ENVIROTHERM

The BGL

Commercial Plants and Pilot Testing

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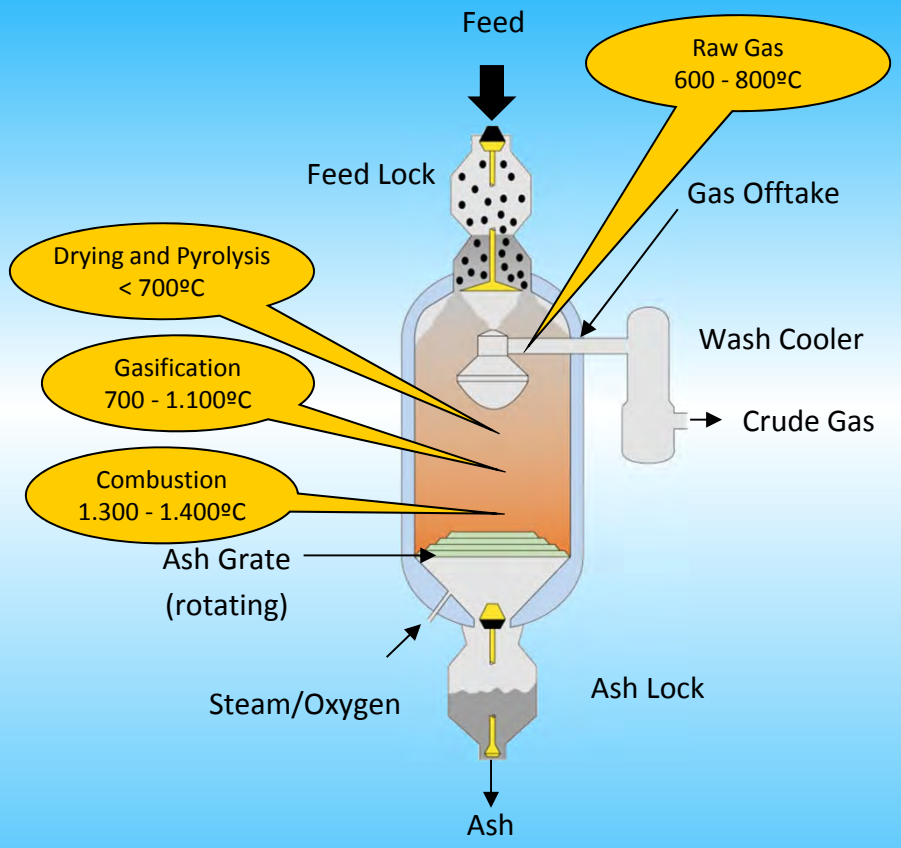
BGL Gasifier

