PRENFLO™ PSG and PDQ

Update on Operation & Projects

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Uhde’s „first of’s“ in Coal Gasification:

- 1909: first Koppers Gas Generators (a total of 536 built)
- 1941: Invention of first Entrained-Flow Gasification:
  - Koppers-Totzek: dry-fed, membrane wall, multiple burners

Development, Design and Construction of

- first Koppers-Totzek Coal Gasification Plant
- first Rummel-Otto Slag Bath Coal Gasification Plant
- first Saarberg-Otto Coal Gasification Plant
- first Texaco (GE) Coal Gasification Plant
- first HTW Coal Gasification Plant
- first Shell-Koppers Coal Gasification Plant
- first PRENFLO Coal Gasification Plant
Uhde’s Gasification „101“

Koppers-Totzek gasification
Modderfontein, South Africa
coal-to-ammonia/fertilisers

HTW coal gasification
Berrenrath, Germany
coal-to-methanol

Texaco (GE) coal gasification
Oberhausen, Germany
coal-to-hydrogen & oxochemicals

Over 101 Gasifiers designed, built and put into successful operation by Uhde

PRENFLO coal gasification
Fürstenhausen, Germany
coal-to-syngas

HTW MSW gasification
Niihama, Japan
waste-to-energy

PRENFLO IGCC
Puertollano, Spain
petcoke/coal-to-energy/hydrogen
World’s largest single-train coal/coke IGCC: PRENFLO Gasification, Elcogas, Puertollano, Spain
Feedstock: petcoke / coal with addition of biomass
PRENFLO with Steam Generation

1200 MW<sub>th</sub>, 42 bar

PRENFLO PSG Features
- dry coal/pet coke powder feed
- 4 horizontal co-annular burners
- membrane wall
- waste heat boiler (PSG)
PRENFLO Gasifier - erection of internals (Puertollano)
Puertollano IGCC: Operating Experience

General

- PRENFLO Gasifier is **flexible** with broad range of **solid fuels**
  - high-ash hard coal and petroleum coke
  - addition of biomass successfully demonstrated (olive residues)
- Flexible **load change** behaviour
- Nearly **constant** gas **heating value** irrespective of fuel
- **No formation** of **higher hydrocarbons**, methane < 0.1 vol. %
- **Non-leachable slag** production
- **Fly ash** sold to cement industry
- Elcogas statistics show that the vast majority of down-times was caused by **non-gasifier** related issues
PRENFLO with Direct Quench

1200 MW\textsubscript{th}, 42 bar

**PRENFLO PDQ Features**
- dry coal/pet coke powder feed
- 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
The PRENFLO process with Direct Quench (PDQ)

Why Direct Quench version?

- Optimize PRENFLO technology for chemical and hydrogen applications
- Focus on areas of significant Capital Cost Reduction
- Water Quench instead of Gas Quench and Waste Heat Boiler
- Keep commercially proven elements of PRENFLO technology
- Design of a robust system
- Low impact on $O$

![Graph showing Δ of electric efficiency vs shifted gas fraction](image)
PRENFLO gasifier with Steam Generation

**PSG**

PRENFLO gasifier with Direct Quench

**PDQ**

**Same gasifier design**

Slag

Raw gas

Oxygen feed
PRENFLO PSG vs. PRENFLO PDQ
Impact on Cost: Process Configuration (e.g. H₂ plant)

**PSG:**
- PSG Gasifier
- Gas Quench
- Waste H. Boiler
- FA Filter
- Scrubber
- Saturator
  - Raw Gas
  - S/G=1.3
- CO-Shift
  - H₂ Gas
  - Steam

**PDQ:**
- PDQ Gasifier
- Direct Quench
- Scrubber
- CO-Shift
  - Raw gas
  - S/G=1.3
  - H₂ Gas
  - Steam

substituted by Direct Quench
PRENFLO PSG vs. PRENFLO PDQ
Impact on Cost: Plant Layout

PRENFLO (PSG)

PRENFLO (PDQ)

EPC cost savings: ~30 %
February 2009:

New Co-operation Agreement Elcogas ~ Uhde

- Extensive integration of Operating Experience with technology and engineering know-how
- Joint implementation of R&D projects
- Platform for plant reliability, operator training, operating and maintenance services
- Regular exchange and presence on site
2009 PRENFLO Projects Update - Highlights
(under development / in engineering)

2 x PDQ coal gasification
U.S.A.
clean-to-liquids

2 x PDQ coal gasification
ICM, Mongolia
clean-to-liquids

1 x PDQ coal gasification
China
clean-to-syngas

2 x PDQ petcoke gasification
SE Asia
clean-to-chemicals

6 x PDQ coal gasification
U.S.A.
clean-to-gasoline

2 x PDQ coal gasification
PA Energy, U.S.A.
IGCC cogeneration complex

1 x PDQ coal gasification
Asia
coal-to-chemicals

1 x PDQ coal gasification
Europe
IGCC

2 x PDQ biomass gasification
Europe
BTL
First Coal-to-Gasoline Plant in China started up in June 2009:
2,500 bbl/day plant applying ExxonMobil MTG technology
Jincheng, Shanxi Province, China

BTL, CTL, and Oil Shale Production Grows With Technology Improvement

Figure 72. Liquids production from gasification and oil shale, 2007-2030 (thousand barrels per day)

Source: EIA Annual Energy Outlook, 2009

MTG Co-operation for over 25 years
TransGas Coal-to-Liquids Complex (18,000 bpd)
2 x PRENFLO PDQ Gasification to produce gasoline from coal
2008: PDQ License Agreement signed & effective
2009: permitting almost complete

Mingo County, West Virginia

watch animated video at www.transgasdevelopment.com
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<td><strong>Service provided by Uhde</strong></td>
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- Gasification projects are **mega projects** – usually **several hundred million**, often **several billion**, US-Dollars need to be financed.

- **Minimisation of interfaces, risk** and **cost** is even more important to project financing under „post-financial crisis“ requirements.

- **Uhde** is **Licensor and EPC provider from a single source** and can thus offer any **project-specific, tailor-made seamless interface and package**.

This **unique** concept:

- **significantly reduces cost and schedule prior to Financial Closure**.
- Allows to “**wrap**” the entire **process chain**.

From the idea to a successful project execution.
Gasification will play an increasingly important role in our future. Oil and gas supply and demand do not match any longer.

The new Co-operation Agreement signed in February 2009 between Elcogas and Uhde ensures the full integration of operating experience and engineering into PRENFLO technology for the full benefit to successful future projects.

As a technology-driven engineering company, Uhde can act as integrated Licensor, E, EP or EPC contractor – PRENFLO is a product.

Depending on the application, PRENFLO is available with conventional steam generation (PSG) or direct quench mode (PDQ) with significant cost savings.

In spite of the financial crisis, a number of new projects identified and selected PRENFLO technology – worldwide.
Thank you for your attention.