ICL Industrial PRODUCTS

VOSTEEN CONSULTING GmbH
Thermal Engineering and Environmental Protection

AUSTRIAN ENERGY & ENVIRONMENT

Bromine based Mercury Abatement in Power Generation and Waste Combustion

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VOSTEEN Mercury Control Technology

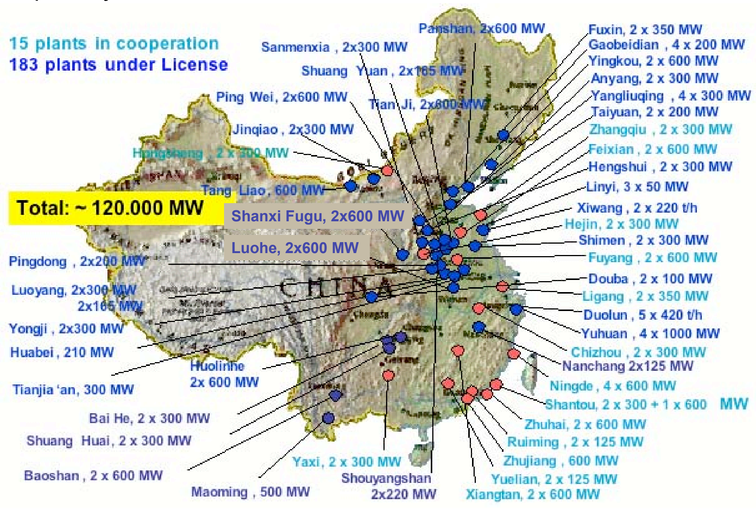
- Invented by **Professor Dr. Bernhard Vosteen** et al. in 2000 - still in his time with **CURRENTA GmbH & Co OHG** and patented by her
- commercially applied to waste incineration plants and power plants since 2001
- A specific bromine-containing chemical **Merquel™** from **ICL-IP** is added to the coal prior to the combustion process to enhance mercury oxidation
- **AE&E** (Austrian Energy & Environment) has licensed rights to the technology from Vosteen Consulting to market to the power generation and waste incineration industry in Europe and some other countries as e.g. in **China or India**

What makes the VOSTEEN Technology Unique ?

- Pre-combustion **Merquel™** addition is the most effective method to enhance mercury oxidation from coal-fired boilers and industrial processes
- **Merquel™** from **ICL-IP** is already used by the power generation industry and the waste incineration industry; The additive is cost-effective and readily available
- The **VOSTEEN** Technology is simple and inexpensive to retrofit to any boiler
- The **VOSTEEN** Technology presents no adverse impacts on the performance of the boiler or downstream the FGD equipment when applied correctly and the FGD operation parameters are optimized according to **AE&E's MERCURYSEPARATION Optimization Skid**

Strong Triangle – VOSTEEN+AE&E+MERQUEL™

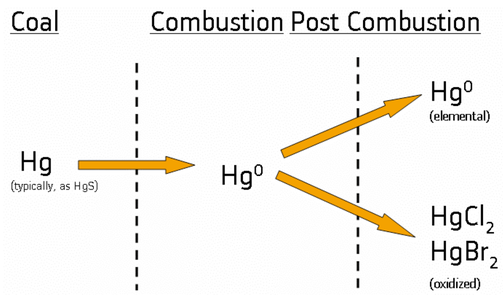
- Combination of Simple Technology, high efficient additive and long term experience in the installation of Air Pollution Control Systems especially in China



- **AE&E Wet FGD Technology** is installed for more than **120.000 MW** of coal fired power plant capacity in China
- **AE&E's Air Pollution Control Technologies** including DeNOx-Systems, Dry Desulphurization Systems and Wet Flue Gas Desulphurization Systems is used from more than 10 Licensees in China

Reaction Mechanism

- Oxidized Mercury can be captured very easy, elemental mercury is difficult to capture



Merquel™ (containing Bromine) is added to the coal prior to combustion. In the flame, all Hg is elemental: Hg^0

Native and added Cl^- and Br^- in the coal form HCl and HBr. On cooling (starting around 1000 °C) following reactions can be found:

$$4HCl + O_2 \rightarrow 2\,H_2O + Cl_2$$

$$4HBr + O_2 \rightarrow 2\,H_2O + Br_2$$

Elemental Hg^0 is effectively oxidized by Br_2 to form $HgBr_2$

Scrubber operation and Mercury Capture

The oxidized Mercury is mainly captured in the wet scrubber of the FGD system and is bound in the scrubber suspension due to complexation with halogenid ions.

$$HgX_2 + X^- \rightleftharpoons [HgX_3]^- \quad ; \quad [HgX_3]^- + X^- \rightleftharpoons [HgX_4]^{2-}$$

molecularly dissolved: with a appreciable vapor pressure

complexes dissociating into ions: with a low vapor pressure

with X = Br, Cl or I

- Re-emission of Mercury from the scrubber slurry due to chemical reduction reactions in the scrubber slurry can be minimized by complexation and/or precipitation
- **PRAVO™** as proprietory precipitation agent from **VOSTEEN** forms mercury sufide (nontoxic cinnabar HgS) e.g. in FGD and/or in off water treatment sludge
- Scrubber operation parameters strongly influence where the captured Mercury will be found in the outgoing FGD flows

