Lurgi’s MPG Gasification plus Rectisol® Gas Purification – Advanced Process Combination for Reliable Syngas Production

Ulrich Koss, Holger Schlichting
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MPG - Multi Purpose Gasification

Content

- Multi Purpose Gasification
  - History of Lurgi’ Gasification Know-How
  - Features of MPG
  - HP-Pox Demonstration Plant
  - Application in Ammonia Plant

- Gas Purification Technology
  - Advantages of Rectisol for a Hydrogen Plant
**MPG - Multi Purpose Gasification**

**Lurgi’s Gasification Technologies**

**Fixed Bed Grate Gasifier**
- Coal; Solid wastes, sewage sludge etc.
- **75% of Syngas from Coal World Wide produced in this type Gasifier**

**BGL Gasifier**
- Coal; Solid wastes, sewage sludge etc.
- Operates since 5 years with feedstock mixture of coal, petcoke and municipal waste

**Multi Purpose Gasifier**
- Residues Coal/Oil Tars Slurries
- **30 years operation with slurry feedstock**

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MPG - Multi Purpose Gasification

Special Features of MPG

Feed

$O_2 + \text{Steam}$

Quench

Water

Gas-offtake

Soot Slurry

Feed A

$O_2$

Feed B

Steam

Cooling Water
MPG - Multi Purpose Gasification

Advantages of MPG

- **Feedstock Flexibility**
  - No limitations on Flash Point of Feedstock
  - Viscosity up to 300 cSt
  - Particles up to 1 mm
- **Life Time of Burner**
  - Higher Reliability and Availability
- **Restart without Inspection**
- **Inherent Safety by pressurized Cooling Water System**
- **Low Feedstock Pressure Drop allows for cheaper Oil-Pumps**
- **Simultaneous feeding of immiscible Feedstock**
- **Integrated Heat-up Burner**

Client did not inspect burner even during 2 weeks general turnaround.
MPG - Multi Purpose Gasification
Comparison Quench/Boiler

Quench Configuration
- Feed
- Oxidant (O₂ Air) Steam
- Burner
- Water
- Syngas
- Soot Slurry

Boiler Configuration
- Feed
- Oxidant (O₂ Air) Steam
- Burner
- Sat. HP-steam
- Heat Recovery Boiler
- Syngas
## MPG - Multi Purpose Gasification

### Comparison Quench versus Boiler Configuration

<table>
<thead>
<tr>
<th>Boiler Configuration</th>
<th>Quench Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock limitations due to possible Boiler fouling</td>
<td>Feedstock flexibility</td>
</tr>
<tr>
<td>HP-Steam available highest thermal efficiency</td>
<td>MP-steam available trade off efficiency versus costs</td>
</tr>
<tr>
<td>2 step gas cleaning strong Claus gas</td>
<td>Fastest route to hydrogen but weak Claus gas</td>
</tr>
<tr>
<td>Higher costs for boiler (normally payback &lt; 2 years)</td>
<td>Lowest cost for hydrogen production unit</td>
</tr>
</tbody>
</table>
MPG - Multi Purpose Gasification

HP-POX Demonstration Plant at Technical University of Freiberg, Saxonia, Germany
MPG - Multi Purpose Gasification

HP-POX Demonstration Plant

Multi Process Test Facility:
ATR, Gas-Pox,
MPG (liquid feedstock)

Feedstock:
Liquid Feedstock 500 kg/h
Natural Gas 500 m³/h
(0.5 MMSCFD)

Reactor:
Operating Pressure 100 bar
MPG - Multi Purpose Gasification
HP-POX Demonstration Plant

Fresh water → Water Treatment → Steam Generator

Liquid Feeds → Storage → Compressor → Pump and Vaporizier

Natural Gas → Compressor

Liquid O₂ → Pump and Vaporizier

Desulphurisation Reactor

Flare System

Flue Gas

Soot Water

Nitrogen Supply
Instrument Air Supply
Measuring Station
Power Supply
Analytical Area
MPG - Multi Purpose Gasification

MPG-Reactor in Asphalt based NH₃-Plant
# MPG - Multi Purpose Gasification

## Feedstock and Product

### Feedstock:

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>970 t/d</th>
<th>8.8 kg/kg</th>
<th>0.04 wt%</th>
<th>360 cSt</th>
<th>20 cSt</th>
<th>170 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residue Asphalt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C/H-Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity at 180°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscosity at 290°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Products:

<table>
<thead>
<tr>
<th>Product</th>
<th>1350 t/d</th>
<th>113 000 Nm3/h</th>
<th>2000 t/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td></td>
<td>(100 MMSCFD)</td>
<td></td>
</tr>
<tr>
<td>Equivalent H₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urea</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MPG - Multi Purpose Gasification
Fertilizer Plant Based on Residue Asphalt

