China Methanol to Olefin (MTO) Technology & Industrialization Progress

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1. MTO technology background
2. MTO Development Progress
3. MTO Commercial Plants
4. Overseas Market Prospect
Content

1. MTO technology background
2. MTO Development Progress
3. MTO Commercial Plants
4. Overseas Market Prospect
Olefins are the base for modern chemical industry
Methanol is a bridge connecting coal chemical and petrochemical industries.

\[ \text{C}_2\text{H}_4 \quad \text{C}_3\text{H}_6 \]

- Naphtha
- Ethane, Propane
- Coal, Natural Gas
- Syngas
- Methanol

\[ >800^\circ\text{C}, \text{H}_2\text{O}, \text{C}_2= + \text{C}_3= \quad \text{Yield} \sim 45\% \]

\[ >800^\circ\text{C}, +\text{H}_2\text{O} \]

Mature Technology

MTO

MTP
SYN Overview

- Demo plant was successful
- SYN Energy Technology Co., Ltd
- License DMTO globally

- DMTO-II Commercial Plant
- Overseas Business Department

- Demonstration
- Baotou DMTO plant

- In 2004
- In 2006
- In 2010
- In 2014
Content

1. MTO technology background
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DMTO Technical process

Methanol consumption for 1 ton olefin is 2.96 ton
ethylene and propylene selectivity $\sim 80\%$
DMTO-II Technical process

Methanol consumption for 1 ton olefin is 2.6~2.7t

Methanol 1800 kt/a

Fuel gas 58.3 kt/a

Ethylene 328 kt/a

Propylene 351 kt/a

C_4 11.3 kt/a

C_5^+ 4 kt/a

Ethylene and propylene selectivity 85-90%

Methanol consumption for 1 ton olefin is 2.6~2.7t

1800 kt/a

CO, CO_2

Reactor

Regenerator

Cracking reactor

Compressor

Depropanizer

Quench & scrubbing

Water

C_4^+

280.58 kt/a
DMTO-III Technical process

- New generation DMTO catalyst
- Methanol treatment capacity: 3000 kta
- Olefins output: ~1100 kta

~2.6 tons MeOH → 1 ton Olefin
Selectivity of Ethylene and Propylene ~90%
Advanced technology-DMTO IP Right

- DMTO filed patent applications and was granted in China and overseas markets.
  - Applied 167 patents in China and 77 granted
  - 24 patents in PCT, 75 patents applied overseas and 11 granted
- SYN licensed the DMTO process worldwide.
DICP first demonstrated good performance of SAPO-34 molecular sieve catalysts in MTO reaction.

A precise development process to ensure the liability and safety of DMTO technology

Pilot Test
- Methanol Feeding: ~120 kg/d
- Gas velocity: ~20 cm/s
- Bed type: bubbling

Industrial Demo
- Methanol Feeding: ~50,000 kg/d
- Gas velocity: ~1 m/s
- Bed type: bubbling

DMTO Commercial Plant
- Methanol Feeding: ~5,500,000 kg/d
- Gas velocity: ~1-1.5 m/s
- Bed type: turbulent

DMTO II Commercial Plant
- Methanol Feeding: ~5,500,000 kg/d
- Gas velocity: ~1-1.5 m/s
- Bed type: turbulent
Stability of catalyst supply

Chia Tai energy material Dalian Co., Ltd

Commissioned in 2008, production capability is 7500 tons per year.

UCC first invented SAPOs in 1982 (USP4440871)

DICP first demonstrated good performance of SAPO-34 in MTO reaction
Largest Market Share

Licensors of MTO or MTP in the China Market

<table>
<thead>
<tr>
<th>Licensor</th>
<th>No. of Contracted Plants</th>
<th>Olefin capacity/MMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYN/LPEC DMTO</td>
<td>20</td>
<td>11.26</td>
</tr>
<tr>
<td>Sinopec SMTO</td>
<td>5</td>
<td>3.2</td>
</tr>
<tr>
<td>UOP-Total MTO</td>
<td>5</td>
<td>2.3</td>
</tr>
<tr>
<td>Lurgi MTP</td>
<td>3</td>
<td>1.4</td>
</tr>
<tr>
<td>FMTP</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td><strong>18.36</strong></td>
</tr>
</tbody>
</table>

