Clean Coal Technology and CCS in Japan

Michiaki Harada
Japan Coal Energy Center

Contents

1. High Efficient Technology in Japan
2. CCS Projects in Japan
3. The Future of Coal
World Coal Trading (2011)

Clean Coal Technologies for Power Generation
1. High Efficient Technology in Japan

- **Pulverized Coal-Fired System (PCF)**: Efficiency upgrade by increasing steam temperature and pressure; A-USC (Advanced USC, 700℃ class) is under development

- **Integrated Coal Gasification Combined Cycle System (IGCC)**: Combined Gas turbine (GT) and steam turbine (ST) cycle; Higher thermal efficiency than PCF; Increasing the GT inlet gas temperature is necessary for efficiency upgrade

- **Integrated Coal Gasification Fuel Cell Combined Cycle System (IGFC)**: Triple combined cycle (GT+ST+FC); Higher thermal efficiency than IGCC

<table>
<thead>
<tr>
<th>① PCF</th>
<th>② IGCC (1500℃ class)</th>
<th>③ IGFC</th>
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</thead>
<tbody>
<tr>
<td>Latest PCF (USC)</td>
<td>700℃ class (A-USC)</td>
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<tr>
<td>Boiler</td>
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<td>ST</td>
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<td>Gross : 42～43% (HHV)</td>
<td>Gross : 48%</td>
<td>Gross : 51～53%</td>
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<td>Net : 41%(HHV)</td>
<td>Net : 46%</td>
<td>Net : 46~48%</td>
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<td>(Basis)</td>
<td>CO₂ reduction: approx. 11%</td>
<td>CO₂ reduction: approx. 13%</td>
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Roadmap on improving the efficiency of coal fired power plants

Source of reference: [Action Plans on Forming a Low Carbon Society] and from [Coal Earth, Energy Technology Innovation Project]

Three Purposes
- Output Upgrade
- Environmental Upgrade
- Efficiency Upgrade

Old Isogo, Startup: 1967
New Isogo No.1, Startup: 2002
New Isogo No.2, Startup: 2009

- Output
  - 530MW  (265MW × 2)
  - 1,200MW  (600MW × 2)

- SOx
  - 60 ppm
  - 20 ppm (10)

- NOx
  - 159 ppm
  - 20 ppm (13)

- Dust
  - 50 mg/m³ N
  - 10 mg/m³ N (5)

- Steam condition
  - Sub-critical
  - Ultra Super Critical (USC)

- Efficiency
  - 38% (Gross%; HHV)
  - 42~43% (Gross%; HHV)

- CO₂ Emissions
  - 100
  - 83※

※ A comparison of the CO₂ emission per gross output (kWh) with an old plant (100 basis).
New Energy Efficient Technologies
IGCC in Japan  Nakoso 250MWe

IGCC, IGFC& CCS: Osaki CoolGen Project
IGFC, the Ultimate High Efficiency Coal Fired Power Technology
Demo. Project by Osaki CoolGen Corp.

Output: 170 MW Class
Coal Feed: 1,100 t/d
Net Efficiency: Comparable to 1000 MW Class USC

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<td>+Fuel Cell = IGFC</td>
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2. CCS Projects in Japan

Carbon Capture & Storage (CCS)
Pre, Post, Oxyfuel-combustion

1. Pre-combustion

2. Post-combustion

3. Oxyfuel
Carbon Capture & Storage (CCS)

- Sequestration – Capture
- Storage
- Transport
- Injection

Trial calculation of storage stratum permeability:
- Sweep efficiency: 50%
- CO₂ dissolution rate: 47 kg/m³

<table>
<thead>
<tr>
<th>Storage capacity</th>
<th>Storage stratum thickness</th>
<th>Storage stratum diameter</th>
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<tr>
<td>10,000 t-CO₂</td>
<td>10m</td>
<td>260m</td>
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<tr>
<td>1 million t-CO₂</td>
<td>50m</td>
<td>1.2km</td>
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Microscope photo of water bearing stratum

The layer is a stratum including brine formed by porous sandrock with a high porosity.

Japan-Australia Callide-A Oxy-fuel Project outline

Demonstration of 30MWe coal fired power plant with CCS by Oxy-fuel technology

- Callide-A: 4 x 30 MWe (Use one unit)
- Evaporation: 123 t/h steam 4.1 MPa/460°C
- Operation terminated 2002
- Flue gas treatment / Fabric filter (without DeNOx / DeSOx)

Partners
- CS Energy, Xstrata, Schlumberger
- JPOWER, IHI, Mitsui & Co, JCOAL

CO₂ storage site area (app. 300 km far east from Callide-A)

Callide-A Power Plant
3. The Future of Coal
Thank you for your attention!