High Value Utilization of Biomass Gasification Coupled Coal-Fired Unit Power Generation Technology

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President of DEBO/Senior Engineer
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1. Background
Background

Lack of High Value Utilization of Biomass Energy Resources in China.

Average utilization hours of coal power in China

In 2016, Coal power Output in China

< 4100 hrs

Lack of High Value Utilization of Biomass Energy Resources in China.
The technology of coupling Biomass gasification with Large Coal-Fired Power Station is provided by us.
Advantages

- Power Generation Efficiency 35-40%
- Easy to be measured
- High value of biochar
- Less ash into Boiler
- Clean power generation can be achieved.
- The power industry has been incorporated in the carbon emission reduction trading market in China.
2. R & D Basis
Biomass Database

Melon seeds

NutShell

Wood Chips

Wheat bran

Palm kernel shell

Garbage
Biomass Database

Rice Husk
Bamboo bits
Pellet
Briquette
Cotton Straw
Rice Straw

( More than 100 pcs)
Comparision Biomass with Coal and Oil (Mineral Fuel)

- Contain C, H, O
- Low Heat Value
- Higher Volatile
- CO₂ Zero Pollution
### Characteristic of Biomass Ash

**Analysis of Biomass Ash**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Bituminous Coal</th>
<th>Salix Mongolica</th>
<th>Rice Husk</th>
<th>Corn</th>
<th>Wheat</th>
<th>Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>%</td>
<td>47.04</td>
<td>14.96</td>
<td>80.17</td>
<td>56.68</td>
<td>52.87</td>
<td>15.76</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>%</td>
<td>17.93</td>
<td>6.75</td>
<td>3.25</td>
<td>7.4</td>
<td>3.53</td>
<td>4</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>%</td>
<td>15.08</td>
<td>2.75</td>
<td>1.39</td>
<td>2.65</td>
<td>1.41</td>
<td>1.57</td>
</tr>
<tr>
<td>CaO</td>
<td>%</td>
<td>6.05</td>
<td>53.04</td>
<td>4.92</td>
<td>8.1</td>
<td>6.55</td>
<td>18.92</td>
</tr>
<tr>
<td>MgO</td>
<td>%</td>
<td>0.71</td>
<td>8.27</td>
<td>1.53</td>
<td>5.41</td>
<td>3.61</td>
<td>8</td>
</tr>
<tr>
<td>Na₂O</td>
<td>%</td>
<td>0.14</td>
<td>0.57</td>
<td>0.58</td>
<td>2.27</td>
<td>2.44</td>
<td>5.82</td>
</tr>
<tr>
<td>K₂O</td>
<td>%</td>
<td>0.88</td>
<td>5.9</td>
<td>5.02</td>
<td>14.84</td>
<td>26.05</td>
<td>31.76</td>
</tr>
<tr>
<td>TiO₂</td>
<td>%</td>
<td>1.49</td>
<td>0.2</td>
<td>0.62</td>
<td>0.44</td>
<td>0.22</td>
<td>0.18</td>
</tr>
<tr>
<td>SO₃</td>
<td>%</td>
<td>6</td>
<td>0.66</td>
<td>0.85</td>
<td>2.74</td>
<td>5.06</td>
<td>5.46</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>%</td>
<td>0.19</td>
<td>5.35</td>
<td>2.34</td>
<td>1.3</td>
<td>1.3</td>
<td>2.76</td>
</tr>
</tbody>
</table>

**Biomass ash melting temperature**

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>Bituminous Coal</th>
<th>Salix Mongolica</th>
<th>Rice Husk</th>
<th>Corn</th>
<th>Wheat</th>
<th>Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash melting</td>
<td>DT</td>
<td>°C</td>
<td>1220</td>
<td>1430</td>
<td>1120</td>
<td>1080</td>
<td>760</td>
<td>660</td>
</tr>
<tr>
<td>point</td>
<td>ST</td>
<td>°C</td>
<td>1280</td>
<td>1440</td>
<td>1160</td>
<td>1130</td>
<td>780</td>
<td>820</td>
</tr>
<tr>
<td></td>
<td>FT</td>
<td>°C</td>
<td>1345</td>
<td>1460</td>
<td>1210</td>
<td>1160</td>
<td>790</td>
<td>830</td>
</tr>
</tbody>
</table>
By reducing the excess air coefficient $\alpha$, biogas and more products can be gotten through gasification and pyrolysis.
High Value Utilization of Biomass Gasification Technology

Under the high temperature anaerobic or anoxic conditions, Biomass can be converted into High-Quality Biochar and Syngas.
## Feature of Biogas

