Siemens Gasification and IGCC Update

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Agenda

- Recent Highlights
- Gasification Update
- Gasification O&M / Gasifier Services
- Conclusions
Recent Siemens IGCC and Gasification Highlights

- 2 SFG-500 gasifiers have arrived in China, 2 more shipped in October, and two will ship for Secure Energy at end of 2008
- New FEED contracts:
  - EPCOR, Genesee IGCC Project (SFG-500 gasifier)
  - AEC, Latrobe Valley, UREA, Australia
- Technology selected for IGCC projects in North America and Europe
- Vresova refractory lined gasifier in commercial operation
- 4 FEEDs completed
- 10 feasibility studies completed
Gasification Technology - Worldwide Activities

- Four SFG-500 Gasifiers shipped, 5 being manufactured
- Technology selected and in pre-selection in further projects
Siemens SFG Gasification Technology

SFG Gasifiers

Current Gasifier Products
- SFG-500 500 MWth
  • Cooling Screen Design
- Refractory Lined Gasifier

Highlights

- **OEM Support**
  - Siemens manufactures the critical gasification equipment
  - Siemens invests in R&D to improve both gasifier and gasification island design
  - Siemens provides local sales and gasifier component/service support throughout life of project

- **Project Development Support**
  - Siemens can provide feasibility or pre-FEED information for initial project definition
  - Siemens can provide gasification island basic design and process design packages during FEED
  - Siemens comprehensive gasification test facility is available to confirm gasification characteristics

Siemens OEM support before, during and after construction
Available Product Designs for Different Feedstocks

Gasification conditions depend on feedstock characteristics:

- Carbon, hydrogen content, heating value, moisture level
- Ash composition determines ash melting temperature
- Gasification temperature above AMT: 1,300 - 1,800 °C (2,370 - 3,270 F)

### Feedstock Type

<table>
<thead>
<tr>
<th>Solid</th>
<th>Liquid</th>
<th>Ash Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic dense flow feeding system</td>
<td>Feed pumping Liquid spray burner</td>
<td>&gt; 2 %</td>
</tr>
<tr>
<td>Dust fuel burner</td>
<td></td>
<td>Reactor wall with cooling screen</td>
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<tr>
<td></td>
<td></td>
<td>Slag layer for thermal protection</td>
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<tr>
<td></td>
<td></td>
<td>Reactor wall with refractory lining</td>
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</tbody>
</table>
Siemens SFG-500 Gasification Island with Full Water Quench

Features

Feedstock flexibility
- Wide range of coals
- Petcoke
- Coal / Petcoke blends
- Biomass Co-feed
- Liquid Feedstocks

Entrained flow gasifier
- No tars or oils produced
- Vitreous slag

Full Water Quench
- High water content in raw gas

Mechanical syngas cleaning system

Optimized for chemical syntheses and IGCC with CO₂ capture
Siemens Fuel Gasification Technology Highlights
SFG-500 Standard Design (Cooling Screen)

Dry feeding
- High efficiency
- High carbon conversion rate (> 98 %)

Cooling screen
- Short start-up / shut-down
- Low maintenance
- High availability

Full quench
- Simple and reliable
- Ideal for CO sour shift

Multi-fuel gasifier
- Accepts a wide variety of fuels
  (e.g., bituminous & sub-bituminous coal, lignite, biomass, liquid wastes, petcoke and vacuum residues)

Tar free raw gas
Siemens Fuel Gasification Technology Highlights

Unique Cooling Screen Technology

Advantages
- Enables reduced reactor dimensions
- Leads to higher availability
- Self-protecting
- Self-renewal of protection layer

<table>
<thead>
<tr>
<th>Material</th>
<th>Conductivity</th>
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</thead>
<tbody>
<tr>
<td>Water</td>
<td>λ = 50 W/mK</td>
</tr>
<tr>
<td>Tube 3.5 mm</td>
<td>λ = 8 W/mK</td>
</tr>
<tr>
<td>SIC 13 mm</td>
<td>λ = 8 W/mK</td>
</tr>
<tr>
<td>Ramming Mass</td>
<td>λ = 81 W/mK</td>
</tr>
<tr>
<td>Slag 5.5 mm</td>
<td>λ = 81 W/mK</td>
</tr>
</tbody>
</table>

![Diagram showing liquid and solid slag, membrane wall, pressurized water, ramming mass, and pipe coil with studs.](Image)
Siemens Fuel Gasification Technology Highlights
Refractory Lined Gasifier Design

Liquid feeding
- High efficiency
- High carbon conversion rate (> 98 %)

Refractory lined
- Accommodates low ash feedstocks

Full quench
- Simple and reliable
- Ideal for CO sour shift

Multi-fuel gasifier
- Accepts a variety of low-ash fuels (e.g., tars, oils, and other liquid wastes)

Tar free raw gas
Siemens Gasification Test Facility

- Gasifier reactor with cooling screen, 3-5 MW, max. 30 bar
- Different fuel feeding systems (300 kg/h)
  - Pulverized fuel dosing & feeding system
  - Slurry feeding
- Full gas treatment
  - Desulphurization unit (Sulforox)
  - COS hydrolysis
  - HCN hydrolysis
- Waste water treatment

Over 60 feedstocks tested in over 100 tests provides valuable design data for better FEEDs
Siemens Gasification Test Facility
Gasification Test Results

Recent Feedstocks Tested:
- Bituminous Coal
- PRB
- Lignite
- Petcoke
- Biomass
- Pyrolysis oil

Information Generated:
- Syngas Compositions
- Carbon Conversion Rates
- Specific \(O_2\) Consumption
- Optimized Gasification Temperatures
- Slag Composition
- Waste Water and Soot Compositions

Results used for:
- Research and development
- Project development support
  - Design input
  - Permitting support
Next Steps
R&D Focus Areas

- Gasifier Scale-up
- Partial quench with heat recovery for IGCC applications
- Biomass feedstocks

Objective is to improve plant economics for a range of application
Active involvement by OEM after the commercial operation date can help improve plant availability and reliability in the early years of operation.
Conclusions

Global demand for gasification is still strong

- Chemicals / SNG
- Transportation liquids
- IGCC + CCS

Regardless of the applications customers are requiring

- High availability
- Fuel flexibility
- Optimization for CO2 capture

OEM business model well accepted in market

Siemens is leveraging its 150 years of OEM and 45+ years of IGCC and gasification know-how to develop gasification based solutions for tomorrow
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