China Methanol Industry: Story of Coal and MTO

Prepared for

IMPCA Methanol Conference
Singapore
Nov 1st – 3rd, 2016

By:
James Xie
Consultant (MMSA)
Today’s Takeaway points

• China methanol markets are driven by coal. “Capacity Reduction Campaign”, and summer power generation demand help coal prices rebound, pushing up the cash cost of methanol.
  – Coal based methanol dominates supply in China, as marginal producer, supported by stranded coal inland China.
  – Natural gas restriction will limit the production in this sector, unlike natural gas based US production.
  – Coke oven gas output is subject to coking plant operation.

• China is becoming self sufficient. Domestic production will increase. China coastal MTO will rely heavily on Import, as methanol demand remains apart from supply.
  – China methanol should stay mostly in China.
  – China 2014 additions were last of merchant wave, record production continues. New MTO capacity in Shaanxi, Inner Mongolia and Shandong limits the trade flow from inland to coastal.
  – China coastal MTO will rely heavily on Imports, although US – China “methanol bridge” not ready until ‘18 earliest.

• Demand for methanol driven by “energy intermediate”, even after crude correction. Upcoming MTO startup end 2016/early 2017 will create increment demand.
  – Traditional derivatives like formaldehyde still play an important role in methanol demand and pricing.
  – Use as “energy intermediate” supported by “low coal, high natural gas, high crude” economics. Gasoline Blending, and MTG gaining interest.
  – MTO blossom, but production economics is challenged, increasing pricing volatility.

• Global prices and margins remain connected, and methanol must stay affordable in China energy applications over time. The outages in Atlantic basin limited trade flow from America to China, supporting the methanol prices in the 4Q. Delayed Startup upset China balance.
  – Affordability in China energy applications required.
  – Economic feasibility for China coal based production required.
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  - Dedicated Consultants with over 62 years of Methanol industry experience: Singapore, Shanghai, Frankfurt, Seattle

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  - Methanol Notes™
    - Topics of relevance in brief, weekly
  - MMSA Weekly Methanol Analysis
    - Global market analysis and price assessment every Friday Singapore time
  - China Monthly Methanol Analysis (CMMA)

- Project Services
  - Market and Technical Due Diligence Support
  - Bankable Project Assessments, Valuation

- IMPCA Asian Conference – Singapore Nov 1 – 3, ‘16

- Methanol Policy, Technology Congress – Frankfurt Nov 29th - Dec 1st, ‘16

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China Methanol Capacity-Driven by Coal

- Coal based production benefits from competitively priced and abundant coal
  Long term, slowed coal demand in Iron & Steel, power generation favoring coal chemicals production.
  Short term 276 policy push up coal prices.
- Limited natural gas based production is high cost
  Natural gas policy prohibits new natgas based methanol projects
- Coking gas based production small but can be competitive.
- Limited new capacity in the forecast period.
China Methanol Capacity-”276 policy” pushed up Coal prices, lifting the floor prices of methanol

- The “capacity reduction Campaign” 276 policy by Chinese government, therefore coal market supply remains tight.
- The weather start to cool down, hopefully coal demand will drop, which may slow down the upward trend of coal prices.
- Overall this pushed up the floor price of methanol
China Methanol Capacity—"276 policy" pushed up coal prices, lifting the floor prices of methanol.

- Methanol floor cost increased, explaining the need for recent Chinese methanol price hikes.
China methanol production relies on coal

- The dominance of the inland coal based provinces in methanol production is clear.
- Methanol production from natural gas remains impacted by high natural gas costs and diversions of gas to residential customers, as set by the China Natural Gas Policy.
China Coastal Methanol Demand is growing on MTO startup - Methanol demand remains apart from Supply

- China methanol demand remains apart from supply.
- Trade flow from Northwest China to coastal areas shrank, and intercepted on limited merchant capacity and inland MTO startups, Mengda (600 ktpa), and Shenhua Yulin (600 ktpa). Arbitrage window from Northwest to East China closed. China needs more import.
- Logistics bottleneck, Long lead time and high logistics costs increase price volatility.
China domestic trade flow shrinking on inland MTO startup; China needs more import

- China methanol demand remains apart from supply.
- Trade flow from Northwest China to coastal areas shrank, and intercepted on limited merchant capacity and inland MTO startups, Mengda (600 ktpa), and Shenhua Yulin (600 ktpa). Arbitrage window from Northwest to East China closed. China needs more import.

