MITSUBISHI

Environmental Solution for Coal Fired Power Station

March 2012
Status of Emission Regulation in Europe

**Situation**
- Stringent EU Emission regulation, IED, from 2016
  - The IED also require use of the Best Available Technology (BAT) for reducing emissions more.
  - In case of accommodating CO₂ Capture Plant, Required SO₂ removal efficiency would be over 99%

**Proposal**
Mitsubishi Heavy Industries, Ltd Japan (MHI) to Provide Optimized Environmental Solution in Europe with MHIE and MPSE
MHI Solutions for Coal Fired Power Plant

Available to Cover Whole Flue Gas Conditioning Chain

(A) DeNOx; SCR (Selective Catalytic NOx Removal System)

(B) EP (Electrostatic Precipitator)

(C) FGD (Flue Gas Desulfurization)

(D) CO₂ Capture

(A) DeNOx; SCR

(B) EP

(C) FGD

(D) CO₂ Capture

Clean Flue Gas

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MHI Activities in De-NOx / SCR

600+ “Mitsubishi” SCR Units (World Wide)

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SCR Typical System Configuration

Flexible scope according to client's needs
- LPA Screen
- Urea System
- Ammonia Tank
- Tech. Advisor
- Training

Possible to guarantee for client's needs
- NOx
- NH3 slip
- SO2/SO3
- Mercury
- Catalyst Life
Feature of MHI SCR Catalyst

- Ti-V-W based homogeneous grid type
- No wash coat to delaminate
- Suitable for any type of fuel
- High geometric surface area; small volume required

1. High NOx Removal Efficiency
2. Thermal Stability
3. High Resistance to SOx and Dust
4. High Resistance to Erosion
5. Safe Treatment of Spent Catalyst
MHI Activities in FGD

As of Feb 2012

<table>
<thead>
<tr>
<th>Region</th>
<th>Count</th>
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<tr>
<td>Europe</td>
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<td>Japan</td>
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<tr>
<td>U.S.A</td>
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<td>ASIA</td>
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<td>South America</td>
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<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
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<tbody>
<tr>
<td>OIL-FIRED BOILER</td>
<td>44</td>
</tr>
<tr>
<td>COAL-FIRED BOILER</td>
<td>150</td>
</tr>
<tr>
<td>(Lignite-Fired Boiler)</td>
<td>(10)</td>
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<tr>
<td>OTHERS</td>
<td>21</td>
</tr>
<tr>
<td>TOTAL</td>
<td>215</td>
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</tbody>
</table>
Feature of MHI's FGD

MHI's FGD Typical Configuration
Double Contact Flow Scrubber - DCFS

Single Tower DCFS
SO2 removal eff. $\leq 98\%$

Twin Tower DCFS
SO2 removal eff. $> 98\%$
HEAVY INDUSTRIES, LTD.

MITSUBISHI

2E09-2ZA194EA

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Feature of DCFS

Double-Contact Liquid Column (Rising Up / Falling Down)

Enfoldment of Gas by the Highly Densed Liquid Droplets

Self Washing by Upper Nozzle

Single Stage Nozzles

High efficiency

Simple and easy maintenance

MHI's Unique FGD System Configuration with High efficiency/ Simple and easy maintenance Delivered to All Over the World

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Features of DCFS

- No Internal
- Large Diameter Nozzles
- No Scaling
- No Plugging
- Low Pressure
- Self Washing
- Single Stage Nozzles
- Easy Maintenance

Simple Configuration Enables High Maintainability

Nippon Petroleum Refining Co, Ltd / Osaka
Spray Pipes and Nozzles at inspection
Operation start: Jul. '98
Photo: May '00

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Summary of DCFS

● High Performance
  Desulphurization Efficiency ~99.9 %
  Dedusting Efficiency ~90 %
  Flexibility for Various Kinds of Fuel
    Inlet SO₂ Conc.
    Coal : 754~22,285 mg/m³N (264~7,792 ppm)
    Oil, VR etc. : 730~16,400 mg/m³N (255~5,735 ppm)
    Sintering : 715~83,617 mg/m³N (250~29,239 ppm)

● Economical System
  Low Power Consumption 0.8 ~ 1.0 % against Generating Power
  Compact Absorber Simplified Process DCFS

● Easy Maintenance
  Simple Absorber Internal Single Stage Nozzles
MHI Experience Highlight

HIGH SO2 REMOVAL EXPERIENCES
- 4 Units operate above 99% SO₂ removal
- 25 Units are operating at or above 98% SO₂ removal

HIGH SULFUR EXPERIENCES
- Over 30 units are above 2,000 ppm(d) at inlet
- Most of high sulfur units are operating above 95% SO₂ removal

LARGE ABSORBER MODULE EXPERIENCES
- 34 Units designed or operating at or above 600MW
- 6 Units are operating at or above 1,000MW
- 2 Units designed or operating above 4,000,000 m³N/h at inlet
# FGD for Lignite Fired Power Station Experience

- All with sulfur levels above 10,000 mg/m³ at inlet
- 8 Units designed or operating at over 95% SO₂ removal

<table>
<thead>
<tr>
<th>Year</th>
<th>Customer (Location)</th>
<th>Capacity (MW)</th>
<th>SO₂ Content (mg/Nm³)</th>
<th>Removal Efficiency (%)</th>
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<td>Inlet</td>
<td>Outlet</td>
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<td>EUAS (Afsin-Elbistan-B, Turkey)</td>
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<td>16,500</td>
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(*) Retrofit
Client: EUAS (Electricity Generation Corporation)

Plant: Afsin-Elbistan B Unit 1, 2, 3 & 4, Turkey

Fuel (Sulfur Content): **Lignite (S = 2.0%)**

Generating Power: 360 MW × 4 Units

Gas Flow Rate: 2,226,280 Nm³/h

Inlet SO₂ Conc.: 14,000 mg/ Nm³ (Max)  
16,500 mg/ Nm³ (Peak) Inlet

Inlet Gas Temp.: 173 deg.

Desulfurization Efficiency: 95 %

Start up: Dec. 2004

Absorber Type: DCFS
MHI Activities in CO₂ Capture Plant

- 9 commercial plants under operation for Chemical Plant
- Another 1 commercial plant under construction for Demonstration

KEY
- Plants under operation
- Plants under construction

1. 1999 Malaysia
   - 210 Mt/d

2. 2005 Japan
   - 330 Mt/d

3. 2006 India (Aonla)
   - 450 Mt/d

4. 2006 India (Phulpur)
   - 450 Mt/d

5. 2009 India
   - 450 Mt/d

6. 2010 Abu Dhabi
   - 400 Mt/d

7. 2011 Pakistan
   - 340 Mt/d

8. 2009 Bahrain
   - 450 Mt/d

9. 2010 Vietnam
   - 240 Mt/d

10. 2012 India (Vijaipur)
     - 450 Mt/d

11. 2010 India
    - 450 Mt/d

12. 2012 India
    - 450 Mt/d

13. 2012 India
    - 450 Mt/d
Demonstration Outline
Client: Southern Company (SoCo)
Solvent: KS-1™ Solvent
Capacity: 500 Mt/D
Feed Gas: Coal Fired Boiler (12.0 v% CO₂)
Start up: June 2011
Location: Alabama, U.S.

MHI has been one of the world's front-runner in CO₂ Capture from Flue gas of Coal Fired Power Station
Thank you for your attention