US Experience in Coal Waste Utilization

By

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Issues with Washery Waste Use

- Waste energy conversion system design needs skilled effort
  - Low heating value and varying quality.
  - Low quantity waste production.
  - Most washery units near environmentally sensitive areas.
  - Possible captive power plants.
  - Unsatisfactory experience with bubbling bed combustors.
Coal Wastes and PC boilers

- Coal wastes are extremely difficult to burn in PC/AFBC* boilers
  - Low grade coal needs longer residence time in the furnace and better gas-solid interaction to insure complete combustion.
  - Energy required for grinding per unit heating value of the fuel increases with ash content.
  - Significant variations in fuel quality make the combustion optimization difficult.

* Poor availability reported
Comparison of U.S. and Indian Coal Wastes

- Fuels similar to Indian coal wastes are burned in the U.S. CFB units

<table>
<thead>
<tr>
<th>Ultimate Analysis, % by wt</th>
<th>Mt Carmel Fuel (anthracite culm)</th>
<th>Typical Indian Coal Washery Rejects+other fuel blends</th>
<th>Indian Coal (Typ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Raw Coal</td>
<td>Sinks</td>
</tr>
<tr>
<td>Carbon</td>
<td>24.3</td>
<td>31.6</td>
<td>50.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15.50</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.33</td>
<td>0.4</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.26</td>
</tr>
<tr>
<td>Ash</td>
<td>65.38</td>
<td>44</td>
<td>40.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>71.00</td>
</tr>
<tr>
<td>Moisture</td>
<td>4.71</td>
<td>16.01</td>
<td>3.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.84</td>
</tr>
<tr>
<td>Higher Heating Value, MJ/kg/ (kcal/kg)</td>
<td>8.3 (1973)</td>
<td>12.56 (3000)</td>
<td>19.82(4735)</td>
</tr>
</tbody>
</table>

Ref: Cotton et al 20000
Comparison of PC-CFB Combustion Processes

- CFB process offers better suitability for coal waste combustion

**CFB Benefits**

- No Flame-out Risk
- Solids Inventory Stabilizes Fuel Combustion
- Boiler Can Be Restarted Without Support Fuel
- Insensitive to Sudden Changes in Fuel Quality
- Low furnace temp... Low NOx, Low SO2

**Comparison of PC-CFB Combustion Processes**

- Fuel at 900°C enters the CFB, where it is mixed with sorbent.
- The mixture is heated to 1200°C, where combustion occurs.
- Additional fuel is added at 1600°C to maintain combustion.
- The PC process involves direct combustion at 1200°C, with no sorbent addition.

**Diagram**

- CFB: Combines fuel and sorbent at 900°C, burns at 1600°C.
- PC: Direct combustion at 1200°C.
Experience With High Ash Fuels

Boiler design know-how for very high ash fuels has been established in the U.S.

<table>
<thead>
<tr>
<th>PROJECT*</th>
<th>FUEL ANALYSES (%)</th>
<th>START-UP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ash</td>
<td>Sulfur</td>
</tr>
<tr>
<td>Gilberton¹</td>
<td>45</td>
<td>0.8</td>
</tr>
<tr>
<td>Mt. Carmel¹</td>
<td>70</td>
<td>0.4</td>
</tr>
<tr>
<td>Ebensburg²</td>
<td>45</td>
<td>NA</td>
</tr>
<tr>
<td>Scrubgrass³</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>Seward⁴</td>
<td>Coal waste</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Units supplied by Foster Wheeler¹, Babcock&Wilcox², Kvaerner³, and Alstom⁴
Many units have demonstrated >95% availability.
Conclusions and Suggested Pathway

- CFB technology can be successfully applied to Indian coal wastes and U.S. experience can play a vital role.

- CFB technology is highly suitable to get the best energy conversion from coal wastes.

- Many coal waste-fired U.S. boiler units, based on CFB technology, have shown excellent availability.

- The boiler efficiency and emissions while burning waste fuel can be as good as the boiler burning high quality fuel.

- CFB offers high turndown and minimal use of premium fuels for start-up and low load operation.
Thank You