Trade Flow Northwest China - Coastal

2014: 3 million tons
2015: 1.3 million tons
2016: 0.5 million tons? Almost 0!

Mengda MTO (600 ktpa) early 2016
Shenhua Yulin MTO (600 ktpa) 2015 Nov
Shenda MTO (400 ktpa) 2014 Oct
Fude Changzhou MTO (300 ktpa) end 2016

$105/mt
$100/mt
$50/mt

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Arbitrage Window from Northwest China to East China Closed

Chinese Methanol Prices
Arbitrage window from Northwest China to East China closed

- Northwest China
- East China
- Price Gap

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Methanol markets are driven by Chinese behavior

- Most production on competitively priced coal, as marginal producer
- Use as an “energy intermediate” supported by “low coal, natural gas, high crude” economics
- MTO, gasoline blends in China today.
- Both local production and imports have to increase to meet the growing demand.
China coal based producers have to increase operation rates, as Natural gas and Coking gas based production limited.

- Coal based production will increase operation rates, on competitively priced coal.
  - Major coal based facilities continue to operate on positive production economics, thanks to the competitive coal.
  - Economics challenged by recent price rise.
  - Long process including coal preparation, blending, slurry preparation to synthesis remains obstacle, increasing the vulnerability of sustainable production.

- Natural gas based production remains limited, impacted by high natural gas costs and diversions of gas to residential customers, set by China Natural Gas Policy.
  - China natural gas price remains high, even after the NDRC adjusted the prices, forcing more natural gas based production idled at negative production economics, except those with integrated gas fields.
  - Facilities in North China typically shut down during winter season for up to 5 months for diversions of gas to residential customers
  - Only the natural gas integrated capacity are running, which takes up around 30% of total capacity.

- Coke Oven Gas based production benefit from the cheap coking gas, but operations are subject to availability of feedstock
  - Coking plant operation had stayed at around 60 percent consistently, due to a slowdown of steel demand in China
Where does import come from - China future additions are integrated, merchant projects are mostly in Iran and US, with delayed Iran and USGC startup upset China balance

Supply Capacity for Methanol by Region
2011 - 2021E

Taken from MMSA Methanol and Derivatives Analysis (MDA)
2013, 2014, 2015 Methanol Trade Flow
(Bubble Size Proportional to Capacity to Produce Methanol)

Taken from MMSA Methanol and Derivatives Analysis (MDA)

* Americas Supply  * Persian Gulf Supply  * Other Supply

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China Methanol markets are driven by MTO and other alternate fuel

- Traditional derivatives recovering from financial crisis but mostly track GDP.
- MTO, gasoline blends in China dominates demand growth.
Prices Drivers, and Margins

• Ceiling Prices set by derivative affordability
  – DME used to be the “marginal buyer” of product, but vanishing on low LPG demand. DME economics related to crude via LPG link
  – MTO increasingly important, and replaced DME as marginal end-user.

• Floor prices set by marginal producers
  – Firmly located in China, based on coal feed
  – Hiking coal prices raised floor prices of methanol. Coal economics are less directly related to crude

• Short term, Prices increase may continue on the higher floor prices amid Chinese hiking coal prices, the global outages, delayed startup of new methanol in Iran and US, and new MTO startups in China.

