An Update On Shell Licensed Gasification Projects and the Performance of Pernis IGCC

2000 Gasification Technologies Conference
8-11 October, San Francisco

J.D. de Graaf
Summary

- Introduction
- Shell Gasification Processes
- Recent Projects
- Feedback Pernis IGCC
- Conclusion
Shell Gasification Processes

- Gasification of (natural) gas
- Gasification of liquids
- Gasification of solids
Shell Gasification Processes

- **Natural gas**
  - SGP @ ~1400 °C, ~50 bar

- **Refinery gas**

- **Vacuum Residue**
  - Vacuum Flashed
    - SGP @ ~1320 °C, 35-65 bar
  - Cracked Residue

- **Asphalts**

- **Coke**
  - SCGP @ ~1600 °C, 25-45 bar

- **Bituminous Coal**
  - SCGP @ ~1500 °C, 25-45 bar

- **Anthracite**
  - SCGP @ ~1600 °C, 25-45 bar
The SMDS process

Natural Gas → Syngas manufacture

CH₄ → CO + 2H₂ → -CH₂-

Syngas manufacture → Synthesis

Synthesis → Hydrogenation

Hydrogenation → Hydrocracking

Hydrocracking → Solvents

Waxes

Middle Distillates

Lube oil feedstock

ASU

Oxygen manufacture

6*SGP

HPS

H₂O

HPC

100 MMSCF/d → 12,500 bbl/d

Shell Global Solutions
ASU incident

• ASU explosion Dec 24th 1997
• Not related to SMDS technology or ops. error
• Extensive investigation - due to haze build up in Aluminium reboiler
• Much more safe design prepared
• Plant rebuilt and started up May 2000
Developments Shell Gasification

- NG gasification for Shell Middle Distillate Synthesis in Malaysia. Rebuilt restarted.
- Large scale SMDS projects with multiple large scale Shell Gasification units for sygas manufacture planned
  - Oil Residue in Pernis refinery for hydrogen and power
  - Oil Residue for Power in Sannazzaro, Italy
  - Petcoke gasification for IOC, Paradip, India
  - Coal gasification for Sella, Sardinia, Italy
  - Coal gasification for Dong-Ting Fertiliser, Hunan, China
Simplified flow scheme Shell Gasification Process

- Residue氧
- Feed pump
- Feed vessel
- Steam
- Oxygen
- Gasifier reactor
- Oxygen heater
- Syngas effluent cooler
- Soot quench
- Soot separator
- HP steam
- HP BF
- Syngas
- Soot scrubber
- Claus gas
- Waste water stripper
- To Biotreater
- LP steam
- Flue gas
- Filter cake work-up
- Ni/V ash
- Filtration

Shell Global Solutions
Developments Shell Gasification

- NG gasification for Shell Middle Distillate Synthesis in Malaysia
- Large scale SMDS projects with multiple large scale Shell Gasification units for sygas manufacture
- Oil Residue in Pernis refinery for hydrogen and power
- Oil Residue for Power in Sannazzaro, Italy
- Petcoke gasification for IOCL, Paradip, India
- Coal gasification for Sulcis, Sardinia, Italy
- Coal gasification for Dongfanghongke, China, China
Demkolec SCGP

- Raw coal
- Milling and drying
- Coal feeding
- Fly ash recirculation
- Gasifier
- Gas
- Quench
- Syngas-cooler
- HP steam
- MP steam
- Dry fly ash removal
- Fly ash system
- Fly ash recirculation
- Slag removal
- Slag
- Water wash
- Coal gas to gas treating
Eastern India Refinery Project

- ASU
  - Oxygen
- SCGP (2+1)
  - syngas scrub.
  - H2S to Claus unit
- H2S/COS removal
- 2 stage shift
- bulk CO2 wash
- PSA
- Power & Utilities block
  - offgas
  - Hydrogen
- Petcoke
  - gasification unit
- CO2 to atmosphere
- clean syngas to GT’s

