Technology Solution for Sox Reduction in Thermal Power plants

Bharat Heavy Electricals Ltd.
Topics

- Technology (FGD) for SOx reduction
- SOx emission level in Thermal power plants
- MOEF norms
- Type of FGD technologies
- BHEL experience FGD technology
- BHEL-MHI FGD Technology and its advantages
- Limestone sources and Gypsum disposal
- Conclusion
FGD

The Flue Gas Desulphurization (FGD) is a process of removal of sulphur dioxide ($\text{SO}_2$) from the flue gas.
Need for FGD

- Combustion of fuel having sulphur results in SO$_2$ Emission

- 95 – 96 % of sulphur is converted into SO$_2$

- Sulphur content in Indian coal ranges from 0.25 to 0.5 % and in imported coal it is more than 0.6 %.

- Coal with 0.5 % sulphur, generates SO$_2$ of range 1500 - 2000 mg/Nm3

- SO$_2$ emission results in Acid-rain, corrosion of buildings & structures and affect human health
**MOEF - Notification on 7.10.15**

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>TPPs ( units) installed before 31st December, 2003*</th>
<th>TPPs ( units) installed after 1st January, 2004 upto 31st December, 2016*</th>
<th>TPPs ( units) to be installed from 1st January, 2017**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (PM)</td>
<td>100 mg/Nm3</td>
<td>50 mg/Nm3</td>
<td>30 mg/Nm3</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO2)</td>
<td>600 mg/Nm3 (Units &lt; 500MW)</td>
<td>600 mg/Nm3 (Units &lt; 500MW)</td>
<td>100 mg/Nm3</td>
</tr>
<tr>
<td></td>
<td>200 mg/Nm3 (Units &gt;= 500MW)</td>
<td>200 mg/Nm3 (Units &gt;= 500MW)</td>
<td></td>
</tr>
<tr>
<td>Oxides of Nitrogen (NOx)</td>
<td>600 mg/Nm3</td>
<td>300 mg/Nm3</td>
<td>100 mg/Nm3</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.03 mg/Nm3 (for units having capacity of 500MW)</td>
<td>0.03 mg/Nm3</td>
<td>0.03 mg/Nm3</td>
</tr>
</tbody>
</table>

*TPPs (units) shall meet the limits within two years from date of publication of this notification.

**Includes all the TPPs (units) which have been accorded environmental clearance and are under construction.
BHEL Experience in FGD

- Successfully commissioned sea water based FGD at Trombay unit#8 250 MW of MHI Technology in 2010.

- Supplied Wet Limestone based FGD to NTPC Bongaigaon 3X250MW of Ducon Technology in 2012.

- BHEL has signed a TCA with M/s MHPS for Wet FGD technology in April 2013.
Types of FGD

- Wet Lime/Limestone FGD
- Seawater FGD
- Dry FGD
FGD Process Flow Diagram

Flue gas System

Absorber System

Limestone Grinding System

Gypsum Dewatering System
Principle of FGD System

The Wet Limestone-Gypsum Process

Chemical Reaction in FGD

SO₂ + CaCO₃ (Limestone) + 1/2O₂ + 2H₂O → CaSO₄ · 2H₂O (Gypsum) + CO₂

SO₂ Removal Efficiency
90% ~ 99.9%

By-Product Gypsum
Purity 90~98% as Valuable material

Limestone

Gypsum board
Sea Water Based FGD
Typical Layout of online FGD
DCFS – Double Contact Flow Scrubber

Single Tower DCFS

Twin Tower DCFS
Spray System Load Adjustment

Energy Saving for Partial Load

Liquid column height is adjusted by changing the number of recirculation pumps according to boiler load, thus for energy saving.
## Comparison with Conventional Spray

<table>
<thead>
<tr>
<th>Item</th>
<th>Spray Tower</th>
<th>BHEL-MHPS DCFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintainability</td>
<td><img src="image1" alt="Diagram of Spray Tower" /></td>
<td><img src="image2" alt="Diagram of BHEL-MHPS DCFS" /></td>
</tr>
</tbody>
</table>
| **Features** | - Scaffolding is required for each stage of spray pipe.  
- It is hard to install the scaffolding for each stage of spray pipe.  
- Maintenance work is hard because the workers are forced to keep looking up the spray pipes and nozzles | - Only one stage scaffolding is required.  
- It is easy to install the scaffolding on spray pipes.  
- Maintenance work is easy because the workers can inspect nozzles by looking down. |
No special maintenance is required, because scaling will not occur due to Mitsubishi’s unique absorber design without internal elements, except for single-stage nozzles of the DCFS system.