**Low Heat Value, High Vapour, Contain Dust/Tar**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Unit</th>
<th>Biomass</th>
<th>Rice Husk</th>
<th>Wheat Straw</th>
<th>Rice straw</th>
<th>Rice Husk50%+Wheat Straw 50%</th>
<th>Rice Husk50%+Rice straw 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas component (volume share)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>N₂</td>
<td>%</td>
<td>43.18</td>
<td>41.35</td>
<td>41.66</td>
<td>41.25</td>
<td>41.45</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>CO₂</td>
<td>%</td>
<td>20.26</td>
<td>17.58</td>
<td>17.47</td>
<td>19.45</td>
<td>19.51</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>CO</td>
<td>%</td>
<td>8.75</td>
<td>9.14</td>
<td>9.50</td>
<td>8.62</td>
<td>8.72</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>H₂</td>
<td>%</td>
<td>12.94</td>
<td>12.71</td>
<td>13.31</td>
<td>13.18</td>
<td>13.43</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>CH₄</td>
<td>%</td>
<td>1.87</td>
<td>1.83</td>
<td>1.91</td>
<td>1.91</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>C₂H₄</td>
<td>%</td>
<td>0.75</td>
<td>0.73</td>
<td>0.76</td>
<td>0.76</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>H₂O</td>
<td>%</td>
<td>11.98</td>
<td>16.29</td>
<td>15.05</td>
<td>14.48</td>
<td>13.83</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>H₂S</td>
<td>%</td>
<td>0.02</td>
<td>0.04</td>
<td>0.03</td>
<td>0.03</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>O₂</td>
<td>%</td>
<td>0.25</td>
<td>0.32</td>
<td>0.31</td>
<td>0.32</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Outlet Gas Ash content</td>
<td>g/Nm³</td>
<td>12.4</td>
<td>13.4</td>
<td>12.4</td>
<td>13.8</td>
<td>13.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tar content</td>
<td>g/Nm³</td>
<td>1.4</td>
<td>3.2</td>
<td>2.9</td>
<td>2.7</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Low calorific value of gas</td>
<td>kJ/Nm³</td>
<td>5078</td>
<td>4698</td>
<td>4790</td>
<td>5029</td>
<td>5080</td>
<td></td>
</tr>
</tbody>
</table>
Clean combustion of biogas

1. Stage combustion

2. NO$_x \leq$150mg/Nm$^3$
## Application of Biochar

Biochar can be divided into charcoal, rice husk charcoal, straw charcoal, etc.

<table>
<thead>
<tr>
<th>Material</th>
<th>Calorific Value /kJ/kg</th>
<th>Ash /%</th>
<th>Volatile /%</th>
<th>Fixed Carbon /%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochar (Bamboo/Wood)</td>
<td>30188 (7222kcal/kg)</td>
<td>8.44</td>
<td>9.76</td>
<td>81.80</td>
</tr>
<tr>
<td>Biochar (Rice Husk)</td>
<td>18497 (4425kcal/kg)</td>
<td>45.35</td>
<td>5.21</td>
<td>49.44</td>
</tr>
</tbody>
</table>

Straw carbon Physical & chemical properties:

- potassium per kilogram of potassium 53g, nitrogen 4.3g, phosphorus 2.6g, magnesium 3.52g, trace elements copper 0.015g, iron 0.58g, zinc 0.11g,
- specific surface area 171m² / g
Application of Biochar

Preparation of combustible charcoal

Acticarbon
Industrial carbon (Insulation)
Application of Biochar

Straw charcoal can be made into carbon-based compound fertilizer, Repair degraded soil.

Rice husk/Bean Straw charcoal
Corn /Cotton Straw charcoal
Biomass Gasification Coupled Coal Fired Power Generation
R&D Process

Capacity: 15kg/h

Capacity: 100kg/h

Capacity: 200kg/h
R&D Process

From 2003 to 2010, our company spent 7 years in developing various capacity 15 to 3000kg/h.
Since Dec. 2012, the various capacity of 12-35t/h Biomass gasifier (15~40MWe) were developed.
The Biomass Gasification Coupled Power Generation Technology is Awarded Second Prize of Hubei Jinmen Science & Technology progress
4、 Biomass Gasification Multi-Production
The main principle: volatile is converted into biogas, fixed carbon is converted into high-quality biochar.
## Benefits Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Biomass</th>
<th>Calorific Value</th>
<th>Biomass Cost</th>
<th>Biochar Cost</th>
<th>Biochar Output Rate</th>
<th>Electricity Price</th>
<th>Electricity Output Rate</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Kcal/kg</td>
<td>RMB/t</td>
<td>RMB/t</td>
<td></td>
<td>RMB/KW·h</td>
<td>KW·h/kg</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Straw</td>
<td>3200</td>
<td>350</td>
<td>1500</td>
<td>20%</td>
<td>-</td>
<td>0.75</td>
<td>715</td>
</tr>
<tr>
<td>2</td>
<td>NutShell</td>
<td>3800</td>
<td>800</td>
<td>3500</td>
<td>28%</td>
<td>-</td>
<td>0.75</td>
<td>1355</td>
</tr>
<tr>
<td>3</td>
<td>Sawdust</td>
<td>3600</td>
<td>400</td>
<td>2500</td>
<td>18%</td>
<td>-</td>
<td>0.75</td>
<td>825</td>
</tr>
<tr>
<td>4</td>
<td>Bamboo chips</td>
<td>3500</td>
<td>400</td>
<td>2500</td>
<td>18%</td>
<td>-</td>
<td>0.75</td>
<td>825</td>
</tr>
<tr>
<td></td>
<td>Sawdust</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rice Husk</td>
<td>3400</td>
<td>350</td>
<td>1300</td>
<td>30%</td>
<td>-</td>
<td>0.75</td>
<td>765</td>
</tr>
</tbody>
</table>
The Biomass Gasification Multi-Production Technology is Awarded second prize of Anhui Hefei Science & Technology Progress
5. Biomass Gasification
   Synthesis Natural Gas
Gasification principle

