Benefits of oxygen enrichment in a biomass fired stoker boiler

Air Products had the opportunity to perform oxygen enrichment testing on an 80,000 lbs/hr mass spread stoker boiler. The boiler tested was firing a combination of municipal solid waste (MSW) and cotton stalks (CS). In this process, MSW was a revenue-generating fuel while cotton stalks were mixed as a supplemental fuel to enhance overall combustion efficiency and boiler stability. Cotton stalks were purchased specifically for this use and created an additional cost to the process. Through the use of oxygen enrichment, the process was optimized to increase the profitability of this one boiler by approximately $650,000 per year (all costs, including oxygen, were taken into account).

Objectives:

- Maximize revenue through increasing MSW utilization while minimizing cotton stalk consumption.
- Enhance boiler stability, as maximizing MSW increases variability in fuel properties.
- Maximize steam generation from the boiler.

Trial Tests:

- Phase 1: Determine optimal oxygen enrichment level without changing fuel ratio.
- Phase 2: Gradually reduce cotton stalk consumption while increasing MSW consumption at the optimal oxygen enrichment level of 1.5% (i.e., composite oxidizer having approx. 22.5 vol% O₂).

Results:

<table>
<thead>
<tr>
<th>Test</th>
<th>MSW (Tons/day)</th>
<th>CS (Tons/day)</th>
<th>Oxygen Enrichment</th>
<th>Steam (Tons/day)</th>
<th>Increased Profit (£/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>333</td>
<td>55</td>
<td>None</td>
<td>840</td>
<td>–</td>
</tr>
<tr>
<td>Phase 1</td>
<td>+7%</td>
<td>+4%</td>
<td>1.50%</td>
<td>+19%</td>
<td>$326,906</td>
</tr>
<tr>
<td>Phase 2</td>
<td>+20%</td>
<td>−10%</td>
<td>1.50%</td>
<td>+14%</td>
<td>$648,275</td>
</tr>
</tbody>
</table>

Revenue calculations based upon: MSW = $25.60/ton; steam = $45/ton; steam = $10.50/ton.
Observations:

- In phase 1, oxygen enrichment alone increased MSW usage, steam, and total revenue without optimizing the fuel ratio. Profitability increased by roughly $326,000 per year.
- In phase 2, MSW total usage was increased by 20% when fuel ratio was optimized.
- In phase 2, cotton stalk usage was reduced by 10% when the fuel ratio was optimized.
- Total steam production was increased by 16% on average.
- Increased profit: The optimized system through the use of oxygen allowed for approximately $650,000 per year increase in profitability based upon processing more MSW, decreasing the use of cotton stalks, and increasing steam production.
- For this unit, increasing steam generation was not as profitable as maximizing the ratio of MSW to cotton stalks. Results are, however, case-specific.
- The use of oxygen also increased the stability of the boiler, allowing for more uniform performance, even with the variability that MSW can cause.

Next steps:

- Develop boiler control strategy with oxygen.
- Continue to refine the process by fine-tuning the oxygen enrichment level and fuel ratio until peak performance is obtained.

For more information, please contact us at:

**North America**
**Corporate Headquarters**
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195-1501
T 800-654-4567 or
T 610-706-4730
F 800-272-4449
gigmrktg@airproducts.com

**Asia**
Air Products Asia, Inc.
Suite 6505-7, Central Plaza
18 Harbour Road
Wanchai
Hong Kong
T +852-2527-1922
F +852-2527-1827

**Europe**
Air Products PLC
Hersham Place Technology Park
Molesey Road
Walton-on-Thames
Surrey KT12 4RZ
UK
T +44-0-1270-614314
apbulkuk@airproducts.com