Markets and Potential for Non-polymer Derivatives of Propylene

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Contents

- Propylene Sources and Technologies
- Overall Global and Asian Scenarios of Propylene and its Derivatives
- Demand-Supply, Technologies, New Projects
  - Acetone/ Phenol
  - Acrolein/ Acrylic Acid/ Acrylonitrile
  - Propylene Oxide
  - Oxo-alcohols
  - Iso-propanol
- Conclusions
Propylene from Multiple Sources

Source: Intratec
Conventional Technologies
- Conventional steam cracking
- Off gases from Fluid Catalytic Cracking (FCC) units in refineries
- Catalytic cracking: Selective Olefin Cracking, Deep Catalytic Cracking
- Enhanced (High Severity) FCC

On-Purpose Technologies
- Propane Dehydrogenation
- Metathesis
- Methanol to Olefins / Methanol to Propylene
- Coal to Olefins

Bio-Propylene
- Corn, Sugar or Switchgrass Fermentation (Ethanol based)
- Fermentation to Propanol (Corn or Sugar based)
- Biomass Gasification

Propylene Technologies
Propylene Derivatives Chart

Propylene

- PP
- Oxo-Alcohols
- Propylene Oxide
- ACN
- Cumene
- Acrylic Acid
- Acrolein
- IPA

- 2-Ethyl Hexanol
- Butanol
- Propylene Glycol
- Polyols
- Acrylic Fiber
- ABS
- SAN
- NBR
- Phenol and Acetone
- Acrylic Esters
- Methionine
- BPA
- MMA

Additional Products:
- Alkylates
- Dimersol
- Polymer Gasoline
- Propylene Oligomers
- Iso-Butyl Benzene
- EPDM Rubbers
Lyondell Basell, BASF, Dow, Sinopec, Chevron, ExxonMobil and PetroChina among largest producers

63% used for PP (53% in North America, 90% in Middle East)

Global demand to grow from 88 million TPA in 2012 to 102 million TPA in 2016, at 3.7% CAGR

Over 45 million TPA new capacity at various stages, including several PDH projects

Asia will account for 50% of global demand by 2016
Global Propylene Demand

Source: CHEMSYSTEMS-Nexant
Polypropylene Consumption: PP Vs. Other Applications

Source: Chemsystems (Nexant)
PROPYLENE - DISTRIBUTION OF GLOBAL CAPACITY- REGIONWISE

TOTAL CAPACITY: 100.4 MN TPA

- ASIA: 43%
- NORTH AMERICA: 22%
- EUROPE: 20%
- MIDDLE EAST: 9%
- SOUTHAMERICA: 4%
- AFRICA: 2%

Source: ICIS
CHINA 34%
SOUTH KOREA 15%
JAPAN 14%
TAIWAN 9%
AUSTRALIA 7%
SINGAPORE 6%
INDIA 5%
THAILAND 5%
MALAYSIA 3%
INDONESIA 2%
VIETNAM <1%
PHILIPPINES <1%
SOUTH KOREA 15%
JAPAN 14%

Source: ICIS
ACETONE AND PHENOL
Phenol Chain

- Benzene
- Propylene
- Phenol
- Cumene
- Acetone
- Bisphenol A
- MMA
- Phenolic Resins
- Nylon Intermediates
- Epoxy Resins
- Polycarbonates
- Solvents
PHENOL- GLOBAL- CAPACITY DISTRIBUTION
TOTAL CAPACITY: 11.7 MN TPA

- ASIA: 44%
- EUROPE: 27%
- NORTH AMERICA: 25%
- SOUTH AMERICA: 2%
- MIDDLE EAST: 2%
- AFRICA: <1%
- MIDDLE EAST: 2%

PHENOL-ASIA- CAPACITY- DISTRIBUTION
TOTAL CAPACITY: 5.15 MN TPA

- CHINA: 32%
- TAIWAN: 21%
- SOUTH KOREA: 19%
- JAPAN: 17%
- SINGAPORE: 6%
- INDIA: 1%
- THAILAND: 4%

Source: ICIS
Phenol Demand: Segmentwise

World Phenol Demand: Application wise

- Bisphenol: 49%
- Phenolic Resins: 25%
- Caprolactam: 8%
- Alkyl Phenols: 4%
- Others: 14%

