Coal & Natural Gas Chemicals

Tecnon OrbiChem Marketing Seminar at APIC 2014
Pattaya, 15 May 2014

Gillian Tweddle
APIC 2014
NATURAL GAS, CRUDE OIL & COAL PRICES

$/mmBtu

Source: Tecnon OrbiChem
APIC 2014
METHANOL CONTRACT vs BRENT, HENRY HUB GAS & COAL PRICES

Dollars per Ton

Source: Tecnon OrbiChem
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NATURAL GAS-BASED SYNTHESIS GAS AND METHANOL PRODUCTION

Natural Gas

De-Sulphuriser

Steam Reformer

H₂ Rich Syngas

Methanol Synthesis

Methanol

Steam

CO₂

Source: Tecnon OrbiChem
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**COAL-BASED SYNTHESIS GAS TO METHANOL PRODUCTION**

- **ASU**
  - Oxygen
  - **Gasifier**
  - **Shift**
    - H₂ Lean Syngas
    - H₂ Rich Syngas
  - **Co-Product Processing**
    - Pure Syngas
    - CO₂ (to sequestration?)
    - Tail Gas
    - Hydrogen
    - **PSA**
      - Hydrogen
  - **Separation**
    - Ammonia
    - Phenolics
  - **Claus Unit**
    - Sulphur
  - **Methanol Synthesis**

Source: Tecnon OrbiChem
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CHEMICALS FROM COAL

Coal
- Calcium Carbide
  - Acetylene
    - BDO
    - VCM & PVC
  - Methanol
- Syngas
  - Ammonia
  - Oxalate
  - Fischer - Tropsch
    - Fuels & Chemicals
- Crude Methanol
  - Formaldehyde
  - Methanol
  - DME
  - MTBE
  - MTO
  - MTP
- Fertilisers
  - MEG
- Ethylene
- Propylene

Source: Tecnon OrbiChem
METHANE TO METHANOL TO ACETIC ACID

Source: Tecnon OrbiChem
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ACETIC ACID PRODUCTION COSTS - US vs CHINA

Dollars per Ton

Source: Tecnon OrbiChem
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WORLD ACETIC ACID CAPACITY vs DEMAND

1,000 Metric Tons

Capacity to produce (90% utilisation)
Growth 3.9%
Capacity to produce (80% utilisation)
Growth 6.8% pa
Forecast Growth 4.2% pa

Annual Acetic Acid Consumption

Source: Tecnon OrbiChem
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**GLOBAL METHANOL DEMAND BY END-USE**

- **Other**: 21%
- **Biodiesel**: 4%
- **MTO**: 4%
- **Fuel Blending**: 12%
- **DME**: 7%
- **MTBE**: 11%
- **Acetic Acid**: 11%
- **Formaldehyde**: 30%

2013 Total 58-60 Million Tons

*Source: Tecnon OrbiChem*
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CHINA METHANOL DEMAND BY END-USE

2013 Total
26-28 Million Tons

2020 Total
>70 Million Tons

Source: Tecnon OrbiChem
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METHANOL-TO-PROPYLENE - LURGI MTP® PROCESS

3.8 Mio Nm³/d
48 Mio mmBtu/a
Natural Gas

12.3 Mio Nm³/d
Syngas

1.7 Mt/a
Methanol

0.47 Mt/a
Propylene

143,000 t/a
Gasoline

936,000 t/a
Water

Source: Lurgi GmbH
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**FEEDSTOCK REQUIREMENTS FOR MTP®**

**Natural Gas**
2600 m$^3$ = 100 mmBtu

- or -

**Methanol**
3.5 tons

**Coal**
9.15 tons total
(6.25 tons feedstock + 2.90 tons fuel)

- or -

**Propylene**
1 ton

Source: Tecnon OrbiChem
MTP not viable using MeOH at international prices
Crude Methanol
1.667 x 10^6 t/a = 5000 t/d

