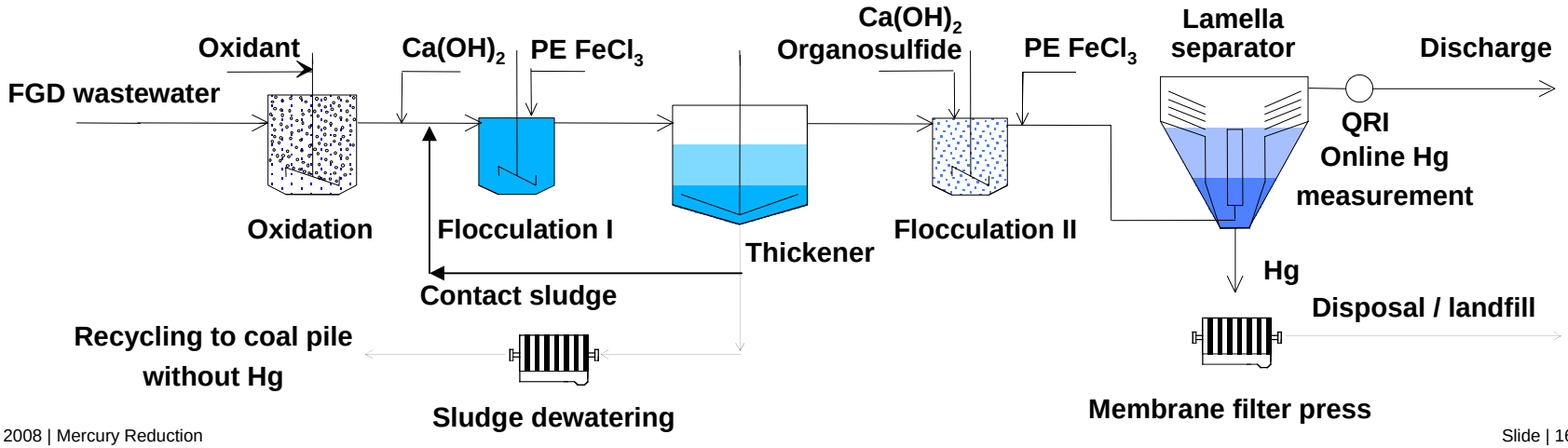
- **Selective Hg removal using a two-stage FGD wastewater treatment process with internal recycling of >95% of the sludge residue produced**
- **Minimized amount for external disposal**
- **Separation of the sludge in two fractions:**
  - **95 – 98 % with a very low heavy metal content, particularly Hg**
  - **2 – 5% with a very high heavy metal content, particularly Hg**
- **Advantage:**
  - **> 95% reduction of the sludge disposal costs**

FGD Wastewater Treatment

Conventional one-stage process

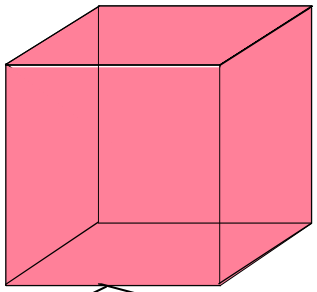


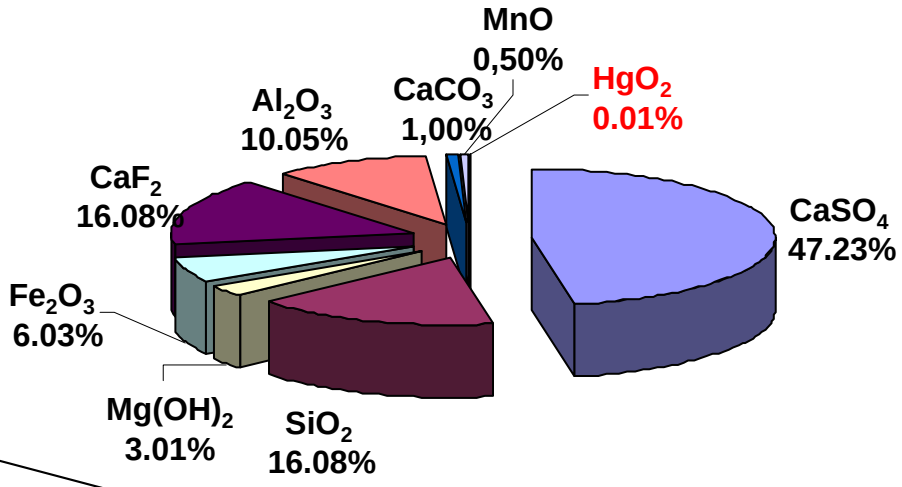
Evonik's two-stage process with selective Hg Separation



