Uhde Biomass and Coal Gasification

Applying *Fluidized Bed* and *Entrained Flow* Gasification

*Karsten Radtke*, Uhde GmbH, Germany
Uhde: 69 years of gasification experience for coal, pet coke, biomass, oil, residues and wastes

[Basis goes back to 1909: Koppers Coal Gas Generators, a total of 536 built]

- **1941: Invention of Entrained-Flow Gasification:**
  - **Koppers-Totzek**: dry-fed, membrane wall, multiple burners design

- **1973: Development of Pressurised Fluidised Bed Gasification:**
  - **High-Temperature Winkler (HTW)**

- Uhde has put **over 100 gasifiers** into successful operation:
  - **PRENFLO** Gasification for Coal, Pet coke, Biomass
  - **HTW** Gasification for Brown Coal, Biomass, MSW
  - **Koppers-Totzek** Gasification for Coal, Oil/Residues
  - **Rummel-Otto** Gasification for Coal
  - **Saarberg-Otto** Gasification for Coal
  - **Texaco (GE) TGP** Gasification for Oil/Residues
  - **Texaco (GE) TCGP** Gasification for Coal
Different Technologies for Different Applications: Uhde’s Gasification History

**TGP**
- 1953: TGP-License
- 1959: Las Palmas, Spain
- 1960: Lisbon, Portugal
- 1971: Rhodes, Australia
- 1973: Start Development
- 1978: Demoplant Holten
- 1986: Oberhausen, D
- 1991: Oberhausen, D
- 1998: Bharuch, India
- 2000: Wesseling, D

**TCGP**

**PRENFLO**
- 1953: TGP-License
- 1959: Las Palmas, Spain
- 1960: Lisbon, Portugal
- 1971: Rhodes, Australia
- 1973: Start Development
- 1978: Demoplant Holten
- 1986: Oberhausen, D
- 1991: Oberhausen, D
- 1998: Bharuch, India
- 2000: Wesseling, D

**Koppers-Totzek**
- 1941: Koppers-Totzek
- 1941: Las Palmas, Spain
- 1959: Lisbon, Portugal
- 1974: Pressurised Entrained Flow: Start of Development
- 1980: Demoplant, Hamburg
- 1982: Essen, Germany
- 1986: Fürstenhausen
- 1997: Puertollano, Spain
- 2013: BioTfueL, France
- 2014: TransGas, USA

**HTW**
- 1926: Winkler Process
- 1973: Fluidised Bed Gasification: Start of Development
- 1978: Frechen
- 1985: Berrenrath
- 1985: Oulu, Finland
- 1988: Wesseling
- 1989: KoBra
- 1993: KoBra
- 2000: SHI, Japan
- 2002: Vresova, Cz.
- 2014: Värmlands, S
PRENFLO with Steam Generation

1200 MW\textsubscript{th}, 42 bar

**PRENFLO PSG Features**
- dry powder feeding
- 4 horizontal co-annular burners
- membrane wall
- waste heat boiler (PSG)

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World’s largest single-train IGCC: PRENFLO Gasification
Elcogas, Puertollano, Spain
Feedstock: petcoke / coal with addition of biomass

New CO₂ Capture Pilot Plant
PRENFLO with Direct Quench

1200 MW_{th}, 42 bar

PRENFLO PDQ Features

- dry powder feeding
- 4 horizontal co-annular burners
- membrane wall
- direct water quench
- operation pressure flexible to requirements (25 - 42 bar)
- raw gas temperature outlet of quench (200 - 250 °C)
- slag lock-hopper system

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TransGas Adams Fork Energy CTG Complex (18,000 bpd)

- 2 x PRENFLO PDQ Gasification to produce gasoline from coal
- Dec 2008: PDQ License Agreement signed & effective
- Feb 2010: „Permit to Construct“ achieved
- 28 Oct 2010: EPC phase initiated
MTG JAM project Shanxi, China
started-up in June 2009 as China’s first Coal to Gasoline Plant

Picture courtesy of Shanxi Jincheng Anthracite Coal Mining Group

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Market Trend: Biomass „+ X“

PSG  PDQ  HTW
Entrained-Flow  Fluidised Bed

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Why BTL?

