Pilot Scale Demonstration of the Syngas Chemical Looping Gasification Process
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INTRODUCTION

OXYGEN CARRIER SELECTION

Desired Properties
- Good oxygen carrying capacity
- Good gas economics in both the reduction and oxidation reactors
- High rate of reaction
- Suitable long term recyclability and durability
- Good mechanical strength

Comparison of the Key Properties of Different Metal Oxide Candidates

<table>
<thead>
<tr>
<th>Metal Oxide</th>
<th>Cost</th>
<th>Oxygen Capacity (mEq)</th>
<th>Thermochemistry</th>
<th>Kinetics Reactivity</th>
<th>Melting Point</th>
<th>Strength</th>
<th>Environmental and Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeOx</td>
<td>0</td>
<td>20</td>
<td>100</td>
<td>+</td>
<td>200</td>
<td>+</td>
<td>Positive, Negative, Neutral</td>
</tr>
<tr>
<td>NiO</td>
<td>1</td>
<td>10</td>
<td>200</td>
<td>+</td>
<td>1000</td>
<td>+</td>
<td>Positive, Negative, Neutral</td>
</tr>
<tr>
<td>CuO</td>
<td>2</td>
<td>50</td>
<td>100</td>
<td>+</td>
<td>1000</td>
<td>+</td>
<td>Positive, Negative, Neutral</td>
</tr>
</tbody>
</table>

OXYGEN CARRIER PERFORMANCE

FeOx – The Selected Oxygen Carrier

REACTOR TYPE SELECTION

Fluidized Bed vs. Moving Bed

<table>
<thead>
<tr>
<th>Reactor Type</th>
<th>11.1% Maximum Solid Conversion</th>
<th>50.8% Gas Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluidized Bed</td>
<td>&gt; Vmax</td>
<td>&gt; Vmax</td>
</tr>
<tr>
<td>Moving Bed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fe3O4 CO2/H2O Moving Bed

PILOT SCALE SCL PROJECT

Full Size Cold Model
- Construction and shake down completed
- Finished two tests successfully

Hot Unit P&ID

Current Status
- B&W selected as the A&E firm;
- Preliminary P&ID completed;
- Preliminary design specification documents completed;
- Internal HAZOP completed;
- Cost estimate based on preliminary P&ID completed;
- Updated budget and schedule being prepared for DOE review.

CURRENT STATUS AND FUTURE WORK

- Sub-Pilot Test and Process Analyses
  - Five Test Campaigns
  - 50+ hours of continuous operations
  - >90% syngas conversion and >99% He purity were achieved
  - Non-mechanical valves tested successfully
  - Flexible for H2, electricity, and liquid fuel productions
  - 10% more efficient than conventional processes with 100% CO2 capture

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