ECUST Coal Gasification Updates: New Projects and Operations Experience

East China University of Science and Technology (ECUST)
Gasification Technologies 2014 Conference
Oct. 29, Washington DC, USA
ECUST Focus on coal clean utilization

Raw material:
- Coal, petroleum coke (Ash, FT, Coal Slurry)

Capacity

Product

Total: 40 Projects, 127 gasifiers

Technology Solution:
- Feedstock: Slurry/Dry feed
- Gasifier: Muti-Burner/Solo-Burner
- Lining: Refractory brick/Membrane wall
- Heat recovery: Quench/Radiation boiler

ICCT (Institute of Clean Coal Technology)
- ~100 people (21 faculty members including 6 Prof., 5 Associate Prof.)
- National Energy Coal Gasification Technology Research and Development Center of China
- Key Lab of Coal Gasification and Energy Chemical Engineering of Ministry of Education (MOE).
- Co-R&D center of ECUST and SINOPEC

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OMB CWS Gasification Technology
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- **35 projects (99 gasifiers)** in China
- **The total capacity of all projects** is ~120,000 TPD
- **The capacity of single gasifier ranges from 750 to 3000 TPD**
- **15 projects (38 gasifiers)** in operation
OMB CWS Gasification Technology

In operation (15 projects, 38 gasifiers)
## Availability and Reliability (2013)

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity TPD O.P. + S.P.</th>
<th>Availability</th>
<th>Reliability</th>
<th>Total Operation Hours</th>
<th>Longest Continuous Operation Hours</th>
<th>Planned Shutdown Hours</th>
<th>Unplanned Shutdown Hours</th>
<th>Unplanned Shutdown Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiangshu Linggu</td>
<td>2000 1+1</td>
<td>97.2</td>
<td>97.2</td>
<td>8512</td>
<td>1584</td>
<td>0</td>
<td>240</td>
<td>Syngas Compressor</td>
</tr>
<tr>
<td>Jiangshu Sopo</td>
<td>1500 2+1</td>
<td>99.9</td>
<td>99.9</td>
<td>8756</td>
<td>8406</td>
<td>0</td>
<td>4</td>
<td>ASU</td>
</tr>
<tr>
<td>Wanhua Chemical</td>
<td>1200 2+1</td>
<td>92.1</td>
<td>94.6</td>
<td>8064</td>
<td>1656</td>
<td>240</td>
<td>225</td>
<td>ASU, Utilities</td>
</tr>
<tr>
<td>Yankuang Cathay Coal Chemicals</td>
<td>1150 2+1</td>
<td>91.8</td>
<td>99</td>
<td>8041</td>
<td>1875</td>
<td>792</td>
<td>33</td>
<td>Boiler, ASU</td>
</tr>
<tr>
<td>Yankuang Lunan Fertilizer Plant</td>
<td>1150 1+0</td>
<td>86.2</td>
<td>97</td>
<td>7553</td>
<td>2912</td>
<td>977</td>
<td>18</td>
<td>Downstream</td>
</tr>
<tr>
<td>Anhui Huayi Chemicals</td>
<td>1500 2+1</td>
<td>91.5</td>
<td>99.9</td>
<td>8016</td>
<td>3672</td>
<td>744</td>
<td>4.5</td>
<td>Power Grid</td>
</tr>
</tbody>
</table>
Competitive Advantage Derived From Technical Know-how

- **Jiangshu Sopo Group:**
  Continuously operating 511 days, the longest continuous operation record in the world

- **Yankuang Lunan Fertilizer Plant:**
  Totally operating 8492 hours (from 8/11/2013~8/10/2014) with one gasifier

- From the operation data, it is easy to conclude:
  - High availability
  - High reliability
  - Mature technology
Henan Xinlianxin Fertiliser Ltd. Co

- Gasifier: 1200 TPD, 2+1
- Pressure: 6.5 MPa
- Product: H2- MDI
- Startup: 11/16/2013

Yantai Wanhua Polyurethanes Ltd. Co

- Gasifier: 1500 TPD, 2+1
- Pressure: 6.5 MPa
- Product: NH3
- Startup: Sep/2014
- The 2nd project for Wanhua Chemical Group
World-Largest Gasifier Presently In Operation

Inner Mongolia Rongxin Chemicals Company

- Location: Ordos, Inner Mongolia
- Gasifier: 3000 TPD, 2+1
- Pressure: 6.5 Mpa
- Product: methanol/alkene
- Startup: 6/24/2014
OMB CWS Gasification Technology

OMB technology to be licensed for the largest coal to hydrogen project in China

Hengli Petrochemical Co., Ltd.
- Location: Dalian, Liaoning
- Gasifier: 1500 TPD, 4+2
- Capacity: ~460000 Nm³(CO+H₂)/h
- Pressure: 6.5 MPa
- Product: Hydrogen
- Startup: 2016
OMB CWS Gasification Technology