Filter Cake Composition

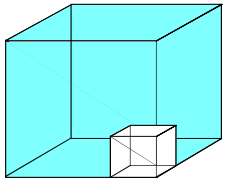
Until 2000: 7,200 per year of WWT filter cake to disposal



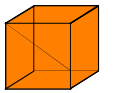


Since 2000:
6,980 tons per year of heavy metal free WWT filter cake recycled back to the coal pile

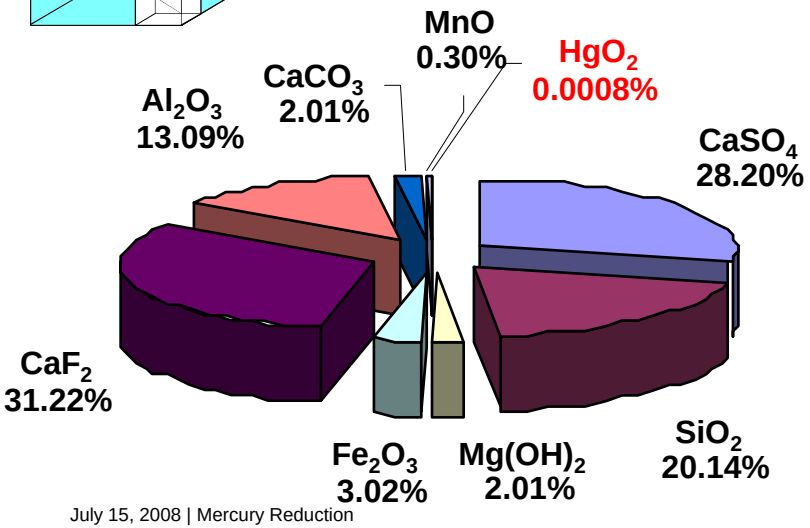
97 %

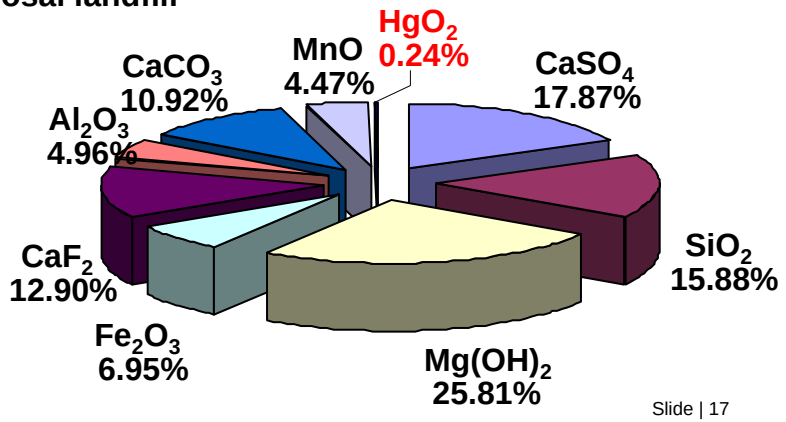


3 %



Since 2000:
220 tons per year of heavy metal WWT filter cake to a disposal landfill





Cost Savings

Actual situation until 2000 with the conventional single-stage WWTP

Filter cake amount to disposal:	**6,500 t/a**
Specific disposal cost:	**90 €/t**
Total FGD WWT operating costs:	**585,000 €/a**

After retrofit of the two-stage WWTP and recycling of heavy metal free sludge back to the coal pile:

Filter cake amount back to the coal pile:	**6,300 t/a**
Filter cake amount to deposit	**200 t/a**
Specific disposal cost:	**150 €/t**
Total Disposal costs:	**30,000 €/a**
Additional chemical consumption cost:	**50,000 €/a**
Total FGD WWT operating cost:	**80,000 €/a**

Total saving of FGD WWT operating cost: 505,000 €/a

Conclusions

- **High mercury removal efficiency**
- **Few modifications to existing processes**
  - **Activated Carbon Injection**
  - **Extension of WWT Plant**
  - **Change to Operation of WWT System**
- **Significant decrease of disposal cost**
- **Significant decreased waste water effluent**
  - **Co-combustion of waste water sludge has no measurable impact on flue gas composition**
  - **Fly ash still marketable**
  - **Gypsum still marketable**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