Air Separation → HP-Steam Boiler → Refrigeration Unit

Gasification + WHB → Rectisol H₂S Removal → CO-Shift

Carbon Recovery → Claus Unit

Soot and Ash Pellets → Sulfur

HP-Steam

O₂

Pure CO₂

Liquid N₂ Wash → Rectisol CO₂ Removal → NH₃ Synthesis

Liquid Ammonia

Urea Synthesis → Urea

Pure Hydrogen
MPG - Multi Purpose Gasification

Lurgi’s Gas Purification Technology Ownership

- **Natural Gas**
  - Rectisol®

- **Raw Syngas**
  - Purisol®
  - aMDEA

- **Off-Gas**
  - MDEA / DEA
  - Others

- **Ultra Pure Syngas**
  - Turbine Gas
  - Pipeline Gas
  - Pure Off-Gas
  - Pure CO₂ By-Product

- **Sulphur Recovery**
- **Tail Gas Treating**

- **Sulphur**
## MPG - Multi Purpose Gasification

### Selection of Appropriate Gas Purification Process

#### Product Gas Purity

<table>
<thead>
<tr>
<th>Process</th>
<th>H₂S purity</th>
<th>COS removal</th>
<th>CO₂ purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectisol®</td>
<td>0.1 - 1 ppm</td>
<td>H₂S + COS</td>
<td>10 - 50 ppm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CO₂</td>
</tr>
<tr>
<td>Purisol®</td>
<td>5 - 50 ppm</td>
<td>H₂S, no COS removal</td>
<td></td>
</tr>
<tr>
<td>MDEA</td>
<td>3 - 50 ppm</td>
<td>H₂S; no COS removal</td>
<td></td>
</tr>
<tr>
<td>aMDEA®</td>
<td>1 - 50 ppm</td>
<td>H₂S</td>
<td>5 - 50 ppm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CO₂</td>
</tr>
</tbody>
</table>
MPG - Multi Purpose Gasification

MPG based H₂ Plant

Feedstock

Steam

MPG Quench

Raw Gas Shift

Gas Cooling

Selectiv AGR

Methanation

Impure CO₂

Low BTU

Fuel Gas

97%

Hydrogen

LP-Steam

O₂

Carbon Slurry

ASU

MARS

O₂

O₂

OxyClaus®

Sulphur

Waste Water Treatment

Process Water

97% Hydrogen

S > 100 ppm

Fuel Gas
<table>
<thead>
<tr>
<th><strong>“Five-in-one”:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trace contaminant removal</td>
<td>COS, CS₂, NH₃, HCN, Hg ……</td>
</tr>
<tr>
<td>2. Deep Desulfurization</td>
<td>directly to synthesis feed quality (Total S &lt; 0.1 ppmv) only with Rectisol®!</td>
</tr>
<tr>
<td>3. Bulk CO₂ removal</td>
<td>100 % CO₂ can be recovered</td>
</tr>
<tr>
<td>4. CO₂ purification</td>
<td>Total S &lt; 5 ppmV in CO₂ Stream</td>
</tr>
<tr>
<td>5. Acid Gas Enrichment</td>
<td>Claus-suited acid gas even at a CO₂/H₂S ratio of &gt; 500</td>
</tr>
</tbody>
</table>

*one Rectisol® compares with five tasks to be performed in five processes steps*

So, set up the right B.L. when comparing costs!
It's the small bugs that can bother you most!

- COS
- Hg
- VOC's
- CS$_2$
- NH$_3$
- Carbonyls
- HCN
- Mercaptans

© Wilhelm Busch
Today, Rectisol purifies:

- 75% of the world's synthetic gas produced from oil residue, coal, & wastes
- 90% of synthesis gas produced by gasification (non-IGCC use)

Source: GTC Gasification Data Base
A Gasification Plant consists not only of the gasifier

Consider optimum integration of the required process steps
- Gasification
- CO-Shift Conversion
- Gas Purification
- Soot Water Handling
- Claus Process

Advantages of Rectisol Gas Purification are worldwide recognized

6 new Rectisol plants in the last 2 years
MPG - Multi Purpose Gasification

Contact:

Ulrich Koss
Head Syngas Technology
Dept. A-TE
Phone +49 69 5808 3740
Fax +49 69 5808 2645
e-mail ulrich_koss@lurgi.de

Dr. Holger Schlichting
Process Manager MPG
Dept. A-TEE
Phone +49 69 5808 1418
Fax +49 69 5808 2645
e-mail dr_holger_schlichting@lurgi.de

Lurgi AG
D-60295 Frankfurt am Main
Germany
Internet: www.lurgi.de