Sasol-Lurgi Coal Gasification Technology and Low Rank Coal

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Joint Venture (JV) between large **Operator**, Sasol and a world-renowned **Engineering Company**, Lurgi:
- established in August 2001
- transferred all IP from Lurgi and Sasol into new JV

**Intent of strategic venture:**
- combine engineering and operational expertise
- custodianship and development of the FBDB technology
- support to existing and future operations, to improve profitability

**Sole licensor of Sasol-Lurgi, Fixed Bed Dry Bottom Gasification:**
- Future deployments

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Fixed bed Gasification Technology Life cycle
Sasol-Lurgi FBDB Gasification
106 Sasol-Lurgi Fixed Bed, Dry Bottom gasifiers in operation worldwide.
### Reference List

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Year</th>
<th>Feed Stock</th>
<th>Number of Gasifiers</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sasol Chemical Industries, Sasolburg South-Africa</td>
<td>1955</td>
<td>100% Sub Bituminous</td>
<td>17 FBDB</td>
<td>Liquid Chemicals</td>
</tr>
<tr>
<td>Swartz Pumpe, Germany</td>
<td>1977/2000</td>
<td>80% Waste / 10% Lignite / 10% Bituminous</td>
<td>5 FBDB, 1 BGL, 1 MPG</td>
<td>Power / Methanol</td>
</tr>
<tr>
<td>Sasol Synfuels, Secunda South Africa</td>
<td>1979</td>
<td>100% Sub Bituminous</td>
<td>80 FBDB</td>
<td>Liquid fuels and Chemicals</td>
</tr>
<tr>
<td>Dakota Gasification Company, Dakota, USA</td>
<td>1985</td>
<td>100% Lignite</td>
<td>14 FBDB</td>
<td>Substitute Natural Gas</td>
</tr>
<tr>
<td>Shanxi-Tianji Coal Chemical Company, People’s Republic of China</td>
<td>1987</td>
<td>Anthracite</td>
<td>5</td>
<td>Ammonia for fertilizer production</td>
</tr>
<tr>
<td>Yima, People’s Republic of China</td>
<td>2000</td>
<td>100% Sub Bituminous</td>
<td>2</td>
<td>Methanol</td>
</tr>
<tr>
<td>KFX, Gillette – Wyoming, United states of America</td>
<td>2005</td>
<td>100% Sub Bituminous</td>
<td>2</td>
<td>Coal beneficiation</td>
</tr>
</tbody>
</table>
Interest in FBDB Gasification follows a renewed interest in application of coal gasification world-wide.
Suitability of S-L FBDB to Low Rank Coals

**Moisture:**
- Can accommodate ROM feed (no external drying required)
- Internal Drying Zone before Gasification Zone

**Ash:**
- High ash (50% ROM basis) accommodated
- Dry Ash (Non-slagging) => low O2 consumption
- Ash bed contributes to agent distr. and provides support bed within GG
- Counter flow results good heat exchange => high cold gas efficiency

**Variability in Feed QA**
- Accommodate variability (PSD, ash, moisture)
- Safety and operability (excess carbon in reactor)

**Reactivity**
- Reactivity higher with low rank coals = supports operation of FBDB
- React H2O with carbon => less oxygen consumption

**Nitrogen**
- Large percentage of N2 produces NH3 => less N in product gas

**Mixed Feed**
- Biomass
- Fine Coal Pelletisation
### Suitability of S-L FBDB to Low Rank Coals (cont)

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total moisture (wt%)</td>
<td>2 – 36</td>
</tr>
<tr>
<td>Proximate analysis (air dry basis wt%)</td>
<td></td>
</tr>
<tr>
<td>- Inherent moisture</td>
<td>4 - 34</td>
</tr>
<tr>
<td>- Ash content</td>
<td>6- 33</td>
</tr>
<tr>
<td>- Volatiles</td>
<td>12 -38</td>
</tr>
<tr>
<td>- Fixed carbon</td>
<td>30 - 54</td>
</tr>
<tr>
<td>- Total sulphur</td>
<td>0.3 – 1.5</td>
</tr>
<tr>
<td>Calorific value (MJ/kg- air dry basis)</td>
<td>12 - 27</td>
</tr>
<tr>
<td>Free swelling index</td>
<td>0 – 1.5</td>
</tr>
<tr>
<td>Types of coal</td>
<td>Bituminous; Sub-bituminous Anthracite; Lignite</td>
</tr>
</tbody>
</table>

**Note:**
- Free swelling index values range from 0 to 1.5 for a specific range of bituminous and sub-bituminous coals.**
Sasol-Lurgi FBDB Gasifier Island - typical Coal-to-Liquids flow scheme

### Key Baseline Technology Selections

**Gasification:** Mark IV / V S-L FBDB Gasifiers (55 - 85 km³n/h crude gas per gasifier)

**Gas Cooling:** Double waste heat boiler (8bar steam, 4 Bar Steam) heat rec. configuration

**GL Sep:** Square modular sep. design, suff. sep capacity, sep oily / dusty GL routes, req. chemical/temp density information.

**Phenosolvan:** Std design, improved heat integration, less direct steam

**Ammonia Recovery:** CLL technology, total-stripper improved design.

**Rectisol/Sulphur Recovery:** Selective Rectisol / Oxy-Claus

**Environment:** Application of latest vent/fugitive emission control technology (e.g. vapour recovery), closed drains, tanks & pits, no tar filtration
Sasol-Lurgi FBDB Gasifier Island - configuration options for co-products

- **Option 1: Process Boiler (steam generation)**
  - Tar recycle to gasification; CTA and oil to produce steam
  - Ammonia to market; SGL to cooling water makeup
  - Total stripping of GL and HC incineration possible

- **Option 2: Multi-purpose Gasifier (MPG) (syngas generation)**
  - Tar recycle to gasification; CTA and oil to MPG for syngas production
  - Ammonia to market; SGL to cooling water makeup

- **Option 3: Depitching & Tar Distillation**
  - Oil / naphtha / DTA to hydrotreating & hydrocracking
  - Pitch to decoker or recycle to gasification
  - Ammonia to market; SGL to cooling water makeup

- **Option 4: Depitching & BTX recovery**
  - Pitch recycle to gasification
  - Naphtha / DTA hydrotreating & hydrocracking; BTX recovery
  - Ammonia to market; SGL to cooling water makeup
Lurgi Multipurpose Gasifier (MPG) for FBDB co-products conversion to syngas
In summary...

► Sasol-Lurgi Technology Company’s and its Engineering Partner, Lurgi’s vision is to:
  ► retain and develop the expertise and experience in gasification technologies
  ► continually improve the operation, maintainability and efficiency of all existing users
  ► seek to meet the synthesis gas needs of new clients and applications

► We believe the Sasol-Lurgi FBDB coal gasification process remains:
  ► strategic alternative to oil and gas.
  ► well demonstrated, low risk, proven technology on low rank coals
  ► advantage wrt low grade, high ash content coal.
  ► robust and mature technology – very high reliability and on-line availability factors. (92%, single GG)
  ► technology can be deployed for various coal based applications including the production of Town Gas; Substitute Natural Gas; Electricity, Synthesis Gas for CTL or a combination to maximize coal utilization.