Presentation of Kawasaki FGD and SCR System

March 12, 2012
Main Topics

1. History of Kawasaki FGD
2. Process Feature of Kawasaki FGD
3. Experience of Kawasaki FGD
4. Introduction of Kawasaki SCR

FGD: Flue Gas Desulfurization
SCR: Selective Catalytic Reduction

All photos quoted from http://www.nationalgeographic.co.jp/environment/photos
To Keep Our Earth Clean

SO₂ (Sulfur Dioxide)  NOₓ (Nitrogen Oxide)

Combustion of coal or oil in boilers

Acid Rain

Kawasaki has been supplying:
- Flue Gas Desulfurization (FGD) Plants for SO₂ removal
- Selective Catalytic Reduction (SCR) Plants for NOₓ removal

http://www.nationalgeographic.co.jp/environment/photos
In 1968, Kawasaki started R&D of FGD process and developed its own Magnesium-gypsum process and Limestone-gypsum process.

As of end of 2011 Kawasaki has installed total 111 Plants (42 in Japan and 59 Overseas), which covers 28,500 MW.
Kawasaki FGD Technology applies to one of the largest coal fired power plants in the world.

Unit 2 (700MW) in 1991
Unit 4,5 (1,000MW x 2) in 2001, 2002

Hekinan Thermal Power Station, Japan
Total 4,100 MW Capacity (700MW x 3 units + 1000MW x 2 units)
Kawasaki FGD technology covers 2,700MW capacity
1. Kawasaki Compact Absorber

SO₂ and dust in flue gas are removed by efficient contact with absorbent slurry.

Advantages
1) Absorber height lowered
2) Easy maintenance achieved
Features of Kawasaki FGD Technology

2. Kawasaki Spiral Spray Nozzle

Specification
- Type: Spiral
- Material: Ceramics

Advantages
1) High SO2 and dust removal performance
2) High flow rate and low spray pressure
3) Less clogging due to large throat diameter
4) High durability to erosion and corrosion
Advantages of Kawasaki FGD Technology

With applying Kawasaki Compact Absorber and Kawasaki Spiral Spray Nozzle, Kawasaki achieves;

1. **Superior Performance**
   Kawasaki’s spiral water curtain spray nozzle achieves superior SO2 and dust removal efficiency.

2. **High Reliability**
   Kawasaki has achieved the highest level of successful operational reliability.

3. **Low Energy Consumption**
   Adequate spray pressure achieves the lowest practical level of energy consumption.

4. **Easy Maintenance**
   Simple absorber design and mist eliminator located outside absorber make maintenance work easier.
Main Equipment

- Boost Up Fan (BUF)
- Circulation Pump
- Gypsum Separator
- Ball Mill
Easy and Reliable Operation

DCS Operation

All equipment in FGD is operated and controlled by Distributed Control System (DCS).

The important controlling factors for FGD performance, are performed automatically by DCS according to boiler operation condition.
Advanced FGD Design

Flow Simulation

Kawasaki can:
1. Confirm uniform flow balance
2. Avoid gas short-pass
3. Avoid scaling trouble
4. Minimize pressure loss

Droplet Flow Analysis

Kawasaki can:
1. Check spray droplets behavior
2. Select optimized gas velocity
3. Reduce carried mist
**Advanced FGD Design**

**FEM Stress Analysis**
- Kawasaki can:
  1. Check structural design
  2. Select adequate reinforcement

  (FEM: Finite Element Method)

**3D Piping Design**
- Kawasaki can:
  1. Determine appropriate piping route
  2. Check no interference among piping, equipment structure, etc
  3. Avoid site modification work
Recent FGD Experience

**Hekinan Thermal Power Station**

**Unit No.4, 5**
Client: Chubu Electric Power Co. Inc.
Location: Hekinan Aichi, Japan
Fuel: Coal
Boiler Capacity: 1000MW x 2