Source: ICIS
Global Acetone Demand Segmentwise

World Acetone Demand – Application wise

- Direct Solvent Application: 29%
- Methyl Methacrylate: 24%
- Bisphenol: 22%
- MIBK: 8%
- Others (MIBC, Isophorone etc.): 17%

Methyl Isobutyl Ketone (MIBK)
Methyl Isobutyl Carbinol (MIBC)

Source: IHS
Acetone Production Capacities

ACETONE- GLOBAL CAPACITY DISTRIBUTION
TOTAL: 7.4 MN TPA

ASIA 43%
EUROPE 27%
NORTH AMERICA 24%
SOUTH AMERICA 2%
MIDDLE EAST 2%
SOUTH AFRICA 2%

ACETONE-ASIA CAPACITY DISTRIBUTION
TOTAL: 3.17 MN TPA

CHINA 31%
TAIWAN 21%
SOUTH KOREA 19%
JAPAN 18%
SINGAPORE 6%
THAILAND 4%
INDIA 1%

Source: ICIS
PHENOL AND ACETONE PRICE MOVEMENTS WITH PROPYLENE
REGION-USA; PRICE-USD/MT

SOURCE: USITC, ICIS
ACROLEIN AND ACRYLIC ACID
ACROLEIN, ACRYLIC ACID : Highlights

• Acrolein produced by vapor phase oxidation of Propylene

• Shell and Sohio developed processes in 1950s

• Glycerol provides an alternate route now

• Refined Acrolein produces Methionine (animal feed additive)

• Arkema, Bluestar, Evonik leading producers

• Main use of Acrolein is Acrylic Acid

• Applications of Acrylic Acid :
  - Superabsorbent polymers
  - Acrylic Esters (60% of global demand)
  - Water treatment chemicals
• **Glacial Acrylic Acid (GAA) is the largest outlet for crude acrylic acid.**
Acrylic Acid: Region wise Capacity Distribution

ACRYLIC ACID GLOBAL CAPACITY DISTRIBUTION

Recent capacities and Projects in Saudi Arabia

<table>
<thead>
<tr>
<th>Company</th>
<th>Capacity, TPA</th>
<th>Completed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasnee/Sahara Petrochemical</td>
<td>250,000</td>
<td>2013</td>
</tr>
<tr>
<td>Rabigh Refining &amp; Petrochemical Co (Petro-Rabigh)</td>
<td>100,000</td>
<td>2016</td>
</tr>
</tbody>
</table>

According to ICIS Projects, > 2 mn TPA capacity of Acrylic acid will be added in next 5 years

Source: ICIS

Total Capacity: 6.2 million TPA
Acrylic Acid: Asian Capacities

**Total Capacity:** 3.30 million TPA

**Source:** ICIS

**ACRYLIC ACID - ASIA - CAPACITY DISTRIBUTION**

- **China:** 52%
- **Japan:** 20%
- **South Korea:** 11%
- **Taiwan:** 5%
- **Malaysia:** 5%
- **Singapore:** 3%
- **Indonesia:** 4%

**Total Capacity:** 3.30 million TPA

Source: ICIS
# Acrylic Acid: Chinese – New plants/ projects

*Total Planned Capacity in China: 1.15 mn TPA*

<table>
<thead>
<tr>
<th>Company</th>
<th>Region</th>
<th>Location</th>
<th>Capacity, TPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuwait Petroleum/Sinopec</td>
<td>Guangdong</td>
<td>Zhangjiang, Guangdong</td>
<td>150,000</td>
</tr>
<tr>
<td>PetroChina Sichuan Petrochemical Co - (PSP)</td>
<td>Sichuan</td>
<td>Pengzhou</td>
<td>190,000</td>
</tr>
<tr>
<td>Shanghai Huayi (Group) Co</td>
<td>Anhui</td>
<td>Wuwei, Anhui</td>
<td>400,000</td>
</tr>
<tr>
<td>Wanzhou Petrochemical (Jiangsu) Co</td>
<td>Jiangsu</td>
<td>Nantong. Jiangsu</td>
<td>80,000</td>
</tr>
</tbody>
</table>

