ThyssenKrupp Uhde's PRENFLO® and HTW™ Gasification Technologies

Global Update on Technology and Projects

Karsten Radtke, Head of Gas Technologies Division
ThyssenKrupp Uhde GmbH, Dortmund, Germany
In 2011, we celebrate round numbers:

- 200 years ago: Krupp founded in 1811
- 140 years ago: Thyssen founded in 1871
- 90 years ago: Uhde founded in 1921
- 70 years ago: Entrained-Flow Gasification Koppers-Totzek invented in 1941

Other round numbers...

- Over **100 gasifiers** put into successful operation by Uhde
- Over **180,000 ThyssenKrupp colleagues** worldwide

„...one slide on the company...“
+ Further News - September 2011:
9,500 bpd CTL facility in Mozambique to apply PRENFLO® PDQ technology

+ Further News - September 2011:
ThyssenKrupp Uhde & SGC Energia sign PRENFLO® Master Contract for CTL

+ Further News - August 2011:
C.GEN selects PRENFLO® PDQ for IGCC in Killingholme, UK
Different Feedstocks require Different Gasification Technology
ThyssenKrupp Uhde’s Gasification Portfolio

PRENFLO®
Entrained-Flow Gasification

HTW™
(High-Temperature Winkler)
Fluidised Bed Gasification

Wastes
Wood
Peat
Brown Coal
Lignite
Hard Coal
Petcoke Residues
Oil Residues
Oil Gasification
ThyssenKrupp Uhde’s Proprietary Gasification Technologies

- PSG: Entrained-Flow
- PDQ: Entrained-Flow
- HTW™: Fluidised Bed
ThyssenKrupp Uhde acquires HTW™ Gasification Technology

- HTW™ goes back to 1926 (Winkler Gasification)
- Fluidised-bed, pressurised gasification
- Main target: low-rank feedstocks, in particular: coals with high ash melting points, brown coal, lignite, wastes
- HTW™ was previously owned by RWE/Rheinbraun
- ThyssenKrupp Uhde acquires the HTW™ technology with all IP rights and know-how from RWE in December 2010
- A number of projects under development, including biomass-to-methanol and DRI projects in Sweden and India
Solid Feedstocks operated in HTW™ Gasification
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)

Current VärmlandsMetanol Project, Sweden:

- Biomass to Methanol plant
- Feedstock: Domestic forest residue
- Grain size: < 4mm for biomass
HTW™: Operating Experience – proven, reliable technology

<table>
<thead>
<tr>
<th>Feedstock operated in HTW</th>
<th>PDU Scale</th>
<th>Pilot Scale</th>
<th>Industrial Scale</th>
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<td><strong>Low-rank coals</strong></td>
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<td>Brown coal</td>
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<td>High-S brown coal</td>
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<td>Lignite</td>
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<td>Subbituminous coal</td>
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<td>Pittsburgh No.8</td>
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<td><strong>Other low-rank fuels (biomass and energy crops)</strong></td>
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<td>Sewage sludge</td>
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<td>Loaded coke</td>
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<td>Used plastics</td>
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</table>
HTW™ Gasification Plant
Berrenrath, Germany
Feedstock: 30 t/h lignite
Product: 300 t/d methanol
HTW™ Gasification Plant
Biomass Gasification
Kemira Oy, Oulu / Finland
Feedstock: 30 t/h peat
Product: 300 t/d NH3
HTW™ Waste Gasification
Sumitomo Heavy Industries Ltd.
Niihama / Japan
Feedstock: 48 t/d MSW

MSW household waste
Co-operation with RWE for WTA Coal Drying Technology

- WTA is a fluidised-bed coal drying technology developed by RWE, which reduces the water content of raw lignite from >55 wt.-% to around 12 wt.-%.

- Key advantage: unlike alternative drying processes that use flue gas at >1,000°C, WTA drying process takes place at a temperature of only 110 °C and re-utilises the heat.

- In February 2009, RWE Power commissioned the world’s largest lignite dryer in Niederaussem, Germany. Capacity: 110 t/h of dry lignite.

- With WTA, the efficiency of lignite-fired power stations increases to >47 %.

- In combination with WTA fluidised-bed dryers, ThyssenKrupp Uhde can offer an integrated process chain for efficient HTW™ and PRENFLO® coal gasification.
IGCC Plant with a capacity of up to 450 MW net + optional hydrogen
Choice for IGCC with CO₂ capture, based on PRENFLO® PDQ direct quench gasification technology
Location Killingholme, UK: industrial port, synergies due to maximum integration into existing industrial network
Standardization of plant to optimize learning curve for subsequent plants

Feedstocks:
- Unconventional hard coal
- Petcoke
- Sustainable biomass
450 MW IGCC with CCS

Killingholme, UK

New JV: Kepco-Uhde Inc.

