Shell Gasification business in action

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Potential syngas applications

Shell (Coal) Gasification Process

Syngas (CO+H₂)

- IGCC-Combined Cycle Power Generation:
  - Electricity
  - Steam
- Chemical feedstock:
  - Ammonia
  - Methanol, Hydrogen, other chemicals
- Conditioning/distribution:
  - Town gas
- Liquefaction:
  - Transportation Fuel

Coal
Lignite
Petroleum
Coke
Oil/Resid
Gas
Biomass
Orimulsion

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Shell Gasification (Oil) Technology in Operation

Recent projects:

- Italy - AGIP Sannazzaro: Commissioning scheduled end of 2005
- Canada - Opti: Advanced state of construction; Commissioning in 2006
- China - Fujian Refinery Ethylene Project: Process Design Package completed; Final Investment Decision expected by end 2005
- Poland - Lotos, Raffineria Gdanska: Process Design package started (Completion end 2005)
Shell (Oil) Gasification Process: successful through development

**Anticipating Changes:**
- Feedstock from thermal cracked residue to **deep** thermal cracked residue
- Feedstock from straight run material to asphalt from SDU ⇒ Higher ash contents & higher viscosities

**Optimum Integration:**
- High efficiency / high conversion rates
- Low oxygen consumption
- Utilisation of by-products ⇒ High syngas quality / high CO+H\textsubscript{2} yield
- ⇒ Very high pressure steam (120 bar)

**Standard Solution:**
- Application from chemical plants to Refineries
- Application from a single product to multi-products ⇒ Reliable supply of syngas
Shell Coal Gasification Process – simplified flow scheme

- **COAL/PETCOKE**
  - Milling/Drying
  - Coal feeding

- **GASIFIER**
  - 900 °C
  - 1600 °C
  - HP STEAM
  - MP STEAM

- **DSR**
  - Wet Scrubbing
  - Gas Treating

- ** Flynn ash system**
  - Water Treatment
  - SLAG
  - Fly ash to MILLING AND DRYING

- **CLEAN SYNGAS**
  - SALTS
  - SULPHUR
Shell Coal Gasification Process - Energy balance

- Coal in 100%
- 83% Raw synthesis gas
- 0.8% Steam from reactor wall
- 14.0% HP Steam from Syngas cooler
- 0.2% Unconverted carbon
- 2.0% Low level heat
# Shell’s Leadership in Gasification Technology

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Feedstock</th>
<th>Cooling</th>
<th>Carbon Conversion</th>
<th>Efficiency</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large (Single) Gasifier</td>
<td>Dry Powder</td>
<td>Membrane Wall+Boiler</td>
<td>99%</td>
<td>80~83%</td>
<td>Less</td>
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</tbody>
</table>

**Shell technology advantage:**

- Wider range feedstock
- Higher energy efficiency
- Lower OPEX, hence life-cycle cost
- Less emissions and effluent water
Shell Coal Gasification Process – development to commercialization

From pilot units to the 2000 t/d commercial plant

> 200 coal types tested providing strong and solid data base

- 6 t/d
  - 1976 Pilot Unit
  - Amsterdam

- 150 t/d
  - 1978 Demo Unit
  - Harburg, Germany

- 250 t/d
  - 1987 SCGP-1
  - Houston, USA

- 2000 t/d
  - 1993 NUON IGCC
  - Buggenum, The Netherlands
Shell Coal Gasification in action: NUON IGCC plant, Buggenum, NL

**Buggenum IGCC plant**

- Plant built (1993) and previously owned by the Dutch Electricity Generating Board (SEP), now with NUON
- **COAL INTAKE** 2000 t/d
- **NET OUTPUT** 253 MWe
- **NET EFFICIENCY (LHV)** 43%

- **Availability > 90% (excl. planned downtime)**
- Excellent environmental performance
  - Extremely low NOx, typically below 10 ppm
  - Sulphur removal efficiency over 99%
  - Total acidification components NOx + SO2:
    - coal gas operation better than natural gas
  - Virtually zero emission of fly ash, chlorides & volatile heavy metals
  - Zero discharge: waste water reused in plant
Features and improvements since Buggenum (Nuon)

