Biomass Characterisation and Densification for Evaluating Suitability of Non-conventional Biomass Sources for Power Generation

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- Biomass power generation is an important part of the current renewable energy mix

- Wood is still the main fuel currently

- Alternative fuels in the form of agriculture and industrial residues could be more attractive than wood
- Materials: white wood (eucalyptus), rice husks, bagasse trash and cardboard

- Bagasse trash: dry season and wet season

- Cardboard: Unprinted cardboard (UCB), printed cardboard (PCB), printed paperboard (PPB)

- 7 samples in total
Experiments:

- Drying tests
- Milling and sieving
- Elemental analysis
- Calorific value
- Thermogravimetric analysis (TGA)
- X-ray diffraction (XRD)
Experiment Results
Calorific value measured using a bomb calorimeter:

<table>
<thead>
<tr>
<th>Samples</th>
<th>Eucalyptus</th>
<th>Bagasse trash DS</th>
<th>Bagasse trash WS</th>
<th>Rice husks</th>
<th>UCB</th>
<th>PCB</th>
<th>PPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHV (J/g)</td>
<td>19224</td>
<td>15495</td>
<td>16005</td>
<td>14546</td>
<td>15050</td>
<td>14790</td>
<td>15274</td>
</tr>
</tbody>
</table>
Eucalyptus XRD

Counts vs. 2Theta (Coupled TwoTheta/Theta) WL=1.54060
Cardboard Analysis
Types of cardboard
- Sieving of milled cardboard was impossible using a traditional sieve shaker

- A vibratory sieve shaker was used instead
- Fillers are used in cardboard manufacturing
- Common fillers: calcium carbonate (CaCO_3), kaolin (Al_2Si_2O_5(OH)_4), talc (Mg_3Si_4O_10(OH)_2) and titanium oxide (TiO_2)
- Fillers can have major impact on slagging potential
- CaCO_3 can be identified in the XRD graphs of all 3 types of cardboard
- Kaolinite was identifiable in printed paperboard but not the other cardboard samples
- The 3 cardboard samples were ashed and analysed by XRD to see if the presence of other fillers could be established

- CaO is found, confirming the presence of CaCO$_3$ in the original samples

- Other Al and Si-containing compounds are also found
- TGA graphs of the cardboard samples were used to estimate the CaCO$_3$ content

<table>
<thead>
<tr>
<th>Sample</th>
<th>Unprinted cardboard</th>
<th>Printed cardboard</th>
<th>Printed paperboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO$_3$ content (%)</td>
<td>3.69</td>
<td>7.11</td>
<td>8.27</td>
</tr>
</tbody>
</table>
Sample: Printed cardboard

TGA File: C:\FERIA 2020\TGA\Printed cardboard.001

Weight (%) vs. Temperature (°C)

Deriv. Weight Change (%/min)

Universal V4.5A
Sample: Printed paperboard

Temperature (°C) vs. Weight (%)

-0.01208%/°C

533.26°C 25.81%
664.39°C 19.26%

Deriv. Weight (%/min)

TGA File: C:\FERIA 2020\TGA\Printed paperboard.001

Universal V4.5A
Future work on Cardboard

- Ash fusion oven for evaluating slagging potential – the chemical composition in the different cardboard samples should produce different AFT temperatures

- Drop tube furnace for evaluating burnout and char morphology – the morphology of the pyrolyzed chars will be used to predict combustion rates and overall combustion efficiency. Refire data from the DTF will be used to validate these predictions.
Thank you for listening

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