Sasol-Lurgi Fixed Bed Dry Bottom Gasification for Fuels and Chemicals

Sasol-Lurgi Technology Company (Pty) Ltd

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By: O. Turna, Lurgi AG on behalf of Sasol–Lurgi Technology Company
Email: osman.turna@lurgi.com
Licensing was not considered as part of the original statutes of formation.

A joint venture between

**Sasol Technology (Pty) Ltd** &

**Lurgi South Africa (Pty) Ltd** (subsidiary of **Lurgi AG**)

- **Intent of the strategic venture**
  - Combine engineering and operational expertise
  - Development of Gasification & Down Stream Technologies
  - Support to existing operations to improve profitability

- **Sole licensor of Sasol-Lurgi Fixed Bed Dry Bottom Gasification (FBDB) Technology**
SLTC = Sasol – Lurgi Technology Company (Pty.) Ltd.

**Sasol** an international Oil & Gas Company located in South Africa with a significantly growing global market for chemicals worldwide.

**Lurgi** a leading Engineering Company with proprietary technology and a worldwide network.

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**Fixed Bed Gasification Technology Life cycle**
Commercial Applications of S-L FBDB Gasification

Gasification is unique – “…creates a primary energy carrier…”
Sasol-Lurgi Fixed Bed Dry Bottom Gasification Process

- **Drying**
- **Devolatilisation**
- **Gasification**
- **Combustion**

[Diagram showing coal entering the gasifier, steam, oxygen, or air being added, and gas exiting. The temperature graph shows a phase of drying, devolatilisation, gasification, and combustion.]
The Sasol - Lurgi FBDB Gasifier
(FBDB = Fixed Bed Dry Bottom = dry ash removal)

Typical FBDB Gas Composition

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>H₂</td>
<td>38%</td>
</tr>
<tr>
<td>CO</td>
<td>22%</td>
</tr>
<tr>
<td>CO₂</td>
<td>28%</td>
</tr>
<tr>
<td>CH₄</td>
<td>12%</td>
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</tbody>
</table>

Licensor Sasol Lurgi Technology Company
Johannesburg, South Africa
Characteristics of S-L FBDB Gasification Technology

- Developed by Lurgi in the 1930’s
- High cold gas efficiency due to low gas offtake and ash temperatures
- Low specific oxygen consumption due to counter current gasification and dry ash removal
- Optimum operation for lignite and reactive fuels / coals, high thermal efficiency
- Unique for low rank coals with high ash & moisture
- Gasifiers built for 20 to 100 bar gasification pressure
- Typical crude gas production proven at 30 bar: up to 65 000 Nm3/h Mk IV, 100 000 Nm3/h Mk V (based on known coal)
- > 75 % of all worldwide gasified coal is still converted to gas by the Sasol -Lurgi process principle
- Unmatched plant availability & mechanical reliability
- Stable gasifier performance & robust operation by using simple control systems
Direct use of coarse coal by screening & crushing or washing, no drying & milling required

Fine coal used for steam raising

Surplus of fine coal can be agglomerated and fed to the FBDB gasifiers

Co-products add considerable value to the plant economics

The Sasol CtL plant improves its profit by selling S-L FBDB co-products like NH₃, phenols, char for electrodes, higher hydrocarbons, etc.

The H₂:CO ratio 1,7 – 2,0 of the FBDB derived gas is a very good match for the Fischer-Tropsch Synthesis, no CO-Shift required at Sasol

Fuel additives being produced from tar and oil fractions

High methane yield which is an advantage for SNG production

Methane in the gas requires reforming to CO and H₂ for Methanol- & Ammonia synthesis
Current worldwide operation of 101 Sasol-Lurgi FBDB Gasifiers

Successful Deployment and Operation of well over 101 Sasol-Lurgi FBDB Gasifiers in the last 50 years, >20 million gasifier operating hours and well over 1 billion tonnes coal consumption at Sasol alone.
Sasol Coal to Synfuels Plant

80 x FBDB Units, 28 years in Operation: 1979 – 2007
Coal: Low Rank, Sub-Bituminous
Products: Syngas to Fischer Tropsch Fuels, Ammonia, Phenols, Anode Coke, Sulphur

Sasol Synfuels, Secunda, South Africa
SNG from Lignite - DGC Gasification Plant

14 x FBDB Units, 22 years in Operation: 1985 – 2007
Coal: Low Rank, Lignite
Products: Substitute Natural Gas (SNG), Ammonium Sulphate, Phenols, CO₂ for Oil Exploration

Dakota Gasification Company – Beulah, North Dakota USA
Shanxi Coal to Ammonia Plant

5 x FBDB Units, 20 years in Operation: 1987 – 2007
Coal: Anthracite
Products: Ammonia