- **DMTO, 61%**
- **SMTO, 17%**
- **UOP-Total, 13%**
- **Lurgi MTP, 8%**
- **FMTP, 1%**
Table 1: Number of contracted plants and total olefin capacity of different licensors

<table>
<thead>
<tr>
<th>Licensor</th>
<th>SYN/LPEC-DMTO</th>
<th>UOP/Hydro-MTO</th>
<th>Sinopec-MTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Plant Number</td>
<td>20</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total Olefin capacity (million ton/a)</td>
<td>11.26</td>
<td>2.3</td>
<td>3.2</td>
</tr>
<tr>
<td>Market Share</td>
<td>67%</td>
<td>14%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Table 2: Number of commercial MTO plants currently in operation and olefin capacity of different licensors (up to August 2016)

<table>
<thead>
<tr>
<th>Licensor</th>
<th>SYN/LPEC-DMTO</th>
<th>UOP/Hydro-MTO</th>
<th>Sinopec-MTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Plants Number</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total olefin capacity (million ton/a)</td>
<td>5.8</td>
<td>0.585</td>
<td>0.2</td>
</tr>
<tr>
<td>Market Share</td>
<td>88%</td>
<td>9%</td>
<td>3%</td>
</tr>
<tr>
<td>No.</td>
<td>Project</td>
<td>Methanol (kta)</td>
<td>Olefin (kta)</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------</td>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1</td>
<td>Shenhua (Baotou)</td>
<td>1800</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>Sinopec Zhongyuan Petroleum(Puyang)</td>
<td>600</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Fund Energy (Ningbo)</td>
<td>1800</td>
<td>667</td>
</tr>
<tr>
<td>4</td>
<td>Wison(Nanjing)</td>
<td>800</td>
<td>295</td>
</tr>
<tr>
<td>5</td>
<td>Yanchang Group(Jingbian)</td>
<td>1800</td>
<td>600</td>
</tr>
<tr>
<td>6</td>
<td>China Coal (Yulin)</td>
<td>1800</td>
<td>600</td>
</tr>
<tr>
<td>7</td>
<td>Baofeng Energy (Ningxia)</td>
<td>1800</td>
<td>600</td>
</tr>
<tr>
<td>8</td>
<td>Shenda Chemicals (Shandong)</td>
<td>1000</td>
<td>330</td>
</tr>
<tr>
<td>9</td>
<td>PCEC(Shaanxi)</td>
<td>1800</td>
<td>680</td>
</tr>
<tr>
<td>10</td>
<td>Zhejiang Xingxing(Jiaxing)</td>
<td>1800</td>
<td>690</td>
</tr>
<tr>
<td>11</td>
<td>Shandong Yangmeng Hengtong</td>
<td>800</td>
<td>290</td>
</tr>
<tr>
<td>12</td>
<td>Shenhua (Yulin)</td>
<td>1800</td>
<td>600</td>
</tr>
<tr>
<td>13</td>
<td>ChinaCoal Mengda (Inner Mongolia)</td>
<td>1800</td>
<td>600</td>
</tr>
</tbody>
</table>

**Light olefins produced from DMTO account for 88%.**
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CTO&MTO Reference Plants with DMTO in China
(20 commercial plants with 11.26 million olefin capacity)

- Baofeng Energy (Inner Mongolia) 600 kta
- Shenhua (Baotou) 600 kta
- Chinacoal Mengda (Inner Mongolia) 600 kta
- Shanxi Coking Group (Shanxi) 600 kta
- Shenda Chemicals (Shandong) 330 kta
- Fund Energy (Changzhou) 330 kta
- Zhejiang Xing Xing (Jiaxing) 600 kta
- Fund Energy (Ningbo) 600 kta
- Henan zhongke (Henan) 600 kta

**Shaanxi:**
- Shenhua (Yulin) 600 kta
- Chinacoal (Yulin) 600 kta*2
- Yanchang Petroleum (Jingbian) 600 kta
- Yanchang Petroleum (Yan'an) 600 kta
- PCEC (Pucheng) 680 kta