To achieve high efficiency heat transfer of the furnace to the gasifier at the same time, to avoid the flue gas on the pyrolysis gas blending.
The parameters of double fluidized bed gas

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>20t/h</th>
<th>2x20t/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net gas output</td>
<td>Nm³/h</td>
<td>18696</td>
<td>37392</td>
</tr>
<tr>
<td>Annual gas yield</td>
<td>10⁴Nm³/a</td>
<td>14021.88</td>
<td>28043.76</td>
</tr>
<tr>
<td>Net gas volume composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂</td>
<td>%</td>
<td>39.1</td>
<td>39.1</td>
</tr>
<tr>
<td>CO</td>
<td>%</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>CO₂</td>
<td>%</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>CH₄</td>
<td>%</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>O₂</td>
<td>%</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>C₂H₄</td>
<td>%</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>C₂H₆</td>
<td>%</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>C₃H₆</td>
<td>%</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>C₃H₈</td>
<td>%</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>N₂</td>
<td>%</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>NH₃</td>
<td>%</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>H₂S</td>
<td>%</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Coarse clean gas Low calorific value</td>
<td>KJ/Nm³</td>
<td>13196</td>
<td>13196</td>
</tr>
<tr>
<td>Coarse clean gas High calorific value</td>
<td>KJ/Nm³</td>
<td>14497</td>
<td>14497</td>
</tr>
<tr>
<td>Bio-oil production</td>
<td>t/h</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Bio - oil production</td>
<td>10⁴t/a</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>Waste heat recovery steam production</td>
<td>t/h</td>
<td>19.25</td>
<td>38.50</td>
</tr>
</tbody>
</table>
Features of Biomass Double Fluidized Bed Gasification Synthesis Natural Gas Technology

1. Don't need Pure Oxygen as gasification agent

2. Biomass syngas contains High CH$_4$
6、About DEBO
About Debo

Employee: ~200
R&D Employee: ~50
Academician: 2
Professor: 3
Doctor: 5,
Master: 12

“Anhui Biomass Gasification Academician Work Station”

Research Team

Experts

合肥德博生物能源科技有限公司
Hefei Debo Bioenergy Science & Technology Co., Ltd.
Company Honors

More than 80 technical patents

CE Certification
Hefei Debo Bioenergy Science & Technology has become a new high-tech enterprise, which specialize in researching, manufacturing green energy products and selling them.
Typical Project Cases

- 10MWe Coupled Power Generation in Hubei
- 3MWe Power Generation in Hunan
- 12MWe Coupled Power Generation in Hubei
- 120m$^3$/h Power Generation in Shanghai
- 300KWe Power Generation in Congo.
- 400KWe Power Generation in Greece
- 600 KWe Power Generation in Czech
- 1MWe Power Generation in Myanmar.
- 1000t/a PMMA pyrolysis oil in Bangladesh.
- 3MWt Boiler in Jiangsu.
- 1000t/a syngas in Jiangsu
- 1000t/a Sludge Gasification in Changzhou
- 500 KWe Power Generation in Anhui
- 5 MWe Power Generation in HuNan.
- 3MWe Power Generation in Hebei.
- 350 KWt Drying Oven in Henan
- 6t/h Steam Boiler in Jilin.
- 500KWe Power Generation in Heilongjiang
- 4t/h Steam Boiler in Jiangsu
- 2MWe Power Generation in Jiangxi.
- 1000t/a biomass pyrolysis oil in Jiangsu
- 8t/h Steam Boiler in Zhejiang

More than 100 projects
Project Cases

• 10.8MWe Biomass Gasification Coupled Power Generation in Jingmen.
Project Cases

• 12MWe Biomass Gasification Coupled Power Generation in Xiangyang.
Project Cases

400KWe Gasification in Greek.
Project Cases

400KWe Wood chip Gasification Output Biochar in Slovenia
Project Cases

Wood Chips Gasification for 6T/h Boiler in Hangzhou
Project Cases

10 MW\text{th} Rice Husk Gasification for Heating supply in Jiangxi
Project Cases

2.5MWe Rice Husk Gasification Output Biochar in Hunan
Project Cases

2MWe Gasification Output Biochar in Jiangxi.
Project Cases

3MWe Almond Husk Gasification Output Biochar in Hebei
Project Cases

2MWe Rice Husk Gasification Output Biochar in Yichun
Project Cases

1MWe Wood Chips Gasification Out put Biochar in Yunnan
Project Cases

Rice Husk Gasification for 6t/h boiler Output Biochar in Jilin
Project Cases

Rice Husk Gasification for 4t/h boiler Output Biochar in Jiangsu
Thank you! for your attention

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