Kashima-minami (136MW)
After 6 year operation
(6th Periodical Inspection)

Misumi (1,000MW)
After 2 year operation
(1st Periodical Inspection)

Mikuni (250MW)
After 2 year operation
(1st Periodical Inspection)
Reference Plant (Compact Footprint)

**Independent Type**
- Absorber
- GGH

**Absorber-mounted Type**
- Absorber
- GGH

Absorber-mounted Type fit even small space
A part of the absorber slurry is fed to JAS.

Low pressure area is generated in JAS where air is sucked directly through blower.

**Jet Air Sparger (JAS)**

**Features**

- Energy Saving
  - High air-utilization percentage
  - Blower less

- Reduced maintenance
  - No rotating equipment and high reliability
  - No structural parts

**Oxidation Method**

<table>
<thead>
<tr>
<th>Oxidation Method</th>
<th>Jet Air Sparger</th>
<th>Side-entry Oxidation Agitator</th>
<th>Fixed Air Sparger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air utilization percentage (Indicative)</td>
<td>60</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>
Limestone of size 250 mm

Pent House Magnetic Separator

Crusher

Limestone of 20 mm size

Unloading Hopper

Belt conveyor

Bucket Elevator
Critical Equipment of FGD system

- Booster Fan
- Gas Gas Heater
- Gates & Dampers
- Wet Ball Mill
- Gypsum Dewatering System
- Oxidation Blower
- Recirculation Slurry Pump
- Agitator
Wet Ball Mill System

- Quarry Ground Limestone or On-Site Mill
- Horizontal Ball Mill
- 95% - 325 Mesh (44 μm)
- 30% to 35% Solids
Gypsum Dewatering System

Vacuum Belt Filter

Hydrocyclone

Byproduct Gypsum
Full Scale DCFS R&D SETUP
Reference Plant

Client : Tennessee Valley Authority

Plant : Bull Run Fossil Plant, USA

Fuel (Sulfur Content) : Coal (S = 2.12%)

Generating Power : 920 MW

Gas Flow Rate : 3,311,200 Nm³/h

Inlet SO₂ Conc. : 1,343 ppm(d)

(3,938 mg/Nm³)

Inlet Gas Temp. : 149 deg.C

Desulfurization Efficiency : 98.0 %

Start up : Nov. 2008

Absorber Type : DCFS
## Reference Plant

<table>
<thead>
<tr>
<th>Client</th>
<th>British Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td>Eggborough #3 and 4, UK</td>
</tr>
<tr>
<td>Fuel</td>
<td>Coal (S = 1.6%)</td>
</tr>
<tr>
<td>Generating Power</td>
<td>500 MW each</td>
</tr>
<tr>
<td>Gas Flow Rate</td>
<td>1,980,000 Nm³/h(w)</td>
</tr>
<tr>
<td>Inlet SO₂ Conc.</td>
<td>3,589 mg/Nm³</td>
</tr>
<tr>
<td>Inlet Gas Temp.</td>
<td>125 deg.C</td>
</tr>
<tr>
<td>Desulfurization Efficiency</td>
<td>90.0 %</td>
</tr>
<tr>
<td>Start up</td>
<td>2004</td>
</tr>
<tr>
<td>Absorber Type</td>
<td>DCFS</td>
</tr>
</tbody>
</table>
LIMESTONE SOURCE
Limestone production in India

- Andhra Pradesh (21%)
- Rajasthan (19%)
- Madhya Pradesh (13%)
- Gujarat (9%)
- Karnataka, Chhattisgarh & Tamil Nadu (8% each)
- Maharashtra, Himachal Pradesh (4% each)
- Remaining 6% from other states
Other states of limestone resource

- **Tamil Nadu**
  (Ramanathapuram, Tirunelveli, Tiruchirappalli, Salem, Coimbatore, Madurai and Thanjavur)

- **Maharashtra**
  (Yavatmal, Chandrapur, Nanded and Ahmednagar)

- **Himachal Pradesh**
  (Bilaspur, Kangra and Chamba)

- **Orissa**
  (Sundargarh, Sambalpur and Kalahandi)

- **Other states** Haryana, Assam, Meghalaya, Uttar Pradesh, Jammu and Kashmir
Gypsum Disposal

- Manufacture of wallboard,
- Cement,
- Plaster of Paris,
- Soil conditioning,
- Hardening retarder in portland cement.
Conclusion

Why BHEL?

- OEM of majority of power plants in India
- BHEL is having the best FGD technology in the world
- Optimum design, layout and better interface with Boiler
- Unified DCS running on common platform
- Assured Service after Sales
- BHEL is ‘Making in India’
Thank You