**Qinghai:**
- Qinghai Damei (Qinghai) 600 kta
- Qinghai Yanhu (Qinghai) 330 kta
- Qinghai Mining (Qinghai) 600 kta

**Huahong huijin (Gansu):**
- 600 kta

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*Note: kta stands for thousand tons of olefins.*
DMTO Commercialization Progress

First unit
Shenhua (Baotou)

2007
60/0
2 units

2008
120/0
3 units

2009
153/0
8 units

2010
433/60
13 units

2011
733/60
18 units

2012
1006/60
20 units

2013
1126/120
20 units

2014
1126/406
20 units

2015
1126/535
20 units

2016
1126+/595+
20 units

First CTO plant in the world
Shenhua (Baotou)

First MTO plant in the world
Fund Energy (Ningbo)

1 MTO plant started up
China Coal Mengda (Inner Mongolia)

2 MTO plants started up:
Zhejiang Xingxing (Jiaxing),
Shenhua (Yulin)

3 CTO plants started up:
Yanchang Petroleum Group (Jingbian),
China Coal (Yulin),
Baofeng Energy (Ningxia),
PCEC (DMTO II).

1 MTO plant started up
Shenda Chemicals (Shandong),

Licensed project

Olefin Capacity (10kta)
Contract Capacity/on stream
# CTO & MTO Plants with DMTO Process

<table>
<thead>
<tr>
<th>Reference Plants</th>
<th>Methanol (kta)</th>
<th>Olefin (kta)</th>
<th>Start-up</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CTO Project</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Shenhua (Baotou)</td>
<td>1800</td>
<td>600</td>
<td>2010.8</td>
<td>DMTO</td>
</tr>
<tr>
<td>2 Yanchang Group (Jingbian)</td>
<td>1800</td>
<td>600</td>
<td>2014.6</td>
<td>DMTO</td>
</tr>
<tr>
<td>3 China Coal (Yulin)</td>
<td>1800</td>
<td>600</td>
<td>2014.7</td>
<td>DMTO+OCU</td>
</tr>
<tr>
<td>4 Baofeng Energy (Ningxia)</td>
<td>1800</td>
<td>600</td>
<td>2014.10</td>
<td>DMTO</td>
</tr>
<tr>
<td>5 PCEC (Shaanxi)</td>
<td>1800</td>
<td>680</td>
<td>2014.12</td>
<td>DMTO-II</td>
</tr>
<tr>
<td><strong>MTO Project</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Fund Energy (Ningbo)</td>
<td>1800</td>
<td>667</td>
<td>2013.1</td>
<td>DMTO+OCU</td>
</tr>
<tr>
<td>2 Shenda Chemicals (Shandong)</td>
<td>1000</td>
<td>330</td>
<td>2014.11</td>
<td>DMTO</td>
</tr>
<tr>
<td>3 Zhejiang Xinxing (Jiaxing)</td>
<td>1800</td>
<td>690</td>
<td>2015.4</td>
<td>DMTO+OCU</td>
</tr>
<tr>
<td>4 Shenhua (Yulin)</td>
<td>1800</td>
<td>600</td>
<td>2015.12</td>
<td>DMTO</td>
</tr>
<tr>
<td>5 China Coal (Inner Mongolia)</td>
<td>1800</td>
<td>600</td>
<td>2016.4.15</td>
<td>DMTO</td>
</tr>
<tr>
<td><strong>Total Capacity</strong></td>
<td>17200</td>
<td>5967</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
World first coal-to-olefin plant in Baotou of China Shenhua Group

Scale: 1,800 KTA Methanol → 600 KTA polyolefin
Approved by NDRC (Dec, 2006)
Construction was finished on May 31, 2010
Have been started operation from 8th, August, 2010
# Shenhua Baotou CTO Plant

<table>
<thead>
<tr>
<th>Time</th>
<th>Polyolefin Production (kta)</th>
<th>Operating Income (×100 million RMB)</th>
<th>Profit (×100 million RMB)</th>
<th>Taxes (×100 million RMB)</th>
<th>Profit &amp; Taxes (×100 million RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug-Dec, in 2010</td>
<td>8.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>502</td>
<td>56.42</td>
<td>9.92</td>
<td>8.00</td>
<td>17.92</td>
</tr>
<tr>
<td>2012</td>
<td>546.7</td>
<td>59.1</td>
<td>9.50</td>
<td>7.66</td>
<td>17.16</td>
</tr>
<tr>
<td>2013</td>
<td>545</td>
<td>59.9</td>
<td>11.0</td>
<td>8.2</td>
<td>19.2</td>
</tr>
<tr>
<td>2014</td>
<td>525</td>
<td>58.8</td>
<td>11.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>623.8</td>
<td>53.11</td>
<td>3.18</td>
<td>7.63</td>
<td>10.81</td>
</tr>
</tbody>
</table>
MTO through outsourcing methanol, total investment 6.7 billion RMB.

