The BGL

Commercial Plants and Pilot Testing

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Introduction

• The improved “slagging” version of the existing Lurgi Gasifier was jointly developed with British Gas from 1974 onwards in Westfield/Scotland to:
  - have a reactor to produce non-leachable vitreous slag rather than dry ash
  - improve specific reactor throughput
  - increase fines content acceptable in feed
  - reduce steam consumption and consequent gas condensate production
  - recycle tars/oils to extinction
  - increase CO/H₂-yields

• Technology successfully tested with a wide range of coals and proven on commercial size gasifier units until 1991

• First commercial plant at Schwarze Pumpe, Germany, from 2000 until 2007, using broad range of feedstock including waste

• Technology jointly owned by Envirotherm GmbH and Zemag Clean Energy Technology GmbH
Lurgi and BGL Comparison

**Lurgi Dry Bottom Gasifier**
- Feed Lock
- Feed
- Steam/Oxygen
- Ash Grate (rotating)
- Ash Lock
- Wash Cooler
- Gas Offtake
- Raw Gas 600 - 800°C

Drying and Pyrolysis < 700°C
Gasification 700 - 1.100°C
Combustion 1.300 - 1.400°C

**BGL Slagging Gasifier**
- Feed Lock
- Feed
- Steam/Oxygen
- Ash Lock
- Gas Offtake
- Raw Gas 600 - 800°C

Drying and Pyrolysis < 700°C
Gasification 700 - 1.100°C
Combustion 2.000 - 2.100°C
Slag Tapping Process inside the BGL
Key Benefits of BGL

Operational

• Extensive development history (Lurgi: 75% of worldwide coal gasification experience)
• High cold gas efficiency between 82% and 93% / high specific throughput
• Low oxygen consumption (ca. 0.5-0.6 kg / kg Coal)
• Low steam consumption (ca. 0.3-0.4 kg / kg Coal)
• Lower aqueous liquor production
• Fuel flexibility (nearly all coal types and other types of fuels (e.g. waste) can be processed)
• Excellent load following capabilities
• Modularity (spare/reliability)
• Slag as by-product is non-leachable (vitrified) and can be utilized (road work)

Capital/Investment

• Simple gasifier design (no exotic materials, no sophisticated heat exchangers)
• Smaller air separation unit (ASU) due to low oxygen requirements
New Development

Stirrer

- Caking coals form large agglomerates → insufficient and uneven heat transfer, pressure drop, channelling
- Caking behaviour depending on coal type
- Typical caking range between 350 °C and 500 °C

- Design challenges
  - Internally cooled rotating equipment
  - High torque
  - High temperatures
  - Large temperature differences at stirrer surface
  - Very abrasive bed material (char)
  - Corrosion
BGL Stirrer for Caking Coals
Commercial BGL

China
## BGL in China - Hulunbeier

| **Client** | Yuntianhua United Commerce Co., Ltd. Kunming, Yunnan, PRC  
|            | Hulunbeier New Gold Chemical Co., Ltd., Hailaer, Hulunbeier, Inner Mongolia, PRC |
| **Location of facility** | Hulunbeier, Inner Mongolia, PRC |
| **Application** | Syngas for the production of 500,000 t/year Ammonia, 800,000 t/year Urea |
| **Feedstock** | Domestic dried and briquetted lignite |
| **Features** | Two (2) + one (1) BGL gasifiers (40 barg operating pressure)  
|             | Synthesis gas production 119.000 Nm³/h |
| **Status** | - Installation of entire plant completed in 2011  
|            | - Gasifiers have been operated for limited time (limited feedstock)  
|            | - Technical issues with plant units (briquetting unit and ASU)  
|            | - Commissioning of entire plant still in progress |
BGL in China - Hulunbeier
<table>
<thead>
<tr>
<th><strong>Client</strong></th>
<th>China Yituo Group Co. Ltd., Luoyang, Henan Province, PRC</th>
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</thead>
<tbody>
<tr>
<td><strong>Location of Facility</strong></td>
<td>Luoyang, Henan Province, PRC</td>
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<tr>
<td><strong>Application</strong></td>
<td>Fuel gas for industrial complex – Substitution of 18 existing fixed bed low pressure gasifiers</td>
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<td><strong>Feedstock</strong></td>
<td>Local hard coal</td>
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<td><strong>Features</strong></td>
<td>One (1) + one (1) BGL gasifiers at 30 bar</td>
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<td>Gas production 43,000 Nm³/h</td>
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<td><strong>Start-up</strong></td>
<td>2013</td>
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<tr>
<td><strong>Status</strong></td>
<td>Detailed Design finished in 2011</td>
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<td></td>
<td>Civil works in progress</td>
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</tbody>
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BGL in China - Yituo