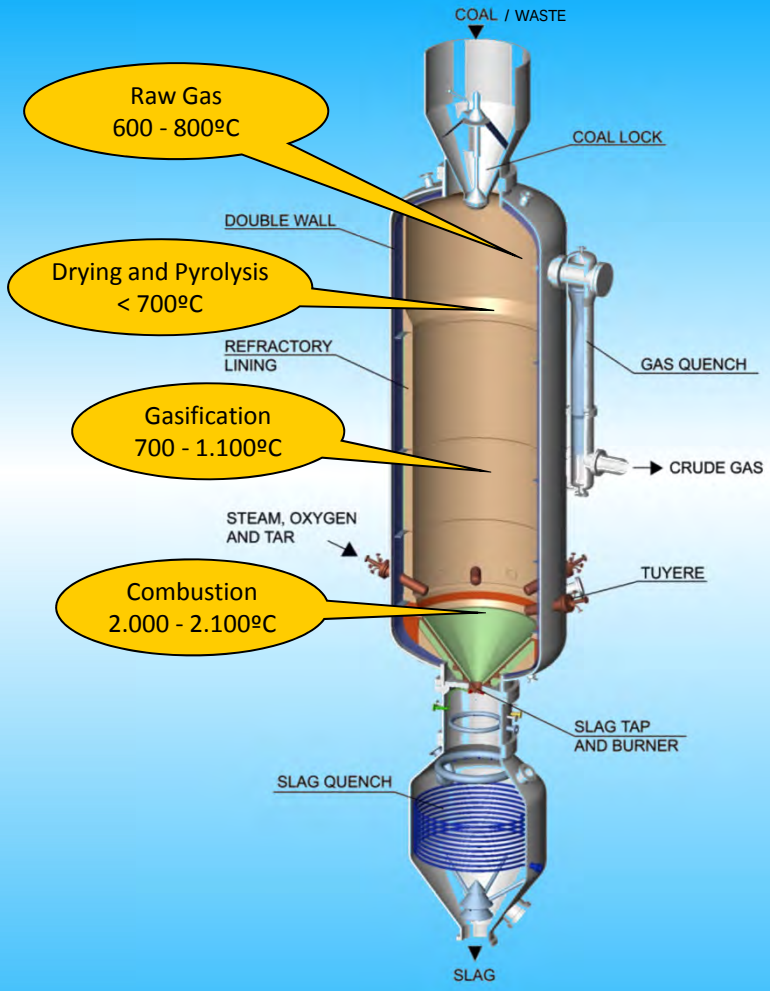
Introduction

- 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/H_2-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