- In 2010.2, DMTO license contract was signed.
- In 2010.12, DMTO Process Package completed.
- In 2012.12, DMTO Plant construction completed.

- On 2013.1.28, DMTO plant start up successful.
- On 2013.2.3, polymer grade ethylene and polymer grade propylene were produced.
- From 2013.4.1, DMTO plant began running at full-load.
In 2013, methanol price was relatively high. (3100-3300 RMB/Ton)
- DMTO plant operation load was 97%.
- Olefin output was 491,000 ton.
- Net profit was 430 million RMB.

In 2014, oil price and olefin price both declined.
- DMTO plant ran 338 days with operation load of 103.2%.
- Olefin output was 651,000 ton.
- Net profit was 404 million RMB.

In 2015
- DMTO plant ran 320 days on 97.1% operation load
- Sales revenue was 530 million RMB.
DMTO commercial plants

China Coal (Yulian)

Baofeng Energy (Ningxia)

Shenda Chemicals (Shandong)

PCEC (Pucheng)

Yanchang Petroleum (Jingbian)

Shenhua (Yulian)

Zhejiang Xingxing (Jiaxing)

China Coal Mengda (Inner Mongolia)
### MTO plants (to be started up in 2016 and later)

<table>
<thead>
<tr>
<th>No.</th>
<th>Project</th>
<th>Methanol (kta)</th>
<th>Olefin (kta)</th>
<th>Start-up time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Qinghai Yanhua (Qinghai)</td>
<td>1000</td>
<td>330</td>
<td>2016</td>
</tr>
<tr>
<td>2</td>
<td>Fund Energy (Changzhou)</td>
<td>1000</td>
<td>330</td>
<td>2016–2017</td>
</tr>
<tr>
<td>3</td>
<td>Qinghai Damei (Qinghai)</td>
<td>1800</td>
<td>600</td>
<td>2017</td>
</tr>
<tr>
<td>4</td>
<td>Qinghai Mining (Qinghai)</td>
<td>1800</td>
<td>600</td>
<td>2017</td>
</tr>
<tr>
<td>5</td>
<td>Huahong huijin</td>
<td>1800</td>
<td>600</td>
<td>2018</td>
</tr>
<tr>
<td>6</td>
<td>Yanchang Petroleum (Yan’an)</td>
<td>1800</td>
<td>600</td>
<td>2018</td>
</tr>
<tr>
<td>7</td>
<td>Shanxi Coking Group (Shanxi)</td>
<td>1800</td>
<td>600</td>
<td>2018</td>
</tr>
<tr>
<td>8</td>
<td>Baofeng Energy (Inner Mongolia)</td>
<td>1800</td>
<td>600</td>
<td>After 2018</td>
</tr>
<tr>
<td>9</td>
<td>Henan Zhongke (Henan)</td>
<td>1800</td>
<td>600</td>
<td>After 2018</td>
</tr>
<tr>
<td>10</td>
<td>China Coal (Yulin) Phase II</td>
<td>1800</td>
<td>600</td>
<td>After 2018</td>
</tr>
<tr>
<td></td>
<td><strong>Total (kta)</strong></td>
<td><strong>16400</strong></td>
<td><strong>5460</strong></td>
<td></td>
</tr>
</tbody>
</table>
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DMTO technology is advanced, well-proven, convincingly-reliable, and could bring a considerable economic profit for the project owner. We are looking for potential customers, and are able to provide license, PDP, Engineering Design and Technical Service to all the global customers.
Natural Gas-Methanol-Olefin Value Chain

Build DMTO plant outside China based on overseas methanol.

- Exporting methanol will suffer greater price competition.
- 3 ton methanol to 1 ton olefin, lower freight rate.
Thank you for your attention