Progress Update of MHI Air-blown IGCC & O2-blown Gasification

May 3, 2010

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Photo:
250MW IGCC Demonstration Plant @Nakoso, Japan

MITSUBISHI HEAVY INDUSTRIES, LTD.

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Contribute to Both of the Power Generation and the Chemical Industries

• **Air-Blown Gasifier with High Temp. GT for IGCC** (i.e. for the Power) at the Highest Plant Efficiency and Economical Merits

• **O2-Blown Gasifier for Chemical Products** (i.e. SNG, CTL, NH3, etc.) at the Minimum Utility Consumption Including Aux. Power
MHI IGCC / Gasification Technology Development

Fuel Capacity (ton/day)

- 2t/d PDU (CRIEPI)
- 200t/d Pilot Plant (Nakoso)
- 1,700t/d / 250MW Demo. Plant Clean Coal Power R&D, Ltd.
- 500MW or More Commercial Plant
- 3,600t/d Commercial Plant
- O2-Blown Gasifier for Chemical Products

PDU: Process Development Unit  
CRIEPI: Central Research Institute of Electric Power Industry
Features of MHI IGCC / Gasifier

Realizes the Lowest Cost with Various Advantages

- **Highest Plant Efficiency** Because of Air-Blown Gasifier for IGCC
- **Minimum Utility Consumption** by MHI O2-Blown Gasifier for Syngas Production
- **Flexibility for Variety of Coal** Including Brown Coal Because of 2-Staged Dry Coal Feed and “Fine” Coal Pulverizing System
- **Higher Reliability & Easier Maintainability** with Membrane Waterwall Configuration
- **Effective Utilization of By-Product** like Discharged Molten Slag, Recovered Sulfur, etc.
- **High Plant Efficiency** by “G” Type High Temp. GT and High Reliability from Abundant “Low BTU Gas Firing” GT
1. **2-Staged Gasification**
- Combustor / Reductor Configuration
  ① Stable Syngas Production for **Wide Variety of Coal**
  ② Smooth Slag Discharge Capability
  ③ No Necessity of Quench Gas

- Chemical Quench (w/o Quench Gas) occurs at 2nd Stage

2. **Char Recycling System**
  ① Minimize Unburnt Carbon in Slag
  ② No Black Water from Gasifier

**Same 2-Staged Gasifier as Air-Blown Nakoso IGCC Project Applied to O2-Blown**
- Without changing the basic design of the existing gasifier in operation
- Reducing O2 consumption by 15-25%
- SGC, as monolithic structure with gasifier, producing steam and supplying aux. power needed in plants
Topics –
Current Activity and Future Possibility

- Realization of Commercially Viable Projects

- Innovating Clean Coal Technology
  - Heightening Thermal Efficiency
  - Enhancing Commercialization of CO2 Capture

- Utilization of Low Grade - High Moisture Coal
  (Discussion)
Current Status of 250MW IGCC Demonstration Project

METI (Ministry of Economy, Trade and Industry)

30% Subsidy

Joint Project Agreement

Clean Coal Power R&D Co., Ltd.

70% Contribution

Researchers

Hokkaido EPCo.
Tohoku EPCo.
Tokyo EPCo.
Chubu EPCo.
Hokuriku EPCo.
Kansai EPCo.
Chugoku EPCo.
Shikoku EPCo.
Kyushu EPCo.
J-Power
CRIEPI

MHI (Single Point Responsibility)

(EPC Turn-Key Contract)

Project is Going on Schedule. Operation Started September, 2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Design</th>
<th>Construction (36M)</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td></td>
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<tr>
<td>2009</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2010</td>
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</table>
# Current Status of 250MW IGCC Demonstration Project