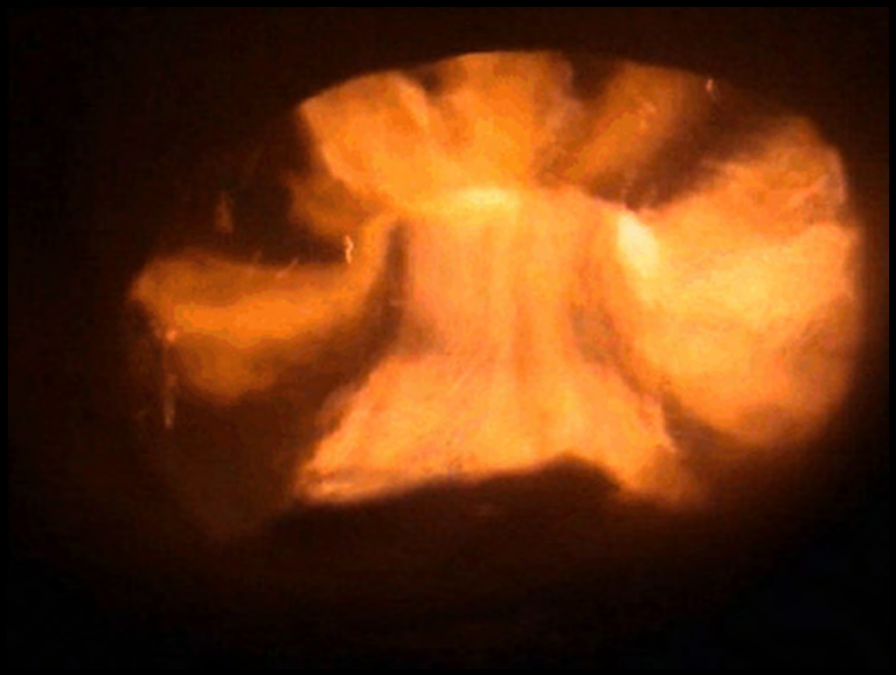
Lurgi Dry Bottom Gasifier



BGL Slagging Gasifier

Slag Tap

Slag Tapping Process inside the BGL



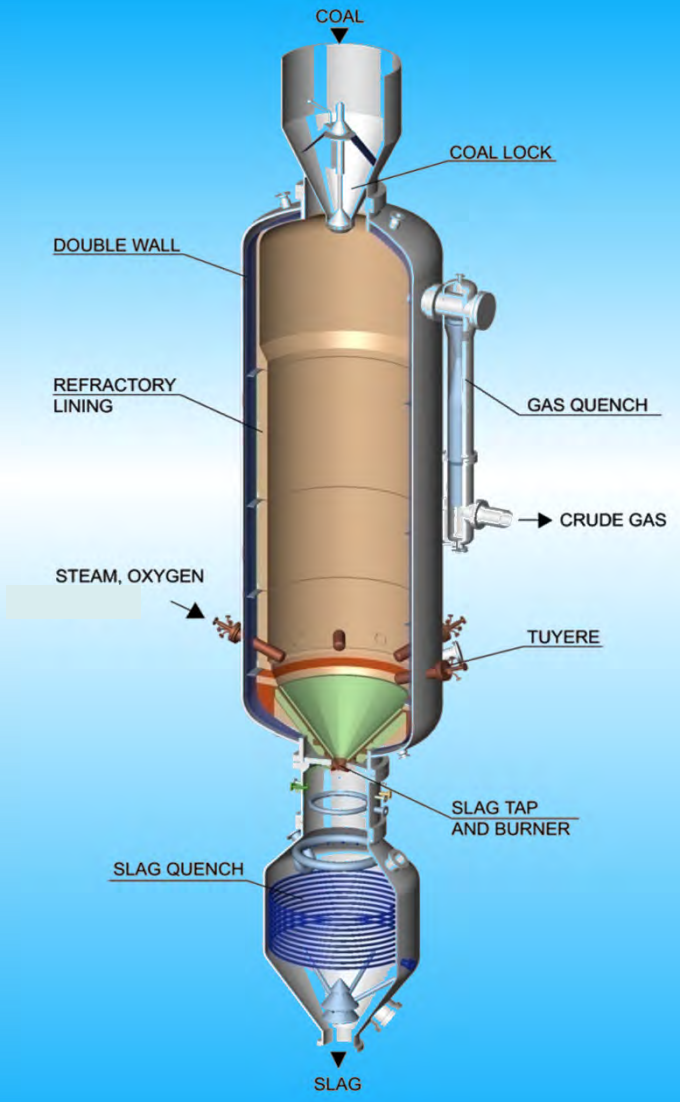
Key Benefits of BGL