Gasifiers to be substituted
BGL in China - Yituo

Gasifiers to be substituted
CONSTRUCTION SITE

BGL in China - Yituo

Construction site
<table>
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<th><strong>BGL in China – China National Coal</strong></th>
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| **Client** | China National Coal Development Co. Ltd, Beijing, PRC  
| | China National Coal Corp, Beijing, PRC |
| **Location of facility** | Ordos Tuke, Inner Mongolia, PRC |
| **Application** | Syngas for the production of 1,000,000 t/year Ammonia, 1,750,000 t/year Urea |
| **Feedstock** | Weakly caking bituminous coal |
| **Features** | Five (5) + two (2) BGL gasifiers (40 barg operating pressure) with stirrers  
| | Synthesis gas production 295,000 Nm³/h |
| **Start-up** | 2013 |
| **Status** | Detailed Design finished – Review May 2012 |
### BGL in USA

| Client                        | South Heart Energy Development, LLC (SHED)  
|------------------------------|---------------------------------------------
|                              | (Joint venture between Great Northern Power Development, L.P. (GNPD) and Allied Syngas Corporation (ASC)) |
| Engineer                     | Black & Veatch, Kansas City, US             |
| Location of facility         | South Heart, North Dakota, US               |
| Application                  | H₂ Production  (approx. 4.7 million Nm³/d for power production) and utilization of CO₂ (2.1 million mt/yr) for enhanced oil recovery (EOR) |
| Features                     | Two (2) + zero (0) BGL gasifiers using briquetted lignite |

### BGL in India

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<th>Client</th>
<th>Shriram EPC Ltd., Chennai, India</th>
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<td>Location of Facility</td>
<td>Dharma, Orissa, India</td>
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<tr>
<td>Application</td>
<td>Syngas for the production of synthetic ammonia</td>
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</tbody>
</table>
| Features                     | Two (2) BGL gasifiers, one relocated from Germany, second gasifier built identically to relocated one, using high ash domestic hard coal  
|                              | Raw gas production 150.000 Nm³/h |
Pilot Scale Slagging Gasifier in Freiberg

- Pilot scale gasifier to be installed at the IEC, TU Bergakademie Freiberg, next to HP-POX and STF unit
- Main Purpose:
  - Investigation of liquid slag behaviour under high pressure
  - Characterisation of slag from different ash compositions
- Additionally, the facility allows for testing of coals to demonstrate the applicability of “unknown” feedstock without interrupting the operation of a commercial plant.
- Commissioning Q1 2013
Pilot Scale Slagging Gasifier in Freiberg

- Pilot plant comprises of coal intermediate storage, feeding system, reactor, gas cooling and gas water system

- Gasifier features:
  - 0.6 m inner diameter
  - Three tuyeres (inlet nozzles for gasification agents)
  - Reactor and Quench in one vessel

- Characteristics / Consumption figures:
  - Operating pressure 40 bar
  - 1.38 t/hr subbituminous coal (Polish coal)
  - 430 Nm$^3$/hr $O_2$ consumption
  - 450 kg/hr steam consumption
  - Reactor capacity approx. 8.5 MW (LHV gas)
  - Approx. 2300 Nm$^3$/hr product gas
Summary

- Unique gasifier design offers major advantages including high fuel flexibility and low consumption of steam and oxygen
- BGL technology for all gasification routes applicable
- New development of stirrer for BGL gasification of caking coals
- Currently 14 gasifiers are installed or in construction phase
- Projects for production of fertilizers, SNG and fuel gas
- Pilot scale slagging gasifier to be built at the IEC in Freiberg, Germany
Thank you very much for your attention!

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