DME Pre-Reactor

Three-Stage Adiabatic Reactor

Product Conditioning

Fuel Gas 15,000 t/a

Propylene 470,000 t/a

LPG 54,000 t/a

Gasoline 143,000 t/a

Water 936,000 t/a

Water Recycle

Olefin Recycle

Source: Lurgi GmbH
Datang International
- 1800 ktpa methanol from coal
- 470 ktpa MTP propylene (Lurgi)
- 456 ktpa polypropylene (Dow Unipol)
- Location: Xilinguole, Inner Mongolia, China
- Operating at 50-60% of capacity

Shenhua Ningxia Coal Industrial Group
- 1670 ktpa methanol (Lurgi)
- 470 ktpa MTP propylene (Lurgi)
- 500 ktpa polypropylene (Lummus Novolen)
- Location: Ningdong, Ningxia province, China
- Start-up: MTP Sept 2010, polypropylene Q4 2010
- Generally operating at 70-80% capacity

Source: Tecnon OrbiChem
OUTPUT FROM a UOP/Hydro MTO PLANT
Configured for 1:1 Ethylene : Propylene Ratio

INPUT
Natural gas (2.1 x 10^9 m^3) 1515
Methanol 2358

OUTPUT
Ethylene 400
Propylene 400
Butenes 123
C_5+ hydrocarbons 46
Fuel gas 40
Other (water, COx, coke) 1349
Total 2358

Source: UOP
Similar to refinery/FCC equipment

Similar to naphtha cracker equipment

Source: UOP
MTP not viable using MeOH at international prices
**Shenhua Baotou Coal to Liquid and Chemical**
- GE gasification
- 1800 ktpa methanol, needing 3450 ktpa coal feedstock
- 600 ktpa DMTO (SYN (Dalian Institute of Chemical Physics) + Lummus)
- 300 ktpa ethylene, 300 ktpa propylene
- 300 ktpa polyethylene (Univation)
- 300 ktpa polypropylene (Dow Unipol)
- Location: Baotou, Inner Mongolia, China
- Start-up: August 2010 all units

**Sinopec Zhongyuan Petrochemical**
- 600 ktpa SMTO (Sinopec Beijing Yanshan Petrochemical); methanol bought
- 200 ktpa ethylene, 100 ktpa propylene
- 200 ktpa polyethylene, 100 ktpa polypropylene
- Existing 180 ktpa ethylene cracker and 60 ktpa polypropylene cannibalised
- Location: Puyang, Henan province, China
- Start-up: 2012

Source: Tecnon OrbiChem
**Ningbo Heyuan Chemical**
- 1800 ktpa methanol consumption
- 600 ktpa DMTO [SYN + Lummus]]
- OCT Olefins conversion 90 ktpa propylene [Lummus]
- 300 ktpa polypropylene
- Location: Ningbo, China
- Start-up Jan 2013

**Wison (Nanjing) Clean Energy**
- 900 ktpa methanol consumption
- 300 ktpa MTO [UOP]
- Location: Nanjing, China
- Start-up 2014

Source: Tecnon OrbiChem
# APIC 2014

## CTO / MTO / MTP PROJECTS 2014 - 2015

<table>
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<tr>
<th>Company</th>
<th>Location</th>
<th>Details</th>
<th>Capacity (ktpa)</th>
<th>Start-Up</th>
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<td>Pucheng Clean Energy</td>
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Source: Tecnon OrbiChem
• Methanol has considerable potential to act as a new feedstock for olefins.
• There is considerable potential for Methanol-to-Propylene plants, with two pioneering MTP® plants having come on stream in China in Q2/Q3 2010.
• Faster growth for propylene than ethylene demand, together with moves to lighter feedstocks for ethylene crackers, mean that alternative routes to propylene are needed.
• Methanol-to-olefin processes, which produce both ethylene and propylene, and especially the Advanced MTO process, offer even higher conversion of methanol to olefins. Four MTO plants already on line in China.
• Coal is the feedstock being used for the MTP and MTO plants in China. Some future plants will use imported methanol.
• Elsewhere natural gas is likely to be preferred; economics are very healthy where the natural gas is “stranded” and therefore cheap, but as the gap between natural gas and crude oil pricing has widened, even some non-stranded gas supplies are looking attractive.
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