The methanol-to-propylene (MTP) process converts methanol to propylene. Methanol is distilled in a first reactor, known as a distal-ether (DAW) reactor, where methanol is converted to DME and water. This stream is fed to another reactor which converts the DME into propylene. This second reactor is the catalytic cracking reactor (MTO) process. Also, the MTP process can deliver LPG and gasoline as byproducts, which is not the case for the MTG technology. One important element of the MTP process is the selective catalyst that is able to convert most of the methanol to propylene. Due to coke formation in the second reaction section, this step is normally executed in three reactors that operate in parallel. The color formation results in carbon losses of less than 2% (Rothaemel, M. et al., 2016). One of them is kept in standby mode to remove the formed coke by introducing air.

The first step reactions of DME production via methanol can be described by the following reaction:

\[ 3 \text{CH}_3\text{OH} \rightarrow \text{CH}_3\text{OCH}_3 + \text{H}_2\text{O} \]

The second step, the conversion of DME to mainly propylene, is described by the following reaction:

\[ \text{CH}_3\text{OCH}_3 \rightarrow 2 \text{CH}_3\text{OH} \]

The product stream is directed to the separation section where water is removed and partially recycled to the reaction section and used as cooling media. After product conditioning, the product stream is directed to fractionation. Then, the product stream is split up into the main product propylene and byproducts LPG, ethylene and gasoline (Jasper, S., El-Halwagi, M. M., 2015 & Zhao, Z. et al., 2020). Polyamide grade propylene (concentration higher than 99.5 mol%) can be produced via this technology (Rothaemel, M. et al., 2016).

In the late 1990s, the development of the so-called MTP® (methanol-to-propylene) process, a Lurgi Technology by Air Liquide Global E&C Solutions, started. After several tests in pilot scale, a demonstration unit was built with the MTP® technology in Herøya, as a side-stream plant of a glass methanol plant using natural gas as feedstock. The demo unit was operated from January 2002 to April 2004.

The first MTP® plant started up in China in 2010 and two more units followed in line (both a capacity of 470 kta propylene each), their feedstock is coal-based methanol. The MTP® technology is currently being commercialized and other plants with the Lurgi technology were constructed worldwide (Rothaemel, M. et al., 2010).

The global propylene industry is expected to expand with the construction of many MTP plants in China. Globally there are currently 19 MTP plants, most of which are situated in China, which use methanol feedstock derived from domestically available coal. Since China has one of the largest coal reserves in the world, producers can readily obtain coal for propylene production. It is forecasted that China will build 13 more MTP plants in the next five years (Recycling Portal, 2018). However, the methanol feedstock can come from renewable sources, such as biogas and green electricity via electrolysis. Regardless of the source of methanol, the MTP process keeps the same configuration.

The global capacity potential was calculated assuming that the 19 MTP plants mentioned present an average capacity of around 500 kta.

<table>
<thead>
<tr>
<th>Energy carrier (per unit of main output)</th>
<th>Energy carrier (per unit of main output)</th>
<th>Energy carrier (per unit of main output)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>Methanol</td>
<td>Methanol</td>
</tr>
<tr>
<td>LPG</td>
<td>LPG</td>
<td>LPG</td>
</tr>
<tr>
<td>Power</td>
<td>Power</td>
<td>Power</td>
</tr>
<tr>
<td>Heat</td>
<td>Heat</td>
<td>Heat</td>
</tr>
<tr>
<td>Electricity</td>
<td>Electricity</td>
<td>Electricity</td>
</tr>
<tr>
<td>LPG</td>
<td>LPG</td>
<td>LPG</td>
</tr>
</tbody>
</table>

The energy and exergy balances are based on Rothaemel, M. et al. (2016) and Zhao, Z. et al. (2020). They represent a 470 kta propylene plant. The losses via coke formation were considered to be around 0.5% of the total methanol input.

**TECHNICAL DIMENSIONS**

- **Potential**: 570.00 kton/year
- **Market share**: 9.500.00%
- **Capacity utilization factor**: 0.91
- **Full load running hours per year**: 20,000
- **Technological lifetime (years)**: 20.00

**COSTS**

- **F.O.R. per Euro**: 2015
  - **Investment costs**: 2015
    - Min: 0.56
    - Average: 0.56
    - Max: 0.56
    - Min: 0.56
    - Average: 0.56
    - Max: 0.56
    - Min: 0.56
    - Average: 0.56
    - Max: 0.56
- **Other costs per year**: 2015
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
- **Fixed operational costs per year (incl. fuel costs)**: 2015
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
- **Variable costs per year**: 2015
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56

**ENERGY IN- AND OUTPUTS**

- **Electricity**: 256.32 Min: 0.99
- **Fuel gas**: 246.22 Max: 0.99
- **Steam**: 13.41 Min: 0.99
- **LPG**: 5.12 Max: 0.99

**MATERIAL FLOWS**

- **Material Flow**: 2015
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56

**MATERIAL FLOWS (OPTIONAL)**

- **Material Flow**: 2015
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
  - Min: 0.56
  - Average: 0.56
  - Max: 0.56
<table>
<thead>
<tr>
<th>Substance</th>
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<tbody>
<tr>
<td>CO2</td>
<td>kton</td>
<td>0.05−0.05</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
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<td></td>
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<td>Min</td>
<td>Max</td>
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<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
</tbody>
</table>

**Emissions explanation**
Emissions consider coke burning for the reactor regeneration. It was calculated based on the ratio between coke and propylene formed, which is around 0.017-0.018 t coke/t propylene (considering carbon losses of 0.5%wt and both sources for the process material yields: Rothaemel, M. et al. (2016) and Zhao, Z et al. (2020)). The emission factor of coke and its LHV value were considered to be 106.8 kg CO2/MJ and 28.5 MJ/kg, respectively (RVO, 2017). The value reflects the CO2 emissions per kton of propylene produced. The utilities production emissions are outside the scope of this factsheet.

**REFERENCES AND SOURCES**
- Recycling portal website (2018). China will continue to lead global propylene capacity growth through 2026. https://recyclingportal.eu/Archive/42837, 2018
- Recycling portal website (2018). China will continue to lead global propylene capacity growth through 2026. https://recyclingportal.eu/Archive/42837, 2018

**RVO (2017). Nederlandse lijst van energiedragers en standaard CO2 emissiefactoren, versie januari 2017**