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

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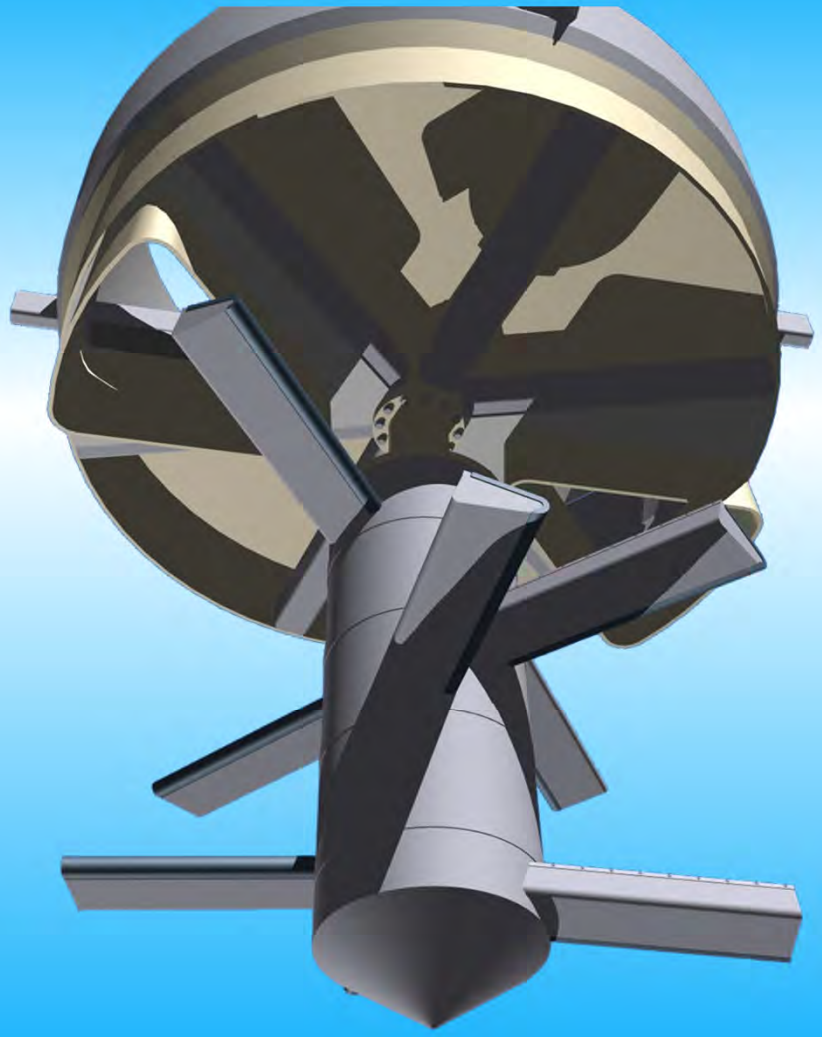
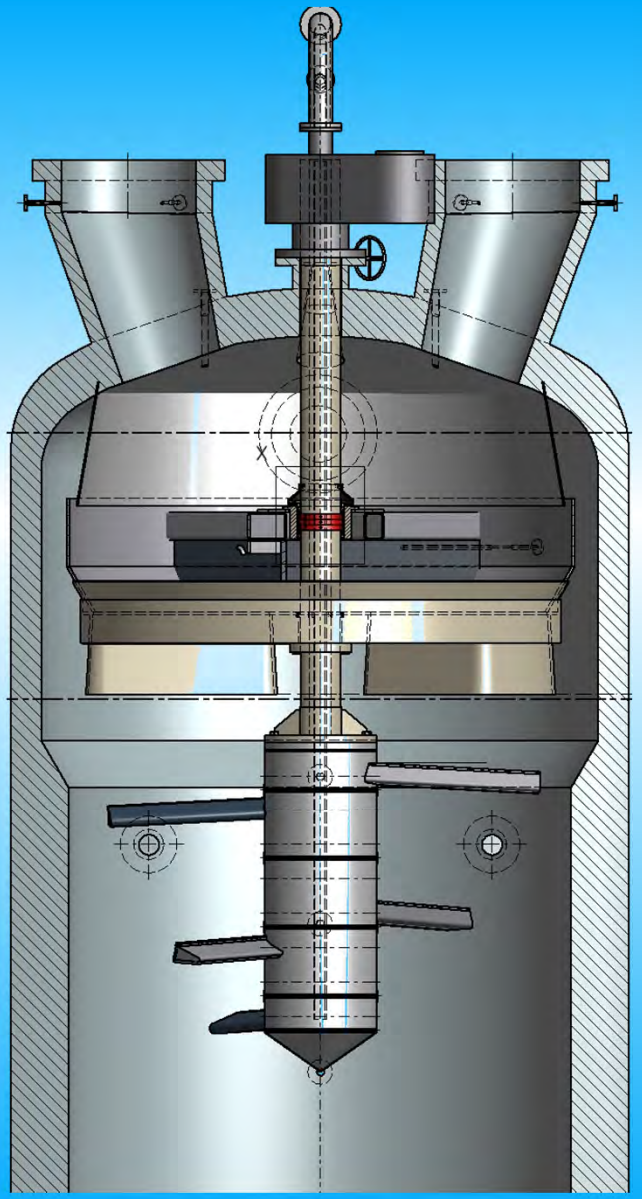
BGL Stirrer for Caking Coals