Operating Experience

**Burner**
- Preventative maintenance
- Operational maintenance
- Optimizing oxygen jet velocity

**Pump**
- Regularly maintenance of high-wear components
- Procurement of imported spare parts

**Ash water system**
- Control the ash water quality, such as pH, alkalinity, hardness
SE Dry Feed Gasification Technology
SE Dry Feed Gasification Technology

SE: Sinopec + ECUST

Target:
- Medium Capacity: 1000-2000TPD
- Extremely high AFT: >1500C

Byproduct:
- 5.5MPa steam

First Industry project:
- Sinopec Yangzi PetroChemical Co.
- Startup: Jan. 2014
SE dry feed gasification technology

Feeding and Gasification unit

Coal milling unit

Black water unit
## Timeline of SE dry feed gasification project

<table>
<thead>
<tr>
<th>Stage</th>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparation</strong></td>
<td>2013.12.25-2014.1.15</td>
<td>Ignition outside gasifier</td>
</tr>
<tr>
<td></td>
<td>2014.1.16-1.23</td>
<td>Ignition and start-up inside gasifier</td>
</tr>
<tr>
<td><strong>The first running</strong></td>
<td>2014.1.23</td>
<td>The first coal feed to gasifier</td>
</tr>
<tr>
<td></td>
<td>2014.1.28</td>
<td>Hydrogen product was qualified</td>
</tr>
<tr>
<td></td>
<td>2014.2.10</td>
<td>Pneumatic conveying using CO2 as carrier gas</td>
</tr>
<tr>
<td></td>
<td>2014.1.25-2.6</td>
<td>Continuous running for 275h.</td>
</tr>
<tr>
<td><strong>Optimization</strong></td>
<td>2014.2.14-3.18</td>
<td>Valves, nitrogen system and so on.</td>
</tr>
<tr>
<td><strong>The second running</strong></td>
<td>2014.3.19-5.11</td>
<td>Continuous running for 53 days. Planned shut-down due to the downward flow process.</td>
</tr>
<tr>
<td><strong>Waiting</strong></td>
<td>2014.5.12-9.13</td>
<td>Waiting for the ready of the downward flow process.</td>
</tr>
<tr>
<td><strong>The third running</strong></td>
<td>2014.9.14- present</td>
<td>Keep running. <strong>Acceptance test was accomplished in Oct. 16-20, 2014.</strong></td>
</tr>
</tbody>
</table>
Performance of SE dry feed gasification-Acceptance test

- Coal type: Blend coal (Anthracite 60% + Bitumite 40%).
- Ash content: 17% - 20%.
- AFT: 1260 °C - 1400 °C.

<table>
<thead>
<tr>
<th>Carrier gas</th>
<th>Pressure</th>
<th>Oxygen flowrate</th>
<th>Coal flowrate</th>
<th>CO</th>
<th>H2</th>
<th>CO2</th>
<th>N2</th>
<th>CO+H2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPa</td>
<td>kg/h</td>
<td>t/h</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>CO2</td>
<td>3.9</td>
<td>34000</td>
<td>40</td>
<td>67.49</td>
<td>22.42</td>
<td>9.82</td>
<td>0.21</td>
<td>89.87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temper. °C</th>
<th>Load %</th>
<th>Oxygen consum. Nm3/kNm3 (CO+H2)</th>
<th>Coal consum. kg/kNm3 (CO+H2)</th>
<th>CO+H2 content %</th>
<th>Fine slag/coarse slag kg/kg</th>
<th>Carbon in fine slag wt%</th>
<th>Carbon in coarse slag wt%</th>
<th>Carbon conversion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400-1550</td>
<td>100</td>
<td>~340</td>
<td>~560</td>
<td>~89</td>
<td>4: 6</td>
<td>~30</td>
<td>&lt; 3</td>
<td>&gt; 98</td>
</tr>
</tbody>
</table>
Performance of SE dry feed gasification

- Multi-functional burner start-up and operation.

- Gasifier ignition flame visible during start-up improving reliability.

- Short start-up time (40min).

- To-date, more than 100 days operation without incident.
Performance of SE dry feed gasification

- Smooth slag layer, and acceptable distribution of layer thickness.
- The outlet of slag is round and clean, no slag accumulation.
- Reasonable temperature distribution give consideration to slag addition and discharge.
Performance of SE dry feed gasification

- Qualified final production H2 within 5 days.
- CO2 recycle as carrier gas within 10 days.
- Continuous operation for 11.5 days at the first coal feed.
- Continuous operation for 53 days within 3 months from first coal start-up.

Records in gasification demonstration plants

The SE dry-fed coal gasification provides technical support for coal chemicals industry in Sinopec:

- MTO project in Zhongan Coal Chemicals Co. (7 gasifiers, 1500t/d).
- SNG project in Xinjiang Energy Chemicals Co. (14 gasifiers, 1500t/d).
- MTO project in Guizhou Energy Chemicals Co.
ECUST-ICCT is not only a gasification technology provider, but also is actively involved in developing novel technologies.

Thanks

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