**Anan Thermal Power Plant No.3**
Client: Shikoku Electric Power Co. Inc.
Location: Anan Tokushima, Japan
Fuel: Oil
Boiler Capacity: 450MW x 1
Commercial Operation: 1998
Recent FGD Experience

**Opatovice Power Plant No.1~6**
Client: Elektrany Opatovice  
Location: Pardubice, Czech Republic  
Fuel: Coal  
Boiler Capacity: 55 MW x 6  
(Total: 330MW)  

**Ho-Ping Power Plant Unit No.1, 2**
Client: Ho-Ping Power Company Co., LTD.  
Location: Ho-Ping, Taiwan  
Fuel: Coal  
Boiler Capacity: 660MW x 2  
Commercial Operation: 2002
Recent FGD Experience

**Anshun Power Plant Unit No.3, 4**
Client: Guizhou Electric Power Corp.
Location: Anshun Guizhou, China
Fuel: Coal
Boiler Capacity: 300MW x 2
Commercial Operation: 2003

**Dingzhou Power Plant Unit No.1, 2**
Client: Hebei Guohua Dingzhou Electric Power Corp.
Location: Dingzhou Hebei, China
Fuel: Coal
Boiler Capacity: 600MW x 2
Commercial Operation: 2004, 2005
Recent FGD Experience

Uong Bi Extension Power Plant
Client: Vietnam Electricity (EVN)
Location: Uong Bi, Vietnam
Fuel: Coal
Boiler Capacity: 300MW x 1
Commercial Operation: 2006

Saudi / IWSP Project
Client: Rabigh Arabian Water and Electricity Company
Location: Rabigh, Saudi Arabia
Fuel: Oil
Boiler Capacity: 470t/h x 3 x 3 (330MW equiv. x 3)
Kawasaki offers NOx removal system based on Selective Catalytic Reduction (SCR) process using ammonia.

Kawasaki SCR consists of catalyst and ammonia injection device.
## Wide Application of Kawasaki SCR System

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<th>Diagram Description</th>
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<td>Boiler Plant</td>
<td><img src="#" alt="Diagram of Boiler Plant with SCR, ESP, and FGD systems" /></td>
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<tr>
<td>Waste Incineration Plant</td>
<td><img src="#" alt="Diagram of Waste Incineration Plant with SCR and NH₃ addition" /></td>
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<tr>
<td>Gas Turbine Power Plant</td>
<td><img src="#" alt="Diagram of Gas Turbine Power Plant with SCR and NH₃ addition" /></td>
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<tr>
<td>Diesel Power Plant</td>
<td><img src="#" alt="Diagram of Diesel Power Plant with SCR, Start Up Bypass, and Cleaning Bypass" /></td>
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### Kawasaki will continue to refine its technology and supply FGD and SCR Plants all over the world to keep our earth clean.

<table>
<thead>
<tr>
<th>Power Plant</th>
<th>Location</th>
<th>Fuel</th>
<th>Capacity</th>
<th>Commercial Operation Year</th>
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<tr>
<td>Opatvice Power Plant No. 1 - 6</td>
<td>Pardubice, Czech Republic</td>
<td>Lignite Coal</td>
<td>330MW</td>
<td>1997</td>
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<tr>
<td>Dingzhou Power Station</td>
<td>Dingzhou Hebei, China</td>
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<td>Saudi / IWSP Project Unit No. 1, 2, 3</td>
<td>Saudi / Rabigh</td>
<td>Heavy Oil</td>
<td>330MWx3</td>
<td>Oct. 2008</td>
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<td>Yangzhou Power Plant No. 5</td>
<td>Yangzhou Jiangsu, China</td>
<td>Bituminous Coal</td>
<td>200 MW</td>
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<td>Anan Thermal Power Station No. 3</td>
<td>Anan Tokushima, Japan</td>
<td>Oil</td>
<td>450MW</td>
<td>1998</td>
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