Siemens Gasification Project Update and Lessons Learned

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Agenda

**Gasification Project Update and Lessons Learned**
- Shenhua Ningxia Coal Group, NCPP I Project
- Shanxi Lanhua, Jincheng Project
- CPI, Coal to SNG Project
- Shenhua, CTL Project
- MidAmerica C2L, Coal to Methanol Project

**IGCC Project Update**
- Huaneng GreenGen Co. Ltd., Tianjin IGCC Project
- Mississippi Power, Plant Ratcliffe
- Summit Power, Texas Clean Energy Project

**Siemens Technology Update**

Conclusions
Siemens Gasification Landscape

9 SFG-500 gasifiers shipped or installed for 3 projects,
32 SFG-500 gasifiers on order
NCPP Project: Ningxia Coal to Polypropylene
5 x SFG-500 / 540,000 Nm³/h (H₂+CO) / dry coal capacity 5 x 85 t/h

Sub-bituminous Coal
- Ash: 7-28 wt%
- Moisture: < 6 wt%

Start Erection (SIEMENS Proprietary Equipment)  January 2009
Mechanical Completion  August 2010
Commissioning period for all 5 gasifiers  October ‘10 – April ’11
Pre-commercial operation  Start April 2011
Performance tests completed  September 2011

Site area: 192 hectares or 474 acres
NCPP I Project
Gasifier Performance

Operational Highlights

- 4 lines in stable, parallel operation
- More than 1,500,000 tons of coal gasified
- More than 5,000 t/d methanol production
- Has accommodated coals with a ash content that typically varies between 10% and 20%
- All gasifier performance guarantees achieved and exceeded

Performance Summary

- Gasification Temperature Range: 1350°C to 1750°C (2,462°F to 3,182°F)
- Carbon conversion 99%
- CH₄ < 0.1% (Vol)
- H₂+CO > 90%
- No heavy hydrocarbon produced
- Cold gas efficiency ~ 80% (depends on coal)
- Low oxygen and coal consumption
Shanxi Lanhua Coal Chemical Co., Ltd.  
Jincheng Project, PR China

**Plant Output**  
- 300,000 t/yr Ammonia  
- 520,000 t/yr Urea

**Coal**  
- Tangan Coal (Anthracite)  
  (FT ~ 1530°C, ash content ~16%)

**Gasification Island Configuration**  
- 1 gasifier in operation  
- 1 gasifier standby

**Gasifier Operating Pressure**  
- 4.0 MPa(g) (580 psig)

**Siemens Scope**  
- Engineering and Gasification Testing  
- Equipment Supply  
  - Internals for Lock Hoppers  
  - Feeder Vessels  
  - 2 x SFG-500 gasifiers  
  - Burners  
  - Gasifier Control System  
  - Dust Measurement  
- Technical Field Assistance  
- Gasification Island Process License

**Status**  
- Agreement with customer extended  
- Commissioning mid 2015

Project located near Jincheng City, in the southern part of province Shanxi
CPI Yinan
Coal to SNG Project

Client & Project
Client: CPI - China Power Investment Corporation
One of first major utilities in China to build coal to SNG
Project: First phase (2 bill Nm³/a) of a 6 bill Nm³/a SNG project
Location: Yili City Xinjiang Province, PR China

Siemens Scope
- PDP / BEDP (supported by Design Institute ECEC)
- 8 x SFG-500 standard gasifier and burners
- 8 x Feeder vessels
- I&C system for burner management
- Dense flow coal measurement devices and feeding internals
- Training, Technical Field Assistance

Schedule
- Contract signed: July 2011
- BEDP delivered: April 2012
- Gasifier manufacturing started: June 2012
- Expected COD: Late 2015
Shenhua, CTL Project

Status

- 24 SFG-500 gasifiers ordered
- Project will produce 4 million metric t/y of Diesel & Naphtha
- Siemens engineering completed
- Siemens equipment on order
- Start of commissioning expected late 2016
MidAmerica C2L, KY Coal to Methanol Project