Injection of Merquel™ in the Process

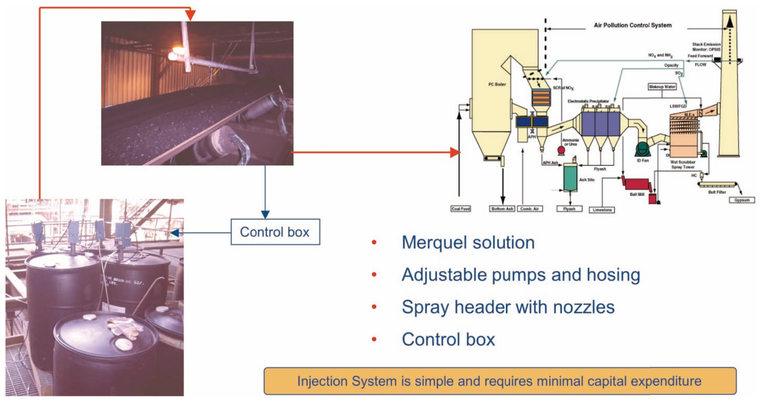
- Spraying **Merquel™** solution on the coal to the conveyor belt during silo charging.

- Spraying **Merquel™** solution on the coal stream from the coal feeders to the mills.

- 1000 liter **Merquel™** solution container for tests at stationary FB Sewage Sludge Incinerator

- 10,000 liter **Merquel™** solution container for long time test at coal-fired boiler (710 MW)

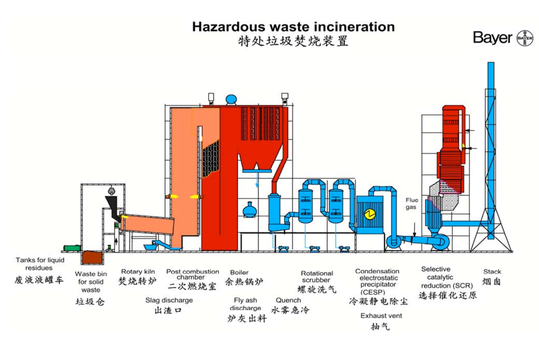
- Process Requirement: Uniform distribution of the additive in boiler flue gas in order to provide uniform Hg oxidation of all flue gas (see Rini, Vosteen in Proceedings of MEGA Symposium 2008, Baltimore)



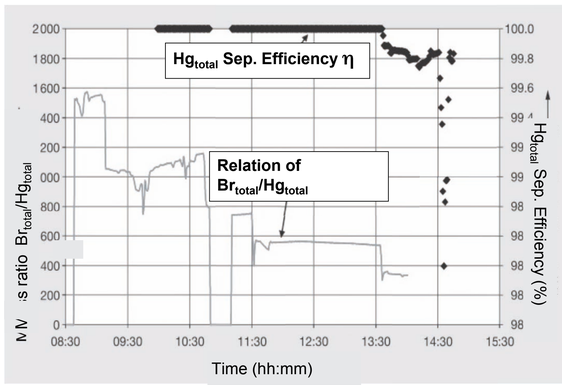
Large Scale Demonstration

The Technology has demonstrated its First Class Performance in the Power Generation and Waste combustion since more than 5 years.

Waste Combustion at CURRENTA GmbH & Co OHG in Germany:

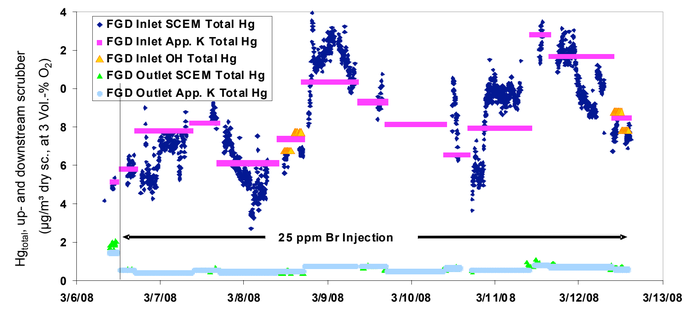


Relationship between Bromine Dosage and Mercury Separation Efficiency (see Vosteen, Kanefke, Köser in VGB PowerTech 86 (2006), p.70 - 75)



Alabama Power Plant Miller (4 x 710 MW) – Demonstration Project in 2006 (Phase I) and 2008 (Phase II) (Foto: Vosteen Consulting)

Mercury content up- and downstream wet limestone scrubber system (see Dombrowski, Berry , Vosteen et al. in Proceedings of MEGA Symposium 2008, Baltimore)



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