Application and Experience of ECUST Coal Gasification

Zhijie Zhou, PhD.
email: zzj@ecust.edu.cn, Tel: +86 21 64252974
Institute of Clean Coal Technology, East China Univ. of Sci. & Tech.
Focus on Coal Gasification

Raw material:
- Coal/
- petroleum coke
- Ash, FT, Slurryability

Product/Scale

Technology

Solution

Feedstock:
- Slurry/Dry feed

Gasifier:
- Muti-Burner/Sin
gle-Burner

Lining:
- Refractory brick/
- Membrane wall

Heat recovery:
- Quench/ Radiation

Gasification Technology

- OMB CWS gasification technology
- OMB dry feed gasification technology
- SE gasification technology
- New heat recovery gasification technology
OMB CWS Gasification Technology
➢ 37 projects (104 gasifiers) in China

➢ The total capacity of all projects is ~130,000 TPD

➢ The capacity of single gasifier ranges from 750 to 3000 TPD

➢ 17 projects (42 gasifiers) in operation

➢ 4 new licensing projects and 14 gasifiers in 2014

➢ 2 projects and 6 gasifiers startup in 2014
OMB CWS Gasification Technology

In operating (17 projects, 42 gasifiers)
OMB CWS Gasification Technology

Equipment Performance on YCCC (1st commercial project, since 2005)

### Work duration of feed injectors

<table>
<thead>
<tr>
<th>Year</th>
<th>Longest (days)</th>
<th>Shortest (days)</th>
<th>Average (days)</th>
<th>Times of shutdown caused by injector(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>31</td>
<td>15</td>
<td>17</td>
<td>No data</td>
</tr>
<tr>
<td>2006</td>
<td>68</td>
<td>4</td>
<td>28</td>
<td>6</td>
</tr>
<tr>
<td>2007</td>
<td>72</td>
<td>13</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>2008</td>
<td>100</td>
<td>20</td>
<td>47</td>
<td>5</td>
</tr>
<tr>
<td>2009</td>
<td>104</td>
<td>97</td>
<td>65</td>
<td>1</td>
</tr>
<tr>
<td>2010</td>
<td>150</td>
<td>53</td>
<td>93</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>139</td>
<td>41</td>
<td>89</td>
<td>0</td>
</tr>
</tbody>
</table>

### Work life of refractory

- 8000~16000hrs
- 24000~26000hrs
- 12000~16000hrs
### Availability and Reliability (2012 & 2013)

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity TPD O.P. + S.P.</th>
<th>Year</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>Reason(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiangshu Linggu, 2000 1+1</td>
<td></td>
<td>2012</td>
<td>97.0</td>
<td>99.7</td>
<td>8520</td>
<td>2040</td>
<td>240</td>
<td>24</td>
<td>Power Grid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</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, 1500 2+1</td>
<td></td>
<td>2012</td>
<td>97.2</td>
<td>99.1</td>
<td>8546</td>
<td>5834</td>
<td>164</td>
<td>74</td>
<td>ASU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</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, 1200 2+1</td>
<td></td>
<td>2012</td>
<td>88.4</td>
<td>96.2</td>
<td>7764</td>
<td>2568</td>
<td>720</td>
<td>300</td>
<td>1. Power Grid, 2. ASU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</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, 1150 2+1</td>
<td></td>
<td>2012</td>
<td>94.7</td>
<td>98.2</td>
<td>8319</td>
<td>2703</td>
<td>312</td>
<td>153</td>
<td>ASU, Utilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</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, 1150 1+0</td>
<td></td>
<td>2012</td>
<td>86.1</td>
<td>99.4</td>
<td>7561</td>
<td>2120</td>
<td>1180</td>
<td>43</td>
<td>Down streams</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</td>
<td>86.2</td>
<td>97</td>
<td>7553</td>
<td>2912</td>
<td>977</td>
<td>18</td>
<td>Down streams</td>
</tr>
<tr>
<td>Anhui Huayi Chemicals, 1500 2+1</td>
<td></td>
<td>2013</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>
OMB CWS Gasification Technology

Performance on 1500TPD (Anhui Huayi as example)

- Project Owner: Anhui Huayi Coal Chemicals.
- Gasifiers: 2+1
- Pressure: 6.5MPa
- Startup: January, 2012