Source: ICIS
# Acrylates Technology Licensors

<table>
<thead>
<tr>
<th>Japan Catalytic Chemical Co., Japan</th>
<th>Mitsubishi Petrochemical Co., Japan</th>
<th>Toyo Soda Company, Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumitomo Chemical Co., Japan</td>
<td>Nippon Shokubai Kagaku Kogyo Co. Ltd., Japan</td>
<td>SOHIO, U.S.A.</td>
</tr>
<tr>
<td>BASF, Germany</td>
<td>Rohm and Hass, U.S.A.</td>
<td>Celanese Corporation, U.S.A.</td>
</tr>
</tbody>
</table>
ACRYLONITRILE
ACRYLONITRILE : Highlights

- Manufactured by ammoxidation of Propylene
- Sohio developed the process
- Initial demand driver : Acrylic Fibre ( DuPont)
- Propane based competitive process ( BP, Mitsubishi, Asahi Kasei)
- Acrylic fiber growth now 1-2 % per annum
- ABS and SAN may show 4 – 5 % growth rates
Acrylonitrile has numerous end uses

- Acrylic Fibre
  - Sweaters, Blankets, Scarves, Hats, Rugs, Hand Knitting Yarn, Toys, Wigs, Furnishings, etc.

- ABS/SAN
  - TV’s, Phones, Computers, Other Electronics, Cars/Vehicles, Home Appliances, Toys, Medical, etc.

- NB Copolymers
  - Construction, Automobile Parts, Cables, Rubber Gloves, Hoses, Conveyor Belts, etc.

- Polyacrylamide
  - Water Treatment, Oil Industry, Pulp and Paper, Minerals/Mining, Enhanced Oil Recovery, Shale Gas etc.

- Carbon Fibre
  - Aircraft, Military, Racing Cars, Passenger Cars, Wind Turbines, Golf Clubs etc.

Source: PCI Acrylonitrile Ltd
Acrylonitrile Capacities

**ACRYLONITRILE - GLOBAL CAPACITY DISTRIBUTION**
TOTAL: 7.04 MN TPA

- ASIA: 55%
- NORTH AMERICA: 22%
- EUROPE: 20%
- SOUTH AMERICA: 2%
- AFRICA: 1%

**ACRYLONITRILE - ASIA - CAPACITY DISTRIBUTION**
TOTAL CAPACITY: 3.86 MN TPA

- CHINA: 37%
- SOUTH KOREA: 22%
- JAPAN: 21%
- TAIWAN: 14%
- THAILAND: 5%
- INDIA: 1%
- SOUTH KOREA: 22%

Source: ICIS
**Acrylonitrile Demand**

**World Consumption of ACN**
- China: 34%
- Other Asia: 25%
- Other: 10%
- Western Europe: 14%
- Japan: 9%
- North America: 8%

**Segmentwise Distribution of Global Demand for ACN – Total 4.762 mn TPA**
- Acrylic Fiber, 1.84, 38%
- ABS/SAN, 1.70, 36%
- NB Copolymers, 0.23, 5%
- Others, 0.23, 5%
- Acrylamide, 0.43, 9%
- Adiponitrile, 0.33, 7%

Source: IHS
Source: PCI Acrylonitrile Ltd
## Acrylonitrile New Capacity Additions

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity, TPA</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asahi Kasei Corp/ SABIC</td>
<td>Saudi Arabia</td>
<td>200,000</td>
<td>study (pre-feasibility)</td>
</tr>
<tr>
<td>China Petrochemical Development Corp - (CPDC)</td>
<td>Taiwan</td>
<td>50,000</td>
<td>planned</td>
</tr>
<tr>
<td>Mehr Petro Kimia Co - (Mepekco)</td>
<td>Iran</td>
<td>90,000</td>
<td>planned</td>
</tr>
<tr>
<td>SINOPEC-Wanda Group JV</td>
<td>China</td>
<td>260,000</td>
<td>construction underway-EXPECTED COMMNG-OCT 2014</td>
</tr>
</tbody>
</table>

