Mk+ Gasification Module

Benefits for Coal to SNG Projects

Update on SNG Projects in China

Highlights on Key Innovations
- Purification of the gas liquor for ZLD solution
- Dry ash handling

Status JSPL Coal to DRI Project in India
Step 1: Starting point: Mark 4 from Jindal Steel & Power Ltd. (JSPL) Angul project
- Lessons learnt from 30 years of operation of Sasol (Secunda, RSA) and DGC (North Dakota, USA) plants
- Latest project: JSPL Angul, India, 40 barg design pressure

Step 2: Increase of the diameter
- Reason: Gain in terms of capacity
- Definition point: Lurgi Mark 5 (Sasolburg 1985 to 2004)

Step 3: Increase of the operating pressure
- Gain in capacity, efficiency, environmental footprint and methane yield
- Optimum pressure: 60 barg for Capex and scale-up risk
- Validation of the gasification process calculations with the Ruhr 100 pilot plant test results and data
The Lurgi FBDB™ Gasifier

- **LURGI FBDB™ Mark4 Gasifier**
  - Outside diameter: 4.13 m
  - Height: 12.5 m
  - Design pressure: 40 barg
  - Raw Gas Loading, dry: up to 60000 Nm³/h

- **LURGI FBDB™ Mark+™ Gasifier**
  - Outside diameter: 5.05 m
  - Height: 17.0 m
  - Design pressure: 60 barg
  - Raw Gas Loading, dry: up to 120000 Nm³/h

1950s - 2010

2011 - ...

- 2500 t/d coal feed
- 500 MWth
Benefits for Coal to SNG projects

- MK+: innovative use of referenced technology for no scale up risks

- Improved Opex and lower Capex compared to Mk4
  - Higher direct production of CH4
  - Reduced coal, O2 and HP Steam consumption
  - Higher thermal efficiency

- 10 to 15% decrease of the SNG cost versus Mk4

- Part of the SNG is produced by ETF gasification for coal fines.
  (ETF: 50% higher SNG cost)
Update on SNG projects in China

- 2 plants started-up with a total capacity of 2.7 BCMY of SNG
  - Datang Keqi phase 1
  - Qinghua Yili phase 1
- More than 20 new projects got the NDRC Lutiao in 2013
- **2 main locations for SNG projects**
  - Inner Mongolia province
  - Xinjiang province
- **Challenges**
  - Magnitude of the Capex (large projects)
  - Management of the project risks
  - Highest standards for emissions and effluents
  - Scarcity of the water
From Gas Liquor to Zero Liquid Discharge

- Full chain of purification of the water – Unique offer from Air Liquide
- Solution based on fully referenced technologies
- Recycle of the purified water as make-up to cooling water circuit

![Diagram of gas liquor purification process with labels such as Lurgi FBDB™ Gasification, CO Shift & Gas Cooling, Gas Liquor Separation, Phenosolvan® Phenols Recovery, CLL NH₃ Recovery, Waste Water Treatment, and Cooling water Make-up.]

Recycle of the water is a must for CtSNG projects (<5 t water /kNm³)
Phenosolvan / CLL / WWT: Economics

- Make-up water for the cooling water system produced by WWT
- WWT consists of advanced bio-treatment followed by high efficiency RO and evaporation / crystallization units
- Impact WWT on SNG cost: 2.5%
- Large credit coming from co-products

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<th>Spec</th>
<th>Unit</th>
<th>RMB/unit</th>
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<tr>
<td>CW</td>
<td>30°C</td>
<td>T</td>
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<tr>
<td>TW</td>
<td>45°C</td>
<td>T</td>
</tr>
<tr>
<td>Demin water</td>
<td>30°C</td>
<td>T</td>
</tr>
<tr>
<td>LP Steam</td>
<td>4.5 bar</td>
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<tr>
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<td>N2</td>
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<td>Kg</td>
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<td>Kg</td>
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<tr>
<td>CTA</td>
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<td>Ammonia</td>
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Flow 550 t/h of GL

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<td>CAPEX + OPEX</td>
<td>RMB/t</td>
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<tr>
<td>Net TCO</td>
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<td>% Total TCO</td>
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<td>% of SNG cost</td>
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<td>3.2%</td>
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<td>Ref 1.7 for 2 BCMY</td>
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Evaluation of dry ash handling for FBDB

- **Wet sluice way system**
  - Most commonly applied worldwide
  - Very reliable
  - Wet ash to be disposed off or sold
  - Loss of water with the ash
  - ~ 3€ / t of ash (handling / separation)

- **Incentives for dry ash handling**
  - No water consumption
  - No effluent water to treat
  - Lower operating costs
  - Broader opportunities to sell the ash
Optimized dry ash handling solution

Interesting competitive solution of the ash management for FBDB

- Ash disposal cost reduced by
  - by 5% (no ash sold)
  - by 11% (10% of the ash sold)

- Footprint reduced by 65%

- Referenced and proven equipment (power plants)
- Easy operation and maintenance
- Solution with high availability (> 99.5%)
The Magaldi Group, founded in 1929, is a world leader in mechanical transportation of hot and abrasive bulk materials for coal-fired power plants, cement manufacturers, steel mills, foundries, mines etc.

Magaldi develops and provides technologies for the safe and environmental friendly handling of raw materials and ash in the coal fired power plants.
The Superbelt® ensures the safest and most reliable transportation of abrasive and hot bulk material, associated with maximum life time.

The Magaldi ECOBELT® is a steel belt conveyor completely enclosed in a dust-proof steel casing, unique in its design and able to transport materials with aggressive properties, both chemical and physical, without any release to the external environment.

Hundreds of successful installations in Power Industry (hot bottom ash, mill rejects, Eco ash); Foundries (hot castings, sand, molds, scraps); Cement Industry (hot clinkers); Metallurgical plants (hot DRI, metal sinter etc.).
JSPL Coal to DRI Gasification Project

Commissioning completed
Start-up on-going

■ **Customer:** JSPL
■ **Location:** Orissa, India
■ **Key Process data:**
  ■ Sub. Coal 35% ash
  ■ 7 MK4 gasifiers
  ■ 225,000 Nm3/h DRI SG
  ■ LHV: 3,500 kcal/Nm3
  ■ H2/CO ratio: 1.7

■ **Scope for complete gas island - gasification, Rectisol, SRU**
  ■ PDP / BE / DE
  ■ Prop Equipt supply
  ■ Operators training
  ■ Start-up assistance

Photos site Jan 2014 – Courtesy JSPL
JSPL Coal to DRI Gasification Project
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