**Evaluation of an Industrial Scale Biomass Gasifier**

**Introduction**

There are many ways to generate electricity from biomass. Among these are the steam-fired or conventional steam approach, pyrolytic co-firing biomass gasification, and fluidized bed gasification, each with different applications and technologies.

**Biomass Gasification**

**Oxidation reactions:**
- **Exothermic reactions:**
  - C (fuel) + O₂ → CO₂ + heat
  - C (fuel) + 2H₂ → CH₄ + heat
  - C (fuel) + H₂O → CO + H₂ (Water gas shift reaction)

**Reduction reactions:**
- CO + H₂O → CO₂ + H₂
- CO + 3H₂ → CH₄ + H₂O

**Objective**

Evaluate the performance of gasification of agronomic waste on an industrial scale gasifier (VIDIR BEST).

**Methods**

1. **Proximate and Ultimate analysis**
   - The "proximate" analysis gives moisture content, volatile content (oven dried to 105°C), and fixed carbon (oven dried to 105°C). The "ultimate" analysis gives the composition of the biomass in terms of carbon, hydrogen, and oxygen (the major components) as well as sulfur and nitrogen (Table 2).

2. **Particulate Matter Emission Testing**
   - The measurement was undertaken using PORTABLE FLUE GAS ANALYZER manufactured by Nova Analytical Systems Inc. in accordance with the acceptable Canadian Standard Method EPA Method 3, B, C, and D.

3. **Gas Composition in Exhaust Stack**
   - The measurement was undertaken using PORTABLE FLUE GAS ANALYZER manufactured by Nova Analytical Systems Inc. in accordance with the acceptable Canadian Standard Method EPA Method 3, B, C, and D.

**Results**

**Updraft or Counter current gasifier**

The updraft type of gasifier is the fixed bed counter current gasifier. The biomass is fed at the top of the reactor and removed immediately at the bottom of the reactor. The air is blown into the bottom and the gas is drawn off at the top. The biomass moves in the reactor converting the gas and waste through the drying zone, the oxidation zone, the combustion zone, the reduction zone, and the exothermic zone.

**Work in progress**

- Development of a 3-D novel model of VIDIR BEST gasifier using Pease 1.02.
- Investigation on effect of fuel composition and moisture content on gasifier performance.

**Preliminary Results**

**Table 1: Proximate Analysis**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Basis</th>
<th>N</th>
<th>S</th>
<th>Ash</th>
<th>Volatile Matter</th>
<th>Fixed Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>11.4%</td>
<td>1.1%</td>
<td>0.1%</td>
<td>21.5%</td>
<td>68.5%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Straw</td>
<td>11.8%</td>
<td>0.6%</td>
<td>0.2%</td>
<td>23.6%</td>
<td>61.0%</td>
<td>15.2%</td>
</tr>
<tr>
<td>Sodder</td>
<td>11.85%</td>
<td>0.3%</td>
<td>0.1%</td>
<td>21.7%</td>
<td>67.8%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Hay</td>
<td>11.5%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>21.6%</td>
<td>68.6%</td>
<td>10.4%</td>
</tr>
<tr>
<td>Wood</td>
<td>11.5%</td>
<td>0.3%</td>
<td>0.1%</td>
<td>21.7%</td>
<td>67.8%</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

**Table 2: Ultimate Analysis**

<table>
<thead>
<tr>
<th>Sample</th>
<th>C</th>
<th>H</th>
<th>N</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.1</td>
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<tr>
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<td>72.6</td>
<td>5.4</td>
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<td>0.1</td>
</tr>
<tr>
<td>Sodder</td>
<td>72.4</td>
<td>5.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hay</td>
<td>72.4</td>
<td>5.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Wood</td>
<td>72.4</td>
<td>5.4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Future Work**

- Validation of models using data obtained from the analysis.
- Make available model for development of an automatic control system for the gasifier.

**References**