The Feasibility of Solar Thermal Process Heat for the Sugarcane Industry in South Africa

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Overview

• Overview of the S.A. Sugar Industry
• Raw Sugar Production
• Drivers of Innovation
• SPH Technology & Low Hanging Fruit
• Potential of SPH Integration
• Expected Results
The S.A. Sugar Industry

Location
The S.A. Sugar Industry
The S.A. Sugar Industry

Overview

Location: KZN & Mpumalanga
Production: > 2m tons/a (20m tons cane)
Season: March - December
Contribution: R12b per year
Employment: 79 000 | 12 750
Sugar Milling: 14 Raw Sugar Factories
Market: Highly Regulated Prices
SMRI: Profitability, Efficiency & Innovation
Drivers of Innovation

Economic Pressure: Low Prices, Rising Input & Operational Costs

→ Reduce Operational Costs
  - Reduce Coal Consumption

→ Explore Alternative Income Streams
  - Bagasse By-Products
  - Bio-Ethanol
  - Electricity Cogeneration
Solar Process Heat Integration

Technology Characteristics

Temperatures: 25 - 450 °C
Pressure: Up to 40 bar
Integration: Supply Level / Process Level
Power and gain: 700 W_p/m^2 peak power
Potential Gain: Up to 1 MWh/m^2 per annum
System size: No technical limit (Area, Capital)
Solar Process Heat Integration

Potential for the Sugar Industry

Objective: Identify & Assess Suitable SPH Integration Points

Methodology:
1. Develop a flow diagram of a generic sugar mill
2. Analyse the energy consumption
3. Identify potential SPH integration points
4. Assess & rank the integration points
5. Develop concept designs
6. Estimate the potential solar gains
7. Assess the techno-economic feasibility
Solar Process Heat Integration

Low Hanging Fruits

• Low Process (Return) Temperature
• High Temperature Lift
• High & Constant Heat Demand
• Demand Concurs with High Irradiance
Solar Process Heat Integration

- **Boiler**
  - Make-Up Water
  - Live Steam 360 °C 28.6 bar
  - Cane
- **Turbo-Alternators**
  - Let-Down Valve
  - Exhaust Steam 130 °C 2.6 bar
- **Prime Movers**
- **Diffuser**
- **Clarification**
- **Evaporator 1**
- **Evaporator 2**
- **Evaporator 3**
- **Evaporator 4**
- **Boiling House**
- **Drying**
  - Raw Sugar
  - Condensate

- **Vapour 1**: 120 °C 2 bar
- **Vapour 2**: 110 °C 1.4 bar
- **Vapour 3**: 95 °C 0.8 bar
Solar Process Heat Integration

Entry Barriers

- Low Cost of Energy: Bagasse
- Heat Distribution: Exhaust, Vapour
- Seasonality: March – December
- Relatively Low Irradiation: 2000 kWh/m²
- Area Requirements: Limited Area
# Solar Process Heat Integration

## Potential Integration Points

<table>
<thead>
<tr>
<th>Heat Sink</th>
<th>Fuel / Heat Source</th>
<th>Process Temperature</th>
<th>Temperature Lift</th>
<th>Mean Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Steam Injection</td>
<td>Bagasse &amp; Coal</td>
<td>360 °C</td>
<td>N/A</td>
<td>90 MW</td>
</tr>
<tr>
<td>Feed Water Pre-Heating</td>
<td>Bagasse &amp; Coal</td>
<td>129 °C</td>
<td>230 °C</td>
<td>75 MW</td>
</tr>
<tr>
<td>Make-Up Water Pre-Heating</td>
<td>Bagasse &amp; Coal</td>
<td>25 °C</td>
<td>335 °C</td>
<td>N/A</td>
</tr>
<tr>
<td>Evaporation</td>
<td>Exhaust Steam</td>
<td>114 °C</td>
<td>7 °C</td>
<td>58 MW</td>
</tr>
<tr>
<td>Clear Juice HEX</td>
<td>Exhaust Steam</td>
<td>100 °C</td>
<td>14 °C</td>
<td>4 MW</td>
</tr>
<tr>
<td>Sugar Drying</td>
<td>Exhaust Steam</td>
<td>25 °C</td>
<td>55 °C</td>
<td>0.6 MW</td>
</tr>
<tr>
<td>Bagasse Drying</td>
<td>Bagasse &amp; Coal</td>
<td>72 °C</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Thank You

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