- Owner's comments:
  - High efficiency
  - More stable than expect
  - Robust 2 independent feeding system result in very high reliability

<table>
<thead>
<tr>
<th>Items</th>
<th>Design</th>
<th>Guaranty</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Conversion %</td>
<td>98</td>
<td>98</td>
<td>98.84</td>
</tr>
<tr>
<td>Oxygen Consumption Nm³/kNm³(CO+H₂)</td>
<td>369</td>
<td>380</td>
<td>373.4</td>
</tr>
<tr>
<td>Coal Consumption Kg/kNm³(CO+H₂)</td>
<td>596</td>
<td>615</td>
<td>572.4</td>
</tr>
<tr>
<td>CO+H₂ in dry syngas Vol%</td>
<td>81.82</td>
<td>81.0</td>
<td>81.84</td>
</tr>
</tbody>
</table>
OMB CWS Gasification Technology

Performance of 2000 TPD gasifier (Jiangsu Linggu, 6 years)

Performance test by MOST (Ministry of Science and Technology)

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Inner Mon. bituminous coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Designed</td>
</tr>
<tr>
<td>Carbon Conversion %</td>
<td></td>
</tr>
<tr>
<td>Oxygen Consumption</td>
<td></td>
</tr>
<tr>
<td>Nm³/kNm³(CO+H₂)</td>
<td></td>
</tr>
<tr>
<td>Coal Consumption</td>
<td></td>
</tr>
<tr>
<td>Kg/kNm³(CO+H₂)</td>
<td></td>
</tr>
<tr>
<td>CO+H₂ in dry syngas</td>
<td></td>
</tr>
<tr>
<td>Vol%</td>
<td></td>
</tr>
<tr>
<td>Cold Efficiency</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td></td>
</tr>
</tbody>
</table>

China Chemical Industry News: The Biggest CWS Gasifier in China Pass Performance Test
OMB CWS Gasification Technology

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

- **Yankuang Lunan Fertilizer Plant:**
  Total operating 8492 hours (from 8/11/2013~8/10/2014) with one gasifier
  - High availability
  - High reliability
  - Proven technology
OMB CWS Gasification Technology

The largest CWS gasifier start-up

Inner Mongolia Rongxin Chemicals

- Location: Ordos, Inner Mongolia
- Gasifier: 2500~3000 TPD, 2+1
- Pressure: 6.5 MPa
- Product: methanol
- Startup: 6/24/2014
OMB CWS Gasification Technology

The currently largest CWS gasifier in China
SE Dry Feed Gasification Technology

SE: Sinopec + ECUST

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

Byproduct:
- 5.5 MPa steam

First Industry project:
- Sinopec Yangzi PetroChemical Co.
- Startup: Jan. 2014
SE Dry Feed Gasification Technology

Top set up of burner: simple structure and operation, low investment.

Lined with membrane wall: suitability for high ash fusion temperature.

Double pipelines of dense-phase pneumatic conveying: stable and reliable.

Concurrent downward flow of syngas and molten slag: decrease the risk of slag block.

Water quench process: reliability, low investment and operation cost.
Demonstration of SE dry feed gasification

Feeding and Gasification unit

Coal milling unit

Black water unit
Demonstration of SE dry feed gasification

Gasifier pressure: 4.0MPa
Capacity: 1000TPD, 70000Nm³(CO+H₂)/h
Product: Hydrogen

Air → ASU → Oxygen 24000Nm³/h → Coal 1000 t/d → SE gasification → Syngas → CO Shift → Shift gas → Rectisol → Purified gas → PSA → Hydrogen 66800Nm³/h → Sulfur → Tail gas → H₂S → S recovery → H₂S → Condensate → Compressor → CO₂
Performance of SE dry feed gasification

- **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 for start-up and running.
- Visualized flame for the gasifier ignition and start-up, more reliability.
- Short start-up time span (40min).
- Until now, more than 100 days accumulated running for the burner without any reparation.
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.
Future Projects

- 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.
- ……
Conclusions

- ECUST is experienced both in R&D and Industrial application in Entrained-Flow coal gasification.
- OMB CWS gasification is proven to be a high efficient and low cost gasification process.
- SE dry coal gasification is developed successfully based on ECUST’s R&D background and SINOPEC’s engineering experience.
- ......
Thanks