## Targets & Accomplishment

<table>
<thead>
<tr>
<th></th>
<th>Target</th>
<th>First year</th>
<th>Second year</th>
<th>Third year</th>
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<tbody>
<tr>
<td>Safe and Stable Operation</td>
<td>250MW</td>
<td>250MW</td>
<td></td>
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<tr>
<td>Long Term Continuous Operation</td>
<td>&gt;2000hr</td>
<td>2039hr</td>
<td>(1568+471hr)</td>
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<tr>
<td>Net Thermal Efficiency</td>
<td>&gt;42.5%</td>
<td>42.4%</td>
<td>42.9%</td>
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<tr>
<td></td>
<td>(LHV basis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Conversion Rate</td>
<td>&gt;99.9%</td>
<td>&gt;99.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Performance</td>
<td>SOx &lt;8ppm</td>
<td>1.0ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx &lt;5ppm</td>
<td>3.4ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dust &lt;4mg/m3N</td>
<td>&lt;0.1mg/m3N</td>
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<tr>
<td>Coals</td>
<td>Bituminous</td>
<td>Chinese</td>
<td>Chinese, PRB &amp; Indonesian</td>
<td>expand coal flexibility</td>
</tr>
<tr>
<td></td>
<td>Sub-bituminous</td>
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<td></td>
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<tr>
<td>Start-up Time</td>
<td>&lt;18hr</td>
<td>20hr</td>
<td>15hr</td>
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<tr>
<td>Minimum Load</td>
<td>50%</td>
<td>50%</td>
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<tr>
<td>Load Change Rate</td>
<td>3%/min</td>
<td>1.2%/min</td>
<td>(no try)</td>
<td>3%/min*</td>
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<tr>
<td>Durability &amp; Maintainability</td>
<td>Evaluate during</td>
<td></td>
<td>(in progress)</td>
<td>5000hr evaluation</td>
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<tr>
<td></td>
<td>5000hr test</td>
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* 2.4%/min already achieved.
Current Status of Australian ZeroGen Project

Principal Specification

<table>
<thead>
<tr>
<th>Coal</th>
<th>Australian Hard Coal</th>
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<tbody>
<tr>
<td>Output</td>
<td>530 MWgross</td>
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<tr>
<td>Gasifier</td>
<td>Air Blown. Dry Feed</td>
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<tr>
<td>Gas Turbine</td>
<td>M701G2 GT (1 on 1)</td>
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<tr>
<td>Carbon Capture</td>
<td>65-90%</td>
</tr>
<tr>
<td>CO2 Storage</td>
<td>2-3 Mil.ton/yr</td>
</tr>
</tbody>
</table>

Key Milestones

- 2008: Award Pre-Study
- 2009: Award FS
- 2010: Commencing FEED
- 2011: Contract EPC
- 2012: Start Commissioning
- 2013: COD
- 2014: EPC
- 2015: Comm.

Project Schedule

- Scoping Study
- Pre-Study
- FS
- Feed
- EPC
- Comm.
Scenario of MHI’s
Clean Coal Technology Innovation

1. Heightening Thermal Efficiency

- Ultra High temp. GT (1,700°C)
- NGCC (Natural Gas)
- IGCC
- CO2 Generation (Power Station)
- CO2 Capture
- CO2 Transportation (Pipe Line, etc)
- CO2 Storage (Ocean & Underground)

2. CO2 Capture

- MHI High efficiency Power Plant
- MHI CO2 Capture technology (Low Energy Capture)
- MHI High Pressure CO2 Compressor for CCS Plant

IGFC: Integrated Gasification Combined Cycle

Japan CCS Co., Ltd., founded in 2008 upon investment from 29 companies, including electric utility companies and oil companies.

TEPCO (Tokyo Electric Power Company) has been in charge to perform a study for CCS demonstration system at Nakoso IGCC site under the Feasibility Study.

Source: Japan CCS CO., Ltd. RITE CCS Workshop 2008
**Current Technology for High Moisture Coal Utilization**

**Dry Feed** system brings;
- High efficiency
  - Low Heat Loss due to Moisture Free
- Flexibility for variety of coal
  - No need to make slurry
  ⇒ Advantageous to high moisture coal

<table>
<thead>
<tr>
<th>Slurry Feed</th>
<th>Dry Feed</th>
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<tr>
<td><img src="Image1" alt="Slurry Feed Image" /></td>
<td><img src="Image2" alt="Dry Feed Image" /></td>
</tr>
</tbody>
</table>

**Same Pulverizer as Conventional Boiler** is used;
- Proven by much experience in variety of coal

Near-future effort being made for more highly moistened coal
Scenario of High Moisture Coal Utilization

Source: WEC Survey of Energy Resources 2008
BP Statistical Review of World Energy 2008

High Moist. Coal: 41.2 bil. ton
- Scenario of utilization -

Mine-mouth IGCC

Pre-Drying

Mine-mouth Synfuel/Chemical Production

Pre-Drying

Gasifier

Synthesis (or other Chemical) Plant

Synfuel

GTCC

Diesel Engine

NH3, etc.
“Mitsubishi’s Contribution for Energy and Environment Solutions”