- ThyssenKrupp Uhde and largest utility in Korea, KEPCO, form Joint Venture Company for PRENFLO® PSG gasification
- “KEPCO-Uhde Inc.” established in South Korea 14 July 2011.
- First 2 SNG projects launched for KEPCO-Uhde
- JV provides strong synergy, cost and schedule advantages

Dr. Thiemann, CEO ThyssenKrupp Uhde

Mr. Kim, CEO KEPCO
Tasks of Kepco-Uhde Inc.

**Market, Design and License**

- **PRENFLO® PSG** for SNG and IGCC applications including CCS

**Research & Development**

- Develop standard IGCC model for > 500 MW output
- Improve efficiency of IGCC and SNG plants
- Integrate CCS solutions

⇒ Combine leadership strengths of both Joint Venture partners...
ThyssenKrupp Uhde and SGC Energia enter into Master License and Supply Agreement for multiple CTL projects applying PRENFLO® PDQ and SGCE’s Fischer-Tropsch Process

⇒ SGCE’s proprietary XTLH™ solution

**September 2011**: License and Supply Agreement for 9,500 barrels/day CTL Plant in Mozambique effective
CTL Project Mozambique

- PRENFLO® PDQ licensed
- High-ash coal (37 %) will be utilised for generating clean Fischer-Tropsch fuels for domestic and export use
- Plant Capacity: 9,500 barrels/day

Adansonia digitata Trees, Mozambique, Africa
TransGas CTG Projects: *Update*
West Virginia and Kentucky Sites
TransGas Ground Breaking, 09 May 2011
Adams Fork Energy Project

U.S. Senator Joe Manchin III., and WV Governor Earl Ray Tomblin
at Ground Breaking Ceremony, 09 May 2011, West Virginia Plant Site

- 18,000 barrels/day Adams Fork Energy CTG Project based on PRENFLO® PDQ permitted, 2 duplicate projects in Kentucky permitted
- Construction for all 3 projects commenced in May/June 2011
- Combined, these 3 TransGas CTG projects represent ~7 % of entire U.S. gasoline import
TransGas: Licensors and Contractors Kick-Off
Adams Fork Energy Project

• Leading Technology Licensors and EPC contractors teamed up for project implementation

• Adjustment to EPC structure and project execution concept arranged

• All 3 projects are in a 50 miles radius and allow for significant synergy effects in engineering, procurement, construction and schedule

• Start-up expected for 2016
BioTfueL Project Update
BioTfueL - a consortium of partners with complementary core businesses...

From R&D to market
From field to wheel

Development and Demonstration of a complete B-XTL process chain
BioTfueL demo plants:

- Feedstock preparation plant (Sofiprotéol – Venette)
  new area at the site border
BioTfueL demo plants:

- **PRENFLO® PDQ** Gasification & syngas treatment
  - Zone 1 fully connected with site facilities (control room, utilities, services...)

![Diagram of BioTfueL demo plants with labels for Eolienne 1, 5, Torche 2, and ZONE 1, 2, 3, 37500 m², 18000 m². The diagram shows the layout and connections between the facilities.]

Logos and branding of Axens, CEA, IFP, Energies Nouvelles, Sofiprotéol, Total, and ThyssenKrupp Uhde are present.
ThyssenKrupp Uhde *GTC 2011 Summary*

- **HTW Technology** acquired to extend gasification applicability
- **WTA Drying Technology:** coal drying technology for increased efficiency
- **Joint Venture with KEPCO** to accelerate IGCC and SNG applications
- **KEPCO-Uhde Inc.:** First 2 SNG projects launched in South Korea
- **TransGas:** Commencement of construction at 3 sites for 3 x 18,000 b/d CTG complexes in West Virginia and Kentucky
- **SGC Energia:** Master Agreement for multiple 10,000 b/d class CTL
- **9,500 b/d CTL Complex:** PDQ License and Supply agreement for Mozambique effective
- **C.GEN:** IGCC with CCS in Killingholme, UK selects PDQ gasification
- **BioTfueL:** BXTL Project, France: Basic Engineering completed, Detailed Engineering and FEED commenced
Thank you for your attention

ThyssenKrupp

ThyssenKrupp Uhde

PREENFLO Gasification Plant, Puertollano, Spain
October 2011

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