Source: ICIS
Acrylonitrile-Butadiene-Styrene (ABS)

**ABS- GLOBAL CAPACITY DISTRIBUTION**

TOTAL CAPACITY: 10.25 MN TPA

- ASIA: 80%
- EUROPE: 10%
- NORTH AMERICA: 8%
- SOUTH AMERICA: 1%
- MIDDLE EAST: 1%

**ABS - ASIA - CAPACITY DISTRIBUTION**

TOTAL CAPACITY: 8 MN TPA

- CHINA: 45%
- SOUTH KOREA: 19%
- JAPAN: 8%
- TAIWAN: 19%
- OTHERS: 7%
- INDIA: 2%
- MIDDLE EAST: 1%

Source: ICIS

- ABS global market size was 7 mn tons in year 2011
- China is the largest producer of ABS with about 34% global capacity
- Chi Mei, Taiwan and Styrolution, Germany (50:50 JV of BASF and INEOS) are the first and second largest producers of ABS in the world with annual capacity of 1.95 million TPA and 1.07 million TPA respectively
ACRYLIC ACID AND ACN PRICE MOVEMENTS WITH PROPYLENE
PRICES-USD/MT, REGION-USA

Source: USITC, ICIS
PROPYLENE OXIDE
Propylene Oxide (PO)

- PO is used in the manufacture of Polyether Polyols for Urethanes, Propylene Glycols, Glycol Ethers and Polyalkylene Glycols for a variety of chemical intermediates and functional fluids.
- Polyols are used for Polyurethanes: Growing at a CAGR of 5% globally.
- Propylene Glycol (PG) is used as solvent and for UPRs, HTFs, anti-freeze, aircraft, deicing fluids etc.: Growing at a CAGR of 2-3% globally.
- PG ethers are used as solvent in coatings, inks etc.
- USA is the largest consumer for PG, with about 1/3rd of the world total.

PO Application wise Demand Distribution

Source: ICIS and IHS
PO Technologies

Dow Hydrogen Peroxide based Process

- The $\text{H}_2\text{O}_2$ process
- Developed and put to use jointly by BASF and Dow in Antwerp,
- SCG-Dow Group, a JV between Dow and Siam Cement Group in Thailand)

Chlorohydrin Process

- This is the traditional process

Propylene Oxide / Styrene Co-product Process (PO/SM)

- Propylene Oxide / Styrene Co-product Process (PO/SM)

Sumitomo PO only Cumene-based Process

- This process was commercialized by Sumitomo

PO Capacity Share by Technology

- CHPO 43%
- PO/TBA 16%
- PO/SM 33%
- CHP (Sumitomo) 4%
- HPPO 5%

Source: Chemsystems
Propylene Oxide (PO)

