Combustibility analysis of high-carbon ash from entrained flow gasifiers

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1. Background and motivation.

Distribution of coal chemical industrial projects in China (2019)

Oil
Gas
Olefin
Ethylene glycol
......

300-360 million t. coal/year
How many high-carbon ash from gasifiers? & how to use it?

Coal: 300-360 million t. coal/year
Dry ash: 64-77 million t. dry-ash/year
Wet ash: 183-220 million t. wet-ash/year
Shaanxi Yanchang Coal Yulin Energy and Chemical Co., Ltd.

Wet ash: 1 million t. wet-ash/year;
4 pulverized-coal (PC) furnaces.
New circulating fluidized bed (CFB) furnace (300,000,000 RMB) ??
Combustibility analysis of high-carbon (HC) ash from entrained flow gasifiers

- Basic fuel characteristics
- Thermos gravimetric analyzer (TGA)
- Drop tube furnace (DTF)
- Bubbling fluidized (BCB)
2. Methods

- Drop tube furnace (DTF)
- Fluidized bed furnace (FBF)
Drop tube furnace (DTF)

Fluidized bed furnace (FBF)
3. Results and discussion.

Morphology

**Raw coal**

**HC-ash**
## Mineral compositions

<table>
<thead>
<tr>
<th>sample</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>S</th>
<th>K</th>
<th>Ca</th>
<th>Ti</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>coal</td>
<td>1.19</td>
<td>1.51</td>
<td>13.92</td>
<td>21.9</td>
<td>8.45</td>
<td>1.41</td>
<td>28.2</td>
<td>2.46</td>
<td>20.91</td>
</tr>
<tr>
<td>HC-ash</td>
<td>2.24</td>
<td>0.79</td>
<td>16.33</td>
<td>35.5</td>
<td>5.08</td>
<td>3.56</td>
<td>13.92</td>
<td>2.67</td>
<td>19.91</td>
</tr>
</tbody>
</table>

▲ — Fe$_2$O$_3$

▼ — SiO$_2$

● — CaO

◆ — Al$_2$O$_3$

★ — CaSO$_4$

△ — CaAl$_2$Si$_2$O$_8$

■ — MgFe$_2$O$_4$
Particle size distribution

![Graph showing particle size distribution](image)

- **Left Panel**: Cumulative distribution of particle diameters.
  - The x-axis represents particle diameter in micrometers (µm), ranging from 10 to 1000 µm.
  - The curves indicate different particle size distributions, with each curve representing a different set of data.

- **Right Panel**: Differential distribution of particle diameters.
  - The x-axis represents particle diameter ranges: 50~125, 125~160, 160~200, >200 µm.
  - The y-axis represents the differential distribution, with bars indicating the frequency or concentration of particles in each size range.

The graph provides a visual representation of how particles are distributed in terms of size, which is crucial for understanding various processes such as filtration, sedimentation, and material science applications.
TGA analysis
Combustibility analysis of HC ash in PC furnaces
Combustibility analysis of HC ash in PC furnaces
Combustibility analysis of HC ash in CFB furnaces
Proposed drying-burning process (flue gas + steam)
4. Summary

1. Basic fuel properties of high-carbon (HC) ash from gasifiers are studied.
2. The ignition and burnout temperatures of HC-ash are 601.6°C and 680.8°C, slightly worse than those of anthracite and raw coal. When HC-ash is mixed with raw coal, the combustion characteristics become worse with the increase of the proportion of HC-ash.
3. In PC, when the burning temperature is high than 900oC, the unburned carbon content of HC-ash is very low. It suggests that HC-ash could be combusted in a pulverized boiler very well.
4. In CFB, the unburned carbon content in a BFB is usually higher than 22% at 850oC. It is not a good idea to combust HC-ash in a BFB or CFB.
5. A feasible scheme for dring-combustion of HC-ash was proposed.