Status

- Selected a more profitable product, Methanol
- Moved project to new site outside of Paducah, KY
- Worked with SK E&C to confirm EPC price for plant
- Currently seeking equity and debt financing for project

Cycle Diagram (provided by MidAmerica C2L)
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Huaneng Greengen Co. Ltd.  
Tianjin IGCC Project

Plant Output
- 250 MWe

Siemens scope
- 1 x SGT5-2000E gas turbine and auxiliaries

Gas turbine main fuel:
- Coal-based syngas diluted with N₂

Gas turbine secondary fuel:
- Fuel oil

GT-G Status
- Gas turbine first fire on secondary fuel in October 2011
- GT-G successfully reached first syngas operation in September 2012, commission of the plant continues as planned
Mississippi Power
Plant Ratcliffe IGCC Project

- Siemens shipped 2 SGT6-5000F Gas Turbine Generators to site in 2012
  - Gas turbines will operate on high H₂ syngas as the primary fuel and natural gas as the backup/startup fuel
  - Gas turbines include capability to extract air for integration with the air-blown gasifier
- Gas Turbine Generators currently being installed at site

Site pictures courtesy of Mississippi Power
Summit Power Group
Texas Clean Energy Project

Plant Output
- 400 MW<sub>e</sub>
- 710,000 t/y Ammonia/Urea
- 2.5 M t/y CO₂ for EOR

Siemens Scope
- 2 X SFG-500 gasifiers
- SGCC6-5000F 1X1 power block operating on high H₂ syngas with natural gas as the startup/backup fuel
- Various plant compression solutions: CO₂, O₂, N₂, others
- Plant operation and maintenance services (JV with Linde)
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Conclusions
R&D Improves Gasification Economics

- Developed optical 3-D high precision measurement of Vresova’s refractory lined reactor to more accurately determine refractory remaining lifetime and outage planning.

- Developed advanced CFD calculation tool for coal specific gasifier design work resulting in:
  - Maximized throughput
  - Lower operating cost by minimizing possible $O_2$ consumption
  - Optimized gas cleaning and black water treatment systems design
OEM Service Programs Play a Key Role in Improving Long Term Gasification Plant Availability

- Identification of possible failures with impacts on reliability and availability
- FMEA for single faults
- FTA for failure correlations
- Markov models to describe consecutive failures
- Simulative approaches for more complex scenarios and complete poly-generation sites

- Monitors, analyzes and diagnoses plant operating conditions for follow-up action
  - Data acquisition / processing / analysis
  - OEM expert knowledge network
  - Quick user support by web-based expert knowledge software solution
  - Includes development and implementation of condition-based strategies and optimization of plant operations
  - Flame spectrometry for gasifier monitoring
  - Reactor vessel shape measurements

Helps improve reliability, availability, lifetime asset management, and proactive maintenance planning
OEM Support for Operating Gasification Plants

- Siemens Gasifier Component Service Facility opened in 2012
- Located at Siemens turbine works in Huludao, China
- Supports operating and future Siemens gasifiers in China
Siemens – DOE Advanced H₂ Turbine Program Update

PHASE 1 and PHASE 2 Program Goals: ↑ 3-5% pt. in CC efficiency; 2 ppm NOₓ; ↓ 20-30% Plant Cost

Program is On-Track

Siemens DOE H₂ Program Update: Technology Development Path to 2ppm Goal

Advanced High Temperature Combustor + Novel Selective Catalytic Reduction System + Advanced Emissions Sensors = 2 PPM
- Higher Efficiency
- Cost Competitive
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Global demand for gasification is still strong in areas where natural gas prices are high

- Chemicals / SNG
- Transportation liquids

Lessons learned are helping to improve operating flexibility and reliability

Better technology will provide broader feedstock options and improved plant economics

- Better gasification technologies being developed based on lessons learned and R&D
- Today’s F class turbines are ready for high H₂ syngas and new technologies are being developed for the next generation of IGCC gas turbines
- New services and technologies to optimize life cycle operating cost
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