GLOBAL PROPYLENE OXIDE CAPACITY DISTRIBUTION
TOTAL CAPACITY: 9.76 MN TPA

ASIAN PROPYLENE OXIDE CAPACITY DISTRIBUTION
TOTAL CAPACITY: 3.897 TPA

Source: ICIS
## Propylene Oxide New Capacity Additions

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity, TPA</th>
<th>Expected in</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASF-YPC Co Ltd</td>
<td>China</td>
<td></td>
<td></td>
<td>study (pre-feasibility)</td>
</tr>
<tr>
<td>Changling Petrochemical Co</td>
<td>China</td>
<td>100000</td>
<td>2013</td>
<td>construction underway</td>
</tr>
<tr>
<td>Changzhou Sanyue Chemical</td>
<td>China</td>
<td></td>
<td></td>
<td>study</td>
</tr>
<tr>
<td>CNCEC Qidong New Material Co</td>
<td>China</td>
<td>250000</td>
<td>2015</td>
<td>construction underway</td>
</tr>
<tr>
<td>Jinling Huntsman –Nanjing</td>
<td>China</td>
<td>300000</td>
<td></td>
<td>construction underway</td>
</tr>
<tr>
<td>Jishen Chemical (based on Evonik’s Hydrogen Peroxide)</td>
<td>China</td>
<td>150000</td>
<td>2016</td>
<td>study</td>
</tr>
<tr>
<td>Liaoyang Petrochemical Co - (LYPC)</td>
<td>China</td>
<td>150000</td>
<td></td>
<td>study</td>
</tr>
<tr>
<td>Petronas/Evonik</td>
<td>Malaysia</td>
<td></td>
<td>2016</td>
<td>planned</td>
</tr>
<tr>
<td>Sadara Chemical</td>
<td>Saudi Arabia</td>
<td></td>
<td></td>
<td>approved</td>
</tr>
<tr>
<td>Saudi Petrochemical Co - (Sadaf)</td>
<td>Saudi Arabia</td>
<td></td>
<td></td>
<td>study</td>
</tr>
<tr>
<td>Yantai Wanhua Polyurethanes Co</td>
<td>China</td>
<td></td>
<td></td>
<td>engineering underway</td>
</tr>
</tbody>
</table>
Propylene Glycol (PG)

**PROPYLENE GLYCOL GLOBAL CAPACITY DISTRIBUTION**
TOTAL GLOBAL CAPACITY: 2.757 MN TPA

- NORTH AMERICA: 30%
- EUROPE: 29%
- SOUTH AMERICA: 4%
- ASIA: 37%

**PROPYLENE GLYCOL- ASIA - CAPACITY DISTRIBUTION**
TOTAL CAPACITY: 1.02 MN TPA

- CHINA: 49%
- JAPAN: 17%
- THAILAND: 15%
- SOUTH KOREA: 10%
- SINGAPORE: 6%
- AUSTRALIA: 2%
- INDIA: 1%
## Propylene Glycol (PG)

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dow Chemical (Australia) Ltd</td>
<td>Australia</td>
<td>15,000</td>
</tr>
<tr>
<td>CNOOC and Shell Petrochemicals Co Ltd - (CSPCL)</td>
<td>China</td>
<td>60,000</td>
</tr>
<tr>
<td>Manali Petrochemical Ltd - (MPL)</td>
<td>India</td>
<td>15,000</td>
</tr>
<tr>
<td>Asahi Denka Co Ltd</td>
<td>Japan</td>
<td>33,000</td>
</tr>
<tr>
<td>Asahi Glass Co Ltd - (AGC)</td>
<td>Japan</td>
<td>42,000</td>
</tr>
<tr>
<td>Nihon Oxirane Co Ltd</td>
<td>Japan</td>
<td>100,000</td>
</tr>
<tr>
<td>Seraya Chemicals Singapore Pte Ltd</td>
<td>Singapore</td>
<td>65,000</td>
</tr>
<tr>
<td>SKC Chemicals Group</td>
<td>S. Korea</td>
<td>100,000</td>
</tr>
<tr>
<td>SCG-Dow Group</td>
<td>Thailand</td>
<td>150,000</td>
</tr>
</tbody>
</table>

PG Asia Major Capacities: 580,000 TPA
Price Trends

PROPYLENE OXIDE AND PROPYLENE GLYCOL PRICES VERSUS
PROPYLENE- USD/MT - USA

SOURCE: USITC, ICIS
OXO ALCOHOLS
Oxo- ALCOHOLS : Highlights

- 2-EH, n-Butanol and i-Butanol are made from Propylene and Syngas by the Hydroformylation / Oxo process
- Davy – Kvaerner and Dow leading licensors
- 2-EH future growth rate 5 - 6 % / Year
- Similar growth rate envisaged for n-Butanol
2-Ethyl Hexanol

Applications

- 2-ethylhexyl phthalate plasticizers for flexible PVC
- For the production of intermediates for acrylic surface coatings, diesel fuel, and lube oil additives
- End markets: Building and construction, transportation, medical, consumables, and durable goods manufacture

Global production capacity – 3.33 MTPA
Output – 2.87 MTPA with operating rate is 86.2%
Asia, Western Europe and North America having 51%, 17% and 12% world total production capacity respectively.
Asia is the largest