SNOX™ technology for cleaning of flue gas from combustion of high sulfur fuels

“Beneficial By-products of Coal Combustion and Gasification”, Hot Topic Hour
April 28th, 2011 – Erik Eriksson
Presentation outline

- Introduction
- Process layout
- Economy compared with limestone scrubbing
- References
- Summary
What is SNOX™?

SNOX™ – a process for purification of flue gas from combustion of high-sulfur fuels

Removes SOx, NOx and particulates from flue gases.
**SNOX™ – flow diagram**

**Reaction:**

\[ H_2SO_4 (g) \rightarrow H_2SO_4 (liq) \]

**Clean flue gas to stack**

**Cooling air blower**

**WSA condenser**

**SO_2 + 0.5 O_2 \rightarrow SO_3**

**Steam turbine/generator**

**Cooling air**

**Hot combustion air**

**Flue gas**

**ESP**

**Flue gas blower**

**Ashes**

**Boiler**

**Cooling air**

**Steam to process plants**

**High Sulfur Residuals**

**Ammonia or SWS gas**

**Heat exchanger**

**Sulfuric Acid 95%**

**Heat exchanger**

**Heat exchanger**

**Reaction:**

\[ NO + NH_3 + 0.25 O_2 \rightarrow N_2 + 1.5 H_2O \]
**SNOX™ vs. limestone**

**SNOX™**
- STEAM and PREHEATED COMBUSTION AIR
- FLUE GAS
- LIMESTONE
- FLUE GAS
- LIQUID and SOLID WASTE

**Limestone scrubber**
- CLEANED GAS
- SULFURIC ACID
- CLEANED GAS
- LIQUID and SOLID WASTE

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Cost of flue gas desulfurization

$/kWh

TOTAL COST (CAPEX + OPEX) OF FLUE GAS DESULFURIZATION

SULFUR IN FUEL

% Normal coal Heavy Residue Petcoke

Limestone scrubber

SNOX™
Comparison of operating costs

<table>
<thead>
<tr>
<th>Basis: Petcoke</th>
<th>Downshot PC boiler with SNOX™</th>
<th>CFB boiler with SCR DeNOx and limestone FGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 MW electric power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit: USD per year</td>
<td>3,600,000</td>
<td>0</td>
</tr>
</tbody>
</table>

**Income:**
- Sales of sulfuric acid at $30/t: $3,600,000
- 0

**Costs:**
- Limestone at $20/t: $0
- Ammonia at $300/t: $600,000
- $240,000
- Waste disposal at $20/t: $0
- $12,000,000
- Additional petcoke consumption at $40/t: $0
- $400,000
- Total costs: $600,000
- $20,000,000

**Net operating income:**
- + $3,000,000
- – $20,000,000

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## SNOX™ references

<table>
<thead>
<tr>
<th>Plant</th>
<th>Capacity (flue gas)</th>
<th>Start-up</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordjyllandsværket, Denmark</td>
<td>1,000,000 Nm³/h 900 MM SCFD</td>
<td>1991</td>
<td>Coal</td>
</tr>
<tr>
<td>Raffineria di Gela, Italy</td>
<td>1,200,000 Nm³/h 1,075 MM SCFD</td>
<td>1999</td>
<td>Petcoke + RFO</td>
</tr>
<tr>
<td>OMV Refinery, Austria</td>
<td>820,000 Nm³/h 735 MM SCFD</td>
<td>2007</td>
<td>RFO + sour gas</td>
</tr>
<tr>
<td>Petrobras RNEST, Brazil</td>
<td>2 x 650,000 Nm³/h 2 x 582 MM SCFD</td>
<td>Expected 2012</td>
<td>Petcoke + sour gas</td>
</tr>
<tr>
<td>Ohio Edison, USA (demonstration plant)</td>
<td>135,000 Nm³/h 121 MM SCFD</td>
<td>1991-96</td>
<td>Coal</td>
</tr>
</tbody>
</table>
SNOX™ – Raffineria di Gela, Italy

Raffineria di Gela, Sicily, Italy

Boilers: approx. 250 MWₑ + steam and heat

Fuel: 90% Petroleum coke

Additional fuel: Oil and gas

Total flue gas flow: 1,200,000 Nm³/hr
1,075 MM SCFD

H₂SO₄ (95%): 225 t/d

SO₂ removal: 96.5%

Commissioned: 1999

Left stack emits 1,000,000 Nm³/h SNOX™ treated (invisible) flue gas

Right stack emits (hazy) flue gas from the 4th boiler before it was connected to the SNOX™ plant
Seven good reasons for choosing Topsoe SNOX™

- Clean, proven and reliable technology
- No consumption of absorbents
- No process water consumption
- No production of waste solids and liquids
- Valuable sulfuric acid product
- Excellent heat recovery
- Low operating & maintenance costs.
Thank you for your attention!