Commercial BGL

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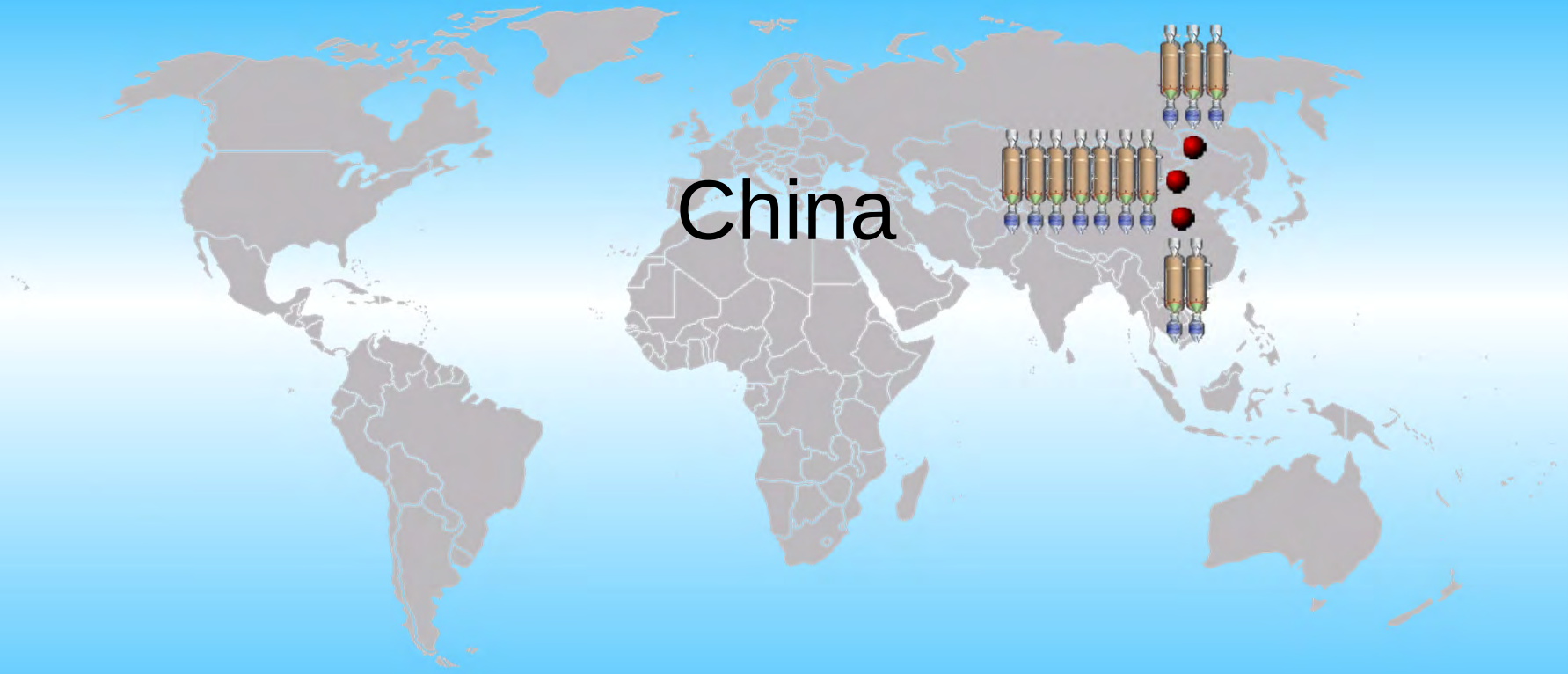

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BGL in China - Hulunbeier

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 Nm^3/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

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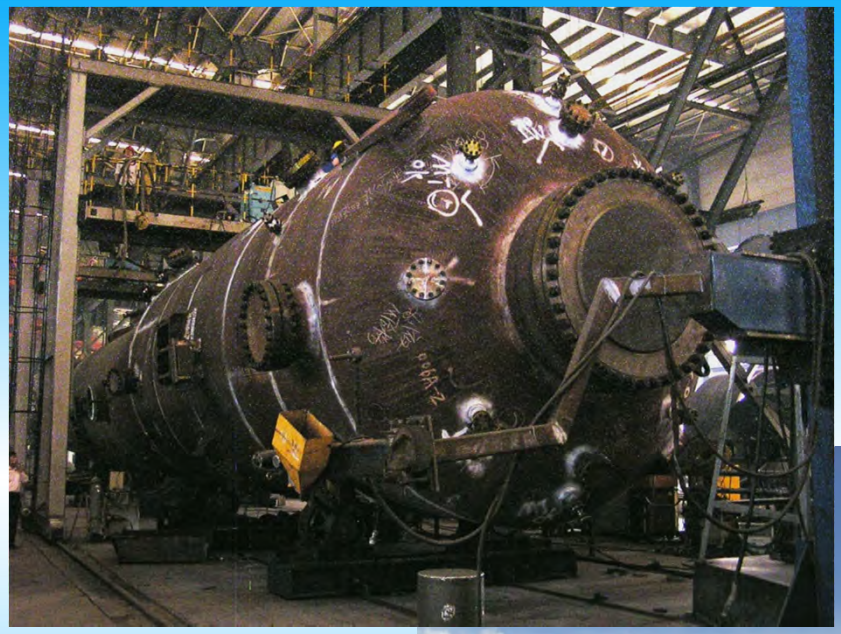
BGL in China - Hulunbeier



BGL in China - Hulunbeier

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BGL in China - Yituo

Client	China Yituo Group Co. Ltd., Luoyang, Henan Province, PRC
Location of Facility	Luoyang, Henan Province, PRC
Application	Fuel gas for industrial complex – Substitution of 18 existing fixed bed low pressure gasifiers
Feedstock	Local hard coal
Features	One (1) + one (1) BGL gasifiers at 30 bar Gas production 43.000 Nm^3/h
Start-up	2013
Status	Detailed Design finished in 2011 Civil works in progress

