One Feedstock, Various Possibilities
2014 Methanol Technology and Policy Congress
Agenda

- Methanol downstream processes
- Introduction of the MTP® Process
- Development of the MTP® Process
- Integration of Lurgi MegaMethanol® and MTP® plant
- Conclusion
Methanol downstream processes
We can do more than only MegaMethanol®

Lurgi MegaMethanol®

Process

ASU

Syngas

Natural Gas

Coal

Crude Oil

Polypropylene

Propyleneoxide

Acrylic Acid

Oxo synthesis

Acrylonitrile

DME

Fuels

MeOH to Olefins

Ethylene, Propylene
(Poly-Olefins)

MeOH to Aromatics

Benzene, Xylenes

MeOH to Gasoline

Fuels

MeOH to Glycol

Ethylene Glycol
Introduction of the MTP® Process
MegaMethanol®
1,667 Mt/a = 5,000 t/d

Optional
Ethylene
60 t/d

Propylene
1,410 t/d

Product Conditioning
MTP-LPG
109 t/d

MTP-Gasoline
540 t/d

Process Water 2,800 t/d
Internal Use (+)

Olefin Recycle
Water Recycle

DME Pre-Reactor

MTP Reactors
(2 Operating + 1 Regenerating)

Product Fractionation

1) Propylene Purity 99.6 wt. %
MTP® – Products Description

### Propylene (PG)
- **Purity**: > 99.60% wt

### Ethylene (PG)
- **Purity**: > 99.90% wt.

### MTP-LPG

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₂ Hydrocarbons</td>
<td>&lt; 0.2 Vol %</td>
</tr>
<tr>
<td>C₃ Hydrocarbons</td>
<td>&gt; 10 Vol %</td>
</tr>
<tr>
<td>C₄ Hydrocarbons</td>
<td>&lt; 90 Vol %</td>
</tr>
<tr>
<td>C₅ Hydrocarbons</td>
<td>&lt; 1.5 Vol %</td>
</tr>
<tr>
<td>Total Sulphur Components, maximum</td>
<td>&lt; 0.1 ppm wt.</td>
</tr>
</tbody>
</table>

### MTP-Gasoline

<table>
<thead>
<tr>
<th>Property</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Density at 15° C</td>
<td>740 - 790 kg/m³</td>
</tr>
<tr>
<td>Equivalent dry vapour pressure</td>
<td>35 - 70 kPa</td>
</tr>
<tr>
<td>Research Octane Number</td>
<td>90 - 95 RON</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffins</td>
<td>15 - 35 % wt.</td>
</tr>
<tr>
<td>Olefins</td>
<td>30 - 60 % wt.</td>
</tr>
<tr>
<td>Aromatics</td>
<td>50 - 15 % wt.</td>
</tr>
<tr>
<td>Benzene</td>
<td>&lt; 1 % wt.</td>
</tr>
<tr>
<td>Total Sulphur Components</td>
<td>&lt; 0.1 ppm wt.</td>
</tr>
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</table>

Excellent characteristics as a blending stock. Processing to pump-grade gasoline available.
MTP® Technical Highlights

- Maximized Propylene Production
  - Selectivity > 65 % (Product Slate)
  - Yield > 28 % Wt. on Methanol Feed

- Main Co-Product: MTP-Gasoline: Valuable blendstock to any gasoline pool

- Proprietary Zeolite Catalyst

- Methanol Conversion > 99%

- Low Coking Catalyst (< 0.5% Carbon Loss)

- In-Situ Regeneration

- Option for some Ethylene production
Three MTP® plants under commercial operation:

- Datang Power Corporation (DTP: Duolon) – start-up 2011
- Shenhua Ningxia Coal Industry Group (SNCG: Ningdong) – start-up 2010
- Shenhua Ningxia Coal Industry Group (SNCG: Ningdong) – start-up 2014
Development of the MTP® Process
## R&D for the MTP® Process / Pilot Plants

### Pilot Plant – Frankfurt, Germany

<table>
<thead>
<tr>
<th>Concept and Background</th>
<th>operation as close as possible to commercial plant, including recycles and product purification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deliverables and Results</td>
<td>design base for commercial process, support for specific plant operation</td>
</tr>
</tbody>
</table>
| Timeframe              | Dec 1999 – Dec 2002 (PDU 1)  
                          | Jul 2003 – today (PDU 2) |
| Scale                  | 500 – 1500 g MeOH / h |

> more than 30,000 hours-on-stream!
- **Reactor Section** → guarantee direct scale-up from pilot to demo to commercial scale
- **Recycle Streams** → realize all important streams in pilot plant
- **Purification** → demonstrate product and by-product quality in pilot plant incl. polymer-grade
The pilot plant in Frankfurt delivered a very good prediction of yields and product properties in comparison to actual performance of the commercial plant.
SNCG MTP I

- MTP downstream a coal based methanol production.
- First World Scale MTP® Plant (1410 t/d)

Project History:
- BE Contract Signed: October 2006
- Start of Construction: April 2008
- First MeOH feed in: September 2010
- First On-spec Propylene produced: October 2010
- First Operation at 100%: August 2011
- Performance Test Run: May 2012

4 years
SNCG MTP II

- Coal based methanol as feed stock
- Second plant at SNCG site

Project History:
- BE Contract Signed: July 2011
- Start of Construction: June 2012
- First MeOH feed in: August 2014
- First On-spec Propylene produced: August 2014
- First Operation at 100%: September 2014

3 years, 1 month
Integration Lurgi MegaMethanol® and MTP® plant
Independent plant design

Intermediate Storage

Reforming → Methanol Distillation → Methanol Liquid Grade AA → Methanol Evaporation → DME and MTP Reaction

Methanol Synthesis

Lurgi MegaMethanol® Plant

Purification

MTP® Plant

Steam and Condensate System

Utilities
Conclusion
Conclusion

- MTP® Process mature technology

- MTP® Process offers feedstock independent on purpose propylene production

- Integration with Lurgi Megamethanol® Technology reduces CAPEX and OPEX
End of presentation
Thank you for your attention