SHELL-WISON BOTTOM QUENCH COAL GASIFICATION TECHNOLOGY

Innovation and Advantages

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Shell (China) Projects and Technology
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Reserves: Our use of the term “reserves” in this presentation means SEC proved oil and gas reserves.

Resources: Our use of the term “resources” in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.

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Shell’s coal gasification technology is licensed for 29 applications globally including IGCC power plants and chemical production, in which 22 licenses are in China.
SCGP SYNGAS COOLER DESIGN

- SCGP line-up with syngas cooler has a wide application base in China
- Simplified line-up developed to fit different requirements of (Chinese) customers
**BOTTOM QUENCH PROCESS**

- **COAL/PETCOKE**
- **MILLING/DRYING**
- **FEEDING/PRESS.**
- **Gasifier 1,600°C**
- **WET SCRUBBER**
- **WATER TREATMENT**
- **SLAG**
- **FILTER CAKE**

- **Raw SYNGAS**
- **PROCESS WATER**
- **T~200°C**
- **T~210°C**

Simplified line up
Reduced Capex
Easier operation
IMPACT ON EFFICIENCY

Syngas Cooler

- Coal in 100%
- Raw syngas
- 81.5% LHV 20% moisture in syngas

- 95.9% Thermal Efficiency
- 81.5% Cold gas efficiency

- 1.9% Steam from Membrane Wall
- 12.1% Steam from Syngas Cooler
- 0.5% Unconverted carbon
- 3.6% low level heat

Bottom Quench

- Coal in 100%
- Raw syngas
- 81.5% LHV 50% moisture in syngas

- 85.4% Thermal efficiency
- 81.5% Cold gas efficiency

- 1.9% Steam from Membrane Wall
- 0.5% Unconverted carbon
- 14.1% low level heat
EXTENSIVE RESEARCH AND DEVELOPMENT ON BOTTOM QUENCH

Full size test rig

Cold flow test

CFD modelling

velocity magnitude (m/s) vertical velocity (m/s)

High HTC Low HTC Circulation

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The gasifier reactor and burners used in the Bottom Quench technology are virtually the same as those used in SCGP. The syngas cooler, for heat recovery, has been replaced by a dipleg water quench bath.

Key design features: multi-burner, membrane wall, bottom water quench.

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<th>Bottom Quench</th>
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<td>Membrane wall</td>
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<td>Flyash removal system</td>
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BOTTOM QUENCH COMMERCIAL PROJECT IN NANJING
From construction to successful start-up

Gasifier/quench in the Dongfang workshop
October 2012

Hoisting of the gasifier and quench
December 2012

Site overview
June 2013

Gasifier contract
2011 Aug

Construction kick-off
2012 Jan

MCI
2013 May

Start up
2013 Oct

Planned test phase
2014 Nov

Commercial phase
Now

By Dec 2014, all scheduled tests were completed successfully, and the plant entered its commercial operation stage. The gasifier has achieved a continuous run record of 140 days.
PROVEN TECHNICAL ADVANCES
Good slag coverage in membrane wall

Inspection of the gasifier reactor and quench section was performed after start-up and initial stable running:

The slag coverage inside the gasifier was good; the spray nozzles and quench ring were also in good shape.
SCGP BOTTOM QUENCH IN NANJING: ADVANCES

- **Feedstock:** Successfully tested broad range of coals
  - Shanxi DaYouI (Ash 25%, FT 1450)
  - Shanxi DayouII (Ash 25%, FT >1500)
  - ShenHun (Ash 15%, FT 1300)
  - ShenHua (Ash 8%, FT 1200)
  - Local high ash coal (Ash 30%)

- **Slag re-use for low ash coal**

- **Carbon Conversion**
  > 99% carbon conversion, carbon < 0.5% in slag and < 5% in filter cake,

- **High (> 90%) slagging efficiency**

- **Primary water treatment**
  - Good settling with black water via proper flocculant to recycle gray water:
    - TSS < 50 ppm, COD < 100 ppm

- **Operation Reliability**
  - The gasifier has achieved a continuous run record of 140 days.

Good results of the Shell-Wison Nanjing Bottom Quench gasifier are completely in line with expectations.
LESSONS LEARNED AND IMPROVEMENT
Solved syngas line fouling issue

Build-up in 70 days

Adjusting Conditions Hardware

After 140 days
LESSONS LEARNED AND IMPROVEMENT
Solved fly ash break-through issue

Adjusting Conditions Hardware

70 days

140 days
Project Information

- **Client**: YTH Jinxin Chemical Co Ltd.
- **Location**: Hulunbeier, Inner Mongolia

Gasifier Capacity

- Net syngas production (CO+H₂): 60,000 Nm³/hr
- Feedstock capacity 1200 t/h (lignite coal, AR basis)

Project Schedule

- Licensing contract award: Jan 2014
- BDEP delivery by Shell: May 2014
- Gasifier manufacture: Dongfang Boiler
- Start-up target: 2015
Thanks!