Shell Global Solutions
Eastern India Refinery Project

ASU
- Oxygen

SCGP (2+1)
- syngas scrub.
- gasification unit

H$_2$S to Claus unit

H$_2$/COS removal

2 stage shift

bulk CO$_2$ wash

PSA

Power / Utilities
- offgas

Hydrogen

Oxygen

Petcoke

clean syngas to GT’s

CO$_2$ to atmosphere
Eastern India Refinery Project

- ASU
  - Oxygen
- SCGP (2+1)
  - syngas scrub.
  - H₂S to Claus unit
- H₂S/COS removal
- 2 stage shift
- bulk CO₂ wash
- PSA
  - Hydrogen
  - CO₂ to atmosphere
  - offgas
- clean syngas to GT’s
- Power / Utilities
- Hydrogen plant
- PETCOKE
- gasification unit
Eastern India Refinery Project

ASU

Oxygen

Petcoke

SCGP (2+1)
gasification unit

H₂S to Claus unit

H₂S/COS removal

2 stage shift

bulk CO₂ wash

PSA

Power / Utilities

Hydrogen

offgas

CO₂ to atmosphere

clean syngas to GT's

hydrogen plant

Hydrogen
SCGP for Dongting Fertiliser Plant

Naphtha → Steam Naphtha Reformer → NH3 feedgas preparation → Fertiliser plant
SCGP for Dongting Fertiliser Plant

Naphtha

Steam Naphtha Reformer

NH3 feedgas preparation

Fertiliser plant

ASU

Local Coal

SCGP

Sour Shift

Desulph.
Developments Shell Gasification

- NG gasification for Shell Middle Distillate Synthesis in Malaysia
- Large scale SMDS projects with multile large scale Shell Gasification units for sygas manufacture
- Oil Residue in Pernis refinery for hydrogen and power
- Oil Residue for Power in Sannazzaro, Italy
- Petcoke gasification for IOCL, Paradip, India
- Coal gasification for Sulcis, Sardinia, Italy
- Coal gasification for Dong Ting fertiliser, Hunan, China
Simplified flow scheme of Pernis Shell Gasification Hydrogen Plant

Shell Global Solutions
Outlet Temperatures Syngas Coolers

Temperature Syngas [°C] vs. Total Runtime [hrs]

Maximum allowable level

Shell Global Solutions
Start of gasifier without flaring
Simplified flow scheme of Pernis Shell Gasification Hydrogen Plant

Shell Global Solutions
Pernis SGP H2 Manufacture and Power generation

- OXYGEN
- STEAM
- RESIDUE
- SGP
- GAS CLEAN UP
- SAT VHP STEAM
- HEAT RECOVERY
- HP STEAM
- NATURAL GAS
- SYNGAS
- GT
- CO SHIFT
- CO2 REMOVAL
- METHANATION
- ELECTRIC POWER
- MP STEAM
- ST
- LP STEAM
- G
- ELECTRIC POWER
- H2
- GT

Shell Global Solutions
Gasturbine burner control in Pernis IGCC

Shell Global Solutions
Performance of Gas Turbines in Pernis

<table>
<thead>
<tr>
<th></th>
<th>GT-4700</th>
<th>GT-4800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability till mid 2000</td>
<td>95.2 %</td>
<td>95.5 %</td>
</tr>
<tr>
<td>Availability 1st half 2000</td>
<td>91.8 %</td>
<td>98.9 %</td>
</tr>
<tr>
<td>Excluding planned stop</td>
<td>98.7 %</td>
<td>98.9 %</td>
</tr>
</tbody>
</table>
Gas turbines with SGP in Pernis

- Normal running behaviour
  - No vibrations
  - Normal run hours between inspection stops
- Flexible in accepting a wide range of feeds
  - Can run on syngas only
  - Switch over from full NG to full syngas in minutes
- Load following
Conclusion

- Shell gasification processes selected for several key new applications
  - in gas to liquids
  - for coal to fertiliser
  - for petroleum coke to hydrogen and power
  - for heavy refinery residue to power
- SGP application in Pernis refinery very successful
  - hydrogen for hydrocracking
  - clean fuel gas for gasturbines
Thank You.