Particle Characterisation in Chemical Looping Combustion

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Main Objectives
- To investigate and characterise the morphological and compositional changes in particles such as metal oxide particles after multiple reduction-reoxidation cycles

Chemical Looping Concept
Fuel Reduction:
\[ \text{Fe}_2\text{O}_3 + \text{H}_2 \rightarrow \text{Fe} + \text{H}_2\text{O} \]
Air Oxidation:
\[ \text{Fe} + \frac{1}{2}\text{O}_2 \rightarrow \text{Fe}_2\text{O}_3 \]
Overall:
\[ \text{Fe}_2\text{O}_3 + \text{H}_2 \rightarrow \text{Fe} + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \]

Experimental Program
Concept can be replaced for the production of H2 by introducing steam into the air oxidizer

Operating Conditions
- Pressure: 1 bar
- Temperature: 800°C
- Volatilisation Temperature: 910°C
- Oxidation and Reduction Temperatures: 800°C
- Inlet Air Flow Rate: 1000 L/min
- Inlet Gas Flow Rate: 25 L/min

Fuel Analysis
<table>
<thead>
<tr>
<th>Sample</th>
<th>Cu</th>
<th>Ni</th>
<th>Al</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reacted</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Surface Area & Pore Size
Fresh Iron Oxide
- Rapid decrease in BET surface area after 10 cycles (Internal Pore Sintering)

Scanning Electron Microscope
- Fresh Iron Oxide
- Reacted Iron Oxide (50 Cycles)
- Presence of cracks in the reacted iron oxide particles (attrition)
- Agglomerates on the surface of reacted particles larger than those in fresh particles (Sintering)

Conclusions
- Unsupported iron oxide in stable up to 50 cycles with a working lifetime of about 7.3 hours
- Absence of support causes the iron oxide particles to undergo greater rates of sintering and ash deposition blocking active sites of the particles
- Supported copper oxide remains stable with a working lifetime of about 100 cycles (25 hours)
- Alumina support allows the particles to be robust and able to withstand sintering and blockage of active sites due to ash deposition

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