Biofuels – Second Generation

• Biomass will play a significant role in the energy mix, irrelevant of the scenarios
• For 2020 EU demands a minimum of 10% renewables in the transportation sector

Biofuel Demand Growth

⇒ Reliable Biomass Gasification Technology is required

Source: IEA Energy Technology Perspectives 2008, 2010; BLUE Map scenario
BTL Challenges: Biomass based Feedstocks

– High **variety** of biomass, **availability varies** seasonally
– **Decentralized** production with **low energy content** (HHV: 10-15 MJ/kg)
– **Low storability**, high energy consumption for **transportation** and **grinding**
### Integrated Process Chain for the Production of Synthetic Biofuels

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**Example 1:** Entrained-Flow PRENFLO PDQ

**BXTL Project BioTfueL, France**

applying PRENFLO PDQ and Fischer-Tropsch Technologies
Overview BioTfueL Project (B-XTL process chain)

**Target:**
Development and commercialisation of integrated process chain for the production of 2nd generation biofuels via thermochemical conversion

**Project budget and timeline:**
€ 112.7 million over 7 years

**Uhde contribution**
Provider of PRENFLO PDQ gasification process as well as general know-how on CTL and engineering capabilities
Torrefaction

Process Conditions
- Temperature: 200 - 300 °C
- Residence time: 15 - 90 min
- Atmospheric pressure

Improvement of feedstock properties for
- Enhanced energy content
- Grindability with less energy
- Storage behaviour
- Fluidization behavior
- Pneumatic transportation behaviour

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Example 2: Fluidised Bed HTW

Integrated Process Chain for the Production of Bio-Methanol

Feedstock | Pretreatment | Gasification | Gas Treatment | Synthesis
---|---|---|---|---
Domestic Forest Residues | Grinding, Drying | HTW | CO-Shift | Methanol Synthesis
AGR | | | fuel grade methanol

Biomass to Methanol, VärmlandsMetanol, Sweden applying HTW Fluidised Bed Gasification
VärmlandsMetanol, Sweden
HTW Biomass to Methanol Project

- Uhde selected as technology supplier and EPC contractor

- **Plant Capacity:**
  100,000 t/a of fuel grade methanol + district-heating 15 MW\textsubscript{th}

- **Feedstock:**
  Domestic forest residue, ~25 t/h

- **Process:**
  Fluidized bed gasification (HTW)
  (eq. 111 MW\textsubscript{th})
**HTW Gasification**

- Pressurised, fluidised bed
- Temperature: 800 - 1000 °C
- Pressure: 10 - 30 bar
- Operates below ash melting point (ideal for coals with high ash melting point, biomass, lignite, waste)

**Requirements for VärmlandsMetanol Project**

- Feedstock: Domestic forest residue
- Grain size: < 4mm for biomass

**HTW**

Refactory Lined Gasification Chamber
Cyclone
Recycle Line
stationary Fluidized Bed

HTW Gasifier

Uhde
Commercial-Scale HTW Coal to Methanol Plant
Berrenrath, Germany

Operating results

Capacity: 140 MW<sub>th</sub>; 10 bar
- smooth, reliable gasifier operation
- successful component test program (CTP) for IGCC application
- 67,000 h of operation
- methanol production 800,000 t
- average plant availability over 10 years: ~ 85 %
- best year: > 91 % (>8,000 h)
Feeds operated in HTW Fluidized Bed Gasification

- hard coal
- brown coal
- peat
- wood
- waste

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Key Project Differentiators

**BioTfueL Project:**
- Project target: to develop a complete B-XTL chain, converting biomass into renewables-based fuels
- The PRENFLO PDQ entrained-flow gasifier is designed as multi-feedstock gasifier with the ability to simultaneously gasify biomass, coal, petcoke, liquid vacuum residues and Fischer-Tropsch recycle gases

**VärmlandsMetanol Project:**
- Project target: to produce fuel grade bio-methanol used as liquid motor fuel substituting fossil fuels
- The HTW fluidized bed gasification has a capacity of 111 MW\textsubscript{th} and uses domestic forest residue to produce 100,000 t/a of fuel grade methanol
Process Wrap
From feed-in to product-out, Uhde provides a wrap for the entire process chain.

Execution Wrap
Uhde is licensor, technology provider and engineering contractor from a single source.

Uhde: Our „Wrap“ Offers combining process chains and EPC from a single source
Summary

- Over 100 gasifiers designed, built and put into successful operation by Uhde, which include:
  - Feeding principles:
    - Dry powder feeding
    - Water-slurry feeding
    - Screw conveyor and gravity pipe (fluidised-bed applications)
  - Syngas Cooling with
    - Gas Quench
    - Water Quench
    - Waste Heat Boiler
    - Radiant Cooler
  - Gasifier Insulation with
    - Refractory lining
    - Membrane Wall
- Uhde is an integrated licensor and EPC contractor from a single source
- A number of new projects have selected Uhde Gasification technologies, including:
  - TransGas, CTL / MTG Complex, USA
  - BioTfueL, B-XTL, France
  - VärmlandsMetanol, BTL (methanol), Sweden

All these gasifiers went into successful operation and are fully proven in commercial scale by Uhde
Thank you for your attention

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