BGL in China - Yituo

Gasifiers to be substituted

BGL in China - Yituo

Gasifiers to be substituted

BGL in China - Yituo

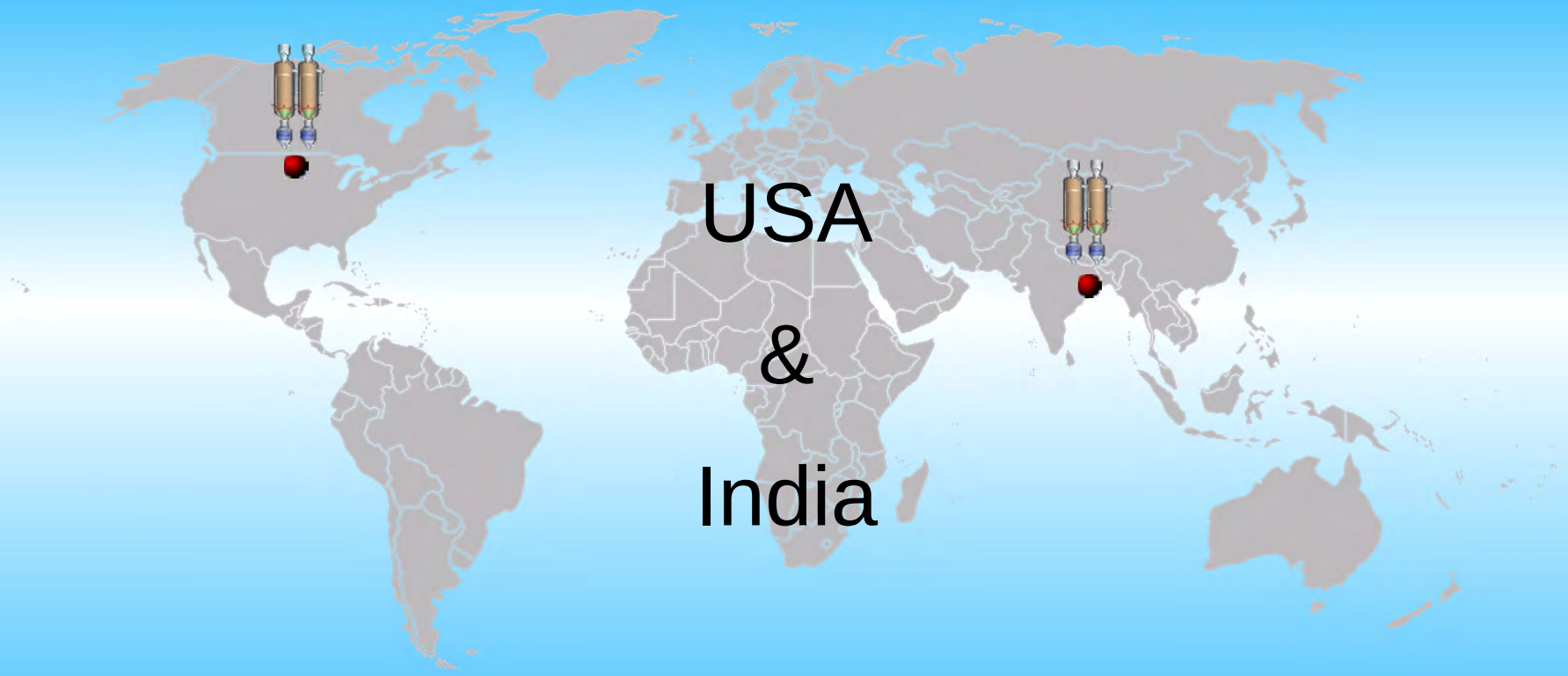
Construction site

ENVIROTHERM

BGL in China – China National Coal

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 Nm^3/h
Start-up	2013
Status	Detailed Design finished – Review May 2012

Commercial BGL



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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 Nm^3/d for power production) and utilization of CO_2 (2.1 million mt/yr) for enhanced oil recovery (EOR)
Features	Two (2) + zero (0) BGL gasifiers using briquetted lignite

BGL in India

Client	Shriram EPC Ltd., Chennai, India
Location of Facility	Dharma, Orissa, India
Application	Syngas for the production of synthetic ammonia
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 Nm^3/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

Contact

Thank you very much for your attention!

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