Proven
- Reactor membrane wall expected life-time > 25 years
- Burner life-time > 20,000 hrs

New Projects
- Reactor-syngas cooler ~ 40% cheaper
- Steam system simplified \(\Rightarrow\) lower cost
- Water cooled skirt reactor
- Slag crusher
- Wider procurement options for equipment \(\Rightarrow\) lower cost
- Reactor-syngas cooler train up to 5,000 tpd
- Unplanned outages < 4% (scheduled maint. project specific)
Shell’s 1st investment in a coal gasification plant

- 50/50 Joint Venture with Sinopec – Yueyang
- Sinopec and Shell Coal Gasification Company Ltd.
- 2000 t/d coal gasification using Shell technology to produce SYNGAS as feedstock for fertilizer production
- Project EPC started June 2003. Planned mech. completion early 2006
Yueyang (Dongting) Sinopec-Shell Coal Gasification Project

Gasifier structure – final height 90m September 2005
Yueyang (Dongting) Sinopec-Shell Coal Gasification Project

Air Separation Unit
September 2005
Yueyang (Dongting) Sinopec-Shell CG Project

Shell Gasifier internals leaving fabrication workshop
December 2004
Enable Operator Training to:

- Increase operational knowledge and readiness
- Increase plant availability and safety

As a Development system to:

- Further improvement in the modeling of Shell Coal Gasification
- Verify/test operational procedures
Shell China coal gasification licences

1. Yueyang Sinopec and Shell Coal Gasification Co Ltd
   - 2,000 t/d plant to supply a fertiliser plant.* 2001
2. Hubei Shuanghuan Chemical Group Co Ltd
   - 900 t/d plant to supply a fertiliser plant. 2001
3. Liuzhou Chemical Industry Co Ltd
   - 1,200 t/d plant to supply a fertiliser plant. 2001
4. Sinopec Hubei Chemical Fertiliser Co
   - 2,000 t/d plant to supply a fertiliser plant. 2003
5. Sinopec Anqing Chemical Fertiliser Co
   - 2,000 t/d plant to supply a fertiliser plant. 2003
6. Yunnan Tianan Chemical Co Ltd
   - 2,000 t/d plant to supply a fertiliser plant. 2003
7. Yunnan Zhanhua Co Ltd
   - 2,000 t/d plant to supply a fertiliser plant. 2003
8. Dahua Group Ltd
   - 1,000 t/d plant to supply methanol plant. 2004
9. Yongcheng Coal and Power Group
   - 2,000 t/d plant to supply a methanol plant. 2004
10. Shenhua Coal Liquefaction Corporation
    - 2x2,000 t/d plant to supply H2 for coal liq. 2004
11. Zhongyuan Dahua Group
    - 1,800 t/d plant to supply methanol plant. 2004
12. Kaixiang Group
    - 1,000 t/d plant to supply methanol plant. 2004

* Shell-Sinopec 50/50 joint venture

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Shell Coal/Coke Gasification: Other global business activities

- Canada
- UK/EU
- Japan
- Australia
- India
Global Giant Joins Smart State Quest for Clean Coal Power

New York: Shell has been selected as the technology provider for a Smart State study of a clean coal technology project which may cut greenhouse emissions, Premier Peter Beattie announced today.

“This study being driven by the Queensland Government's Stanwell Corporation aims to capture the value of coal as a source of competitively-priced energy while reducing carbon dioxide emissions to near-zero levels," said Mr Beattie.

Shell Coal/Coke Gasification in the USA

- Deer Park Houston pilot plant tested wide variety of US coals, incl. PRB and lignites
- Shell Coal Gasification – a growing business of Shell Gas & Power
- Numerous projects involving Shell Coal gasification in development
- Projects in development beyond technology provision, if there is strategic fit
- Building a strong business development and delivery team
- Shell Global Solutions US – world class technical service organisation, providing wide ranging services and support