Shanxi – Tianji Coal Chemical Company, Shanxi Province, PRC
Yima Coal to Methanol Plant

2 x FBDB Units, 7 years in Operation: 2000 – 2007
Coal: Low Rank, Sub-Bituminous
Products: Methanol

Yima Coal Gasification, Henan Province, PRC
## S-L FBDB Major Reference Plants

<table>
<thead>
<tr>
<th>Units</th>
<th>Plant</th>
<th>Location</th>
<th>Start Up</th>
<th>Plant Capacity</th>
</tr>
</thead>
</table>
| 17    | Sasol Chemical Industries (decommissioned now) | Sasolburg, South-Africa        | 1955     | 13 MK III FBDB Gasifiers  
3 MK IV FBDB Gasifiers  
1 MK V FBDB Gasifiers  
11 x 10⁶ nm³/day syngas for liquid fuels and chemicals |
| 80    | Sasol Synfuels                        | Secunda, South Africa           | 1979     | 80 MK IV FBDB Gasifiers  
80 x 10⁶ nm³/day syngas for liquid fuels and chemicals |
| 14    | Dakota Gasification Company           | North Dakota, USA               | 1985     | 14 MK IV FBDB Gasifiers  
1 450 x 10⁶ nm³/ annum SNG (Substitute Natural Gas) |
| 5     | Shanxi-Tianji Coal Chemical Company   | People’s Republic of China  
Lucheng – Shanxi Province        | 1987     | 5 MK IV FBDB Gasifiers  
Ammonia: 300 ktpa (kilo tonnen per annum)  
HNO₃: 540 ktpa  
Nitro Phosphate: 900 ktpa  
Ammonium Nitrate (explosive grade): 200 ktpa |
| 2     | Yima                                 | People’s Republic of China  
Yima City – Henan Province       | 2000     | 2 MK IV FBDB Gasifiers  
80 000 ton per annum methanol |
Multi-train Operation
Sasol Synfuels, Secunda, South Africa

- 80 Mk IV gasifiers in operation - 4 sections each 20 units
- Gasifier availability ~ 93% yearly average, single gasifier > 91%
  - No spare units
  - 24 hour operation – 330 days per year
  - Cumulative time of operation well over 20 Million hours gasifying sub-bituminous coals with high ash
  - Turn down ratio 2.7
Gasifier Unit Size & SLTC Development Topics

- Continuous Feeding of Coal
- Continuous ash removal & increase of ash handling capacity
- Ongoing development of process control & algorithms
- Enhancement of Feed Stock Flexibility
- Redeployment of an advanced coal distributor-stirrer design for caking coals
- Fines Agglomeration
- Reduction of steam consumption by manipulating ash fusion properties
- Biomass co-gasification, increase of biomass proportion
- Complementary gasification of co-products in an MPG for syngas production
- Improvement on environmental aspects
- Fundamental research & plant orientated development

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<thead>
<tr>
<th>Mark II &amp; III</th>
<th>Mark IV</th>
<th>Mark V</th>
<th>Mark VI</th>
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<tbody>
<tr>
<td>ID 2.6m &amp; 3.6m</td>
<td>ID 3.9m</td>
<td>ID 4.7m</td>
<td>Quo Vadis?</td>
</tr>
<tr>
<td>34 000</td>
<td>65 000</td>
<td>100 000</td>
<td>75</td>
</tr>
<tr>
<td>Number of Units built for Sasol</td>
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Quo Vadis?
S-L FBDB Gasification Feedstock Suitability

- Ash fusion temperatures at oxidizing conditions > ~1200°C
- Σ Total Moisture + Ash ~50 % w/w
- Minimum Ash Content ~4 % w/w
- Caking behavior of coal
  - Caking propensity will be balanced by blending of coals
  - A coal distributor & stirrer will be used for caking coals
- Thermal fragmentation < ~55% (SLTC laboratory method)
- Mechanical fragmentation < ~55% (SLTC laboratory method)
- Biomass: 10% blend of biomass pellets with coal feed successfully demonstrated on commercial scale
Unique SL FBDB Market Position for High Ash Coals with High Melting Temperatures
Sasol-Lurgi Technology Company’s offer in Summary

- Ideal for countries with no oil & gas resources but low rank coals
- Securing the future because low rank coal reserves exist in abundance
- Provides a secure energy source utilizing high ash coals at mine mouth
- High melting ash is an advantage to the process
- Flexible in the variety of products
- High availability by multi unit scheme, modular concept
- Robust process and easy to operate
- Advanced proprietary design requiring low grade steel only
- Well proven large scale operation with well over 50 years record
- Many coals tested
- Will also gasify high rank coals at high cold gas efficiency
Questions?

Thank you for your attention!