• Longer term, the startup of new merchant MTO projects, and pull from energy demand will underpin market. Restart of methanol and new methanol capacity should moderate price increase.
MTO will increase Methanol Pricing volatility

Methanol Volume vs. Value - China
Late September '16

Average Price for East China, Ex-Tank, Average September '16; 1 USD = 6.67 CNY

Average Price for East China, Ex-Tank, Average August '16; 1 USD = 6.64 CNY

Cumulative Consumption of MeOH in China, 2016E (Oct '16 Update), 000 tons, Select

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Methanol Derivatives Prices - Bottoming out…

Chinese Methanol and Derivative Prices

- Methanol
- DME
- Formaldehyde
- MTBE
- Gasoline
- Acetic Acid

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Methanol prices vs. Cyclic Formaldehyde—a Slower Than Expected Seasonal Recovery

Methanol prices used to track cyclic formaldehyde production, but now correlation become weaker.
Prices Floor - set by Marginal producer
Elevated by hiking coal prices amid “276 policy”

MeOH Delivered Cash Cost - Early October 2016
Coastal China Main Ports, 2016 Net Available Capacity*

- China Adjusted Import Prices (Sep’16, CFR plus duty, throughput)
- China Adjusted Domestic Prices (Sep’16, Avg East/South China less VAT)

2016E China Demand (Oct’16 Update)
China MTO blossom – Upcoming MTO startup end 2016/early 2017 created increment demand, although production economics remains challenged.

### Methanol-To-Olefins (MTO) Projects

#### Integrated Projects:

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Methanol (mtpa)</th>
<th>Olefin (mtpa)</th>
<th>Start Up</th>
<th>Operation Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheridan Group</td>
<td>Baotou, Inner Mongolia</td>
<td>1.8</td>
<td>0.6</td>
<td>2016 August</td>
<td>Running well. Shut down Sep 4 for 2 month with integrated methanol.</td>
</tr>
<tr>
<td>Shanxi Yuncheng Zhongyu (Chinaoil) Yulin Energy (Energy)</td>
<td>Yulin (Yulin), Shanxi</td>
<td>1.3</td>
<td>0.6</td>
<td>2014 June</td>
<td>Running to plan. Outage 2014 Oct 20th through November and Nov 24th through Nov 28th.</td>
</tr>
<tr>
<td>Shenuai Fushen Clean Energy</td>
<td>Wulai, Shanxi</td>
<td>1.0</td>
<td>0.67</td>
<td>End 2014</td>
<td></td>
</tr>
<tr>
<td>Nengda New Energy</td>
<td>Inner Mongolia</td>
<td>1.8</td>
<td>0.6</td>
<td>2016 April</td>
<td></td>
</tr>
<tr>
<td>Erdos Sarwei Chemical Co. Ltd</td>
<td>Inner Mongolia</td>
<td>0.4</td>
<td>1</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Guangxi Salt Lake Industry Co. Ltd</td>
<td>Guangxi</td>
<td>1</td>
<td>0.33</td>
<td>2016 May</td>
<td></td>
</tr>
<tr>
<td>Shenhua Xinjiang</td>
<td>Guanxi, Xinjiang</td>
<td>1.8</td>
<td>0.68</td>
<td>2016 June</td>
<td>Under construction, 2000tpta PE, 3000tpta PP</td>
</tr>
<tr>
<td>Jingpu &amp; Henan Coal Chemical</td>
<td>Hebi, Henan</td>
<td>1.8</td>
<td>0.6</td>
<td>3Q2016</td>
<td></td>
</tr>
<tr>
<td>Guangxi Pingjiang Huaxin Rd Jin Coal Chemical Co. Ltd</td>
<td>Pingjiang, Guanxi</td>
<td>1.8</td>
<td>0.7</td>
<td>2Q2017</td>
<td></td>
</tr>
<tr>
<td>Total Petrochemical, China Power Investment</td>
<td>Inner Mongolia</td>
<td>1.0</td>
<td></td>
<td>After 2017</td>
<td></td>
</tr>
</tbody>
</table>

#### Non-Integrated Projects:

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Methanol (mtpa)</th>
<th>Olefin (mtpa)</th>
<th>Start Up</th>
<th>Operation Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhonguan Petrochemical (Sinopec)</td>
<td>Puyang, Henan</td>
<td>0.6</td>
<td>0.2</td>
<td>2011 October</td>
<td>Restarted from one-week outage July 2016. Outage 2015 Oct 16 through Nov 7</td>
</tr>
<tr>
<td>Ningbo Fuhe</td>
<td>Ningbo, Zhoushan</td>
<td>1.8</td>
<td>0.6</td>
<td>2012</td>
<td>2012 4Q</td>
</tr>
<tr>
<td>China Wuxi (Chinaoil) Clean Energy</td>
<td>Nanjing, Jiangsu</td>
<td>0.9</td>
<td>0.295</td>
<td>3Q2013</td>
<td>Restarted from 4-5 days outage in Sep. 20-30 maintenance outage. Shut 2015 Sep 18 through 26 to change heat exchanger. Shut down early 2016. Started late August 2014. Reduced to 80 percent on technical issue. Started late November 2014 along with PP and EO. Run at 50 percent until EPA start. Runs at full capacity. Outage 2015 March 3rd-21st. Integrated PP completed construction and commenced commissioning. Running at 70% Commission since July 2015.</td>
</tr>
<tr>
<td>Shandong Yuhai</td>
<td>Dongying, Shandong</td>
<td>0.5</td>
<td>0.1</td>
<td>2014 September</td>
<td>Running to plan. Outage 2015 Mar 3rd-21st. Integrated PP completed construction, and commenced commissioning. Running at 70% Commission since July 2015.</td>
</tr>
<tr>
<td>Shandong Shengda (Legend Holdings)</td>
<td>Zhanzhuang, Shandong</td>
<td>1</td>
<td>0.4</td>
<td>2014 October</td>
<td></td>
</tr>
<tr>
<td>Shandong Xiangji New Energy</td>
<td>Jining, Zhejiang</td>
<td>1.2</td>
<td>0.6</td>
<td>2015 April</td>
<td></td>
</tr>
<tr>
<td>Shandong Taigai Hengtong Chemical Co., Ltd</td>
<td>Linyi, Shandong</td>
<td>0.9</td>
<td>0.295</td>
<td>2015 June 25th</td>
<td></td>
</tr>
<tr>
<td>Shenhua Yulin</td>
<td>Yulin, Shanxi</td>
<td>1.0</td>
<td>0.6</td>
<td>2016 December 15th</td>
<td></td>
</tr>
<tr>
<td>Ningbo Fuhe/DECP Licensor</td>
<td>Changshou, Jiangsu</td>
<td>0.5</td>
<td>0.3</td>
<td>2015 4Q</td>
<td>Delayed to Dec 2016.</td>
</tr>
<tr>
<td>Shanghai Huaxi</td>
<td>Shanghai</td>
<td>0.59</td>
<td>0.18</td>
<td>2016</td>
<td>Completed construction, shut down on economics.</td>
</tr>
<tr>
<td>Shandong Huaxi</td>
<td>Shanghai</td>
<td>0.38</td>
<td>0.12</td>
<td>2016</td>
<td>Completed construction, shut down on economics.</td>
</tr>
<tr>
<td>Lu Shenshi</td>
<td>Shanghai</td>
<td>0.6</td>
<td>0.2</td>
<td>2016</td>
<td>Completed construction, shut down on economics.</td>
</tr>
<tr>
<td>Dehui</td>
<td>Shanghai</td>
<td>9.5</td>
<td>0.5</td>
<td>2016</td>
<td>Completed construction, shut down on economics.</td>
</tr>
<tr>
<td>Better Clean Energy</td>
<td>Shanghai</td>
<td>9.9</td>
<td>0.3</td>
<td>2017</td>
<td>Under construction.</td>
</tr>
<tr>
<td>Jiujiang Energy (Changzhou) Co., Ltd</td>
<td>Liuang, Jiangxi</td>
<td>1.2</td>
<td>0.6</td>
<td>2017 4Q</td>
<td>Phase I 500tpta. Company indicated 2017 70-30k tpta BPA, 150k tpta EO, 200k tpta AA, 50k tpta MMA, 50k tpta EAP, 50k tpta GO.</td>
</tr>
<tr>
<td>China Wuxi (Chinaoil) Clean Energy</td>
<td>Shanghai</td>
<td>1.0</td>
<td>0.3</td>
<td>End 2017</td>
<td>Delayed to end 2017</td>
</tr>
</tbody>
</table>

Operational

<table>
<thead>
<tr>
<th></th>
<th>Integrated</th>
<th>Non-Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>25.9</td>
<td>9.1</td>
</tr>
<tr>
<td>Capacity</td>
<td>5.5</td>
<td>3.1</td>
</tr>
</tbody>
</table>

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China Coastal MTO startup; China needs more import

Trade Flow Northwest China - Coastal

- China methanol demand remains apart from supply.
- Trade flow from Northwest China to coastal areas shrank, and intercepted on limited merchant capacity and inland MTO startups, Mengda (600 ktpa), and Shenhua Yulin (600 ktpa). Arbitrage window from Northwest to East China closed. China needs more import.
MTO production competitiveness—MTO operation consistent, benefiting from integrated derivatives, even amid low crude.

- New CTO/MTO on the way.
- Lower crude forced a lower MTO operation rates, as MTO in the coastal now being challenged by the naphtha based olefin.
- MTO production economics benefit from integrated derivatives production, like PE and PP.
Delays in USGC projects based on several factors (returns, market access most important)

<table>
<thead>
<tr>
<th>Project (Sponsor)</th>
<th>Location</th>
<th>Scale (ktpa)</th>
<th>Start Up Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natgasoline (OCI NV 50%, CEL 50% JV)</td>
<td>Beaumont, TX</td>
<td>1,700</td>
<td>1Q 2018</td>
</tr>
<tr>
<td>Yuhuang Chemical Int</td>
<td>St. James River, LA</td>
<td>1,700</td>
<td>1Q 2020</td>
</tr>
<tr>
<td>Big Lake Fuels LLC</td>
<td>Lake Charles, LA</td>
<td>1,000</td>
<td>1Q 2021</td>
</tr>
<tr>
<td>Valero</td>
<td>St. Charles Parish, LA</td>
<td>1,600</td>
<td>2020+</td>
</tr>
<tr>
<td>Southern Lousiana meOH (ZEEP JV Co.)</td>
<td>LA</td>
<td>1,700</td>
<td>2020+</td>
</tr>
<tr>
<td>Lake Charles Clean Energy (was Leucadia)</td>
<td>Lake Charles, LA</td>
<td>1,000</td>
<td>2020+</td>
</tr>
<tr>
<td>Fairway meOH 2 (Celanese/Mitsui)</td>
<td>Bishop, TX</td>
<td>1,300</td>
<td>2020+</td>
</tr>
<tr>
<td>Northwest Innovations</td>
<td>Clatskanie, OR (Pt of St. Helens)</td>
<td>1,000</td>
<td>TBD</td>
</tr>
<tr>
<td>Northwest Innovations</td>
<td>Port of Kalama, WA</td>
<td>1,000</td>
<td>2020+</td>
</tr>
<tr>
<td>Northwest Innovations</td>
<td>Port of Tacoma, WA</td>
<td>1,000</td>
<td>TBD</td>
</tr>
<tr>
<td>Divide</td>
<td>Mississippi</td>
<td>1,000</td>
<td>TBD</td>
</tr>
<tr>
<td>CCI</td>
<td>TX</td>
<td>1,700</td>
<td>TBD</td>
</tr>
<tr>
<td>Gulf Coast Energy</td>
<td>Pt St Joe</td>
<td>1000</td>
<td>TBD</td>
</tr>
<tr>
<td>Syngas Energy Holdings</td>
<td>St. James Parish, LA</td>
<td>500</td>
<td>TBD</td>
</tr>
<tr>
<td>Zeus</td>
<td>Pt St Joe</td>
<td>1,000</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Global Methanol Prices – Take Direction from China

Global Methanol Pricing

- Delivered Cost Parity Imports to China
- Methanol China Spot, Avg. CFR China Main Ports USD/metric ton
- Methanol US Contract Index, Avg Realized Price FOB USGC USD/metric ton
- Methanol West Europe Contract (T2), Avg Realized Price FOB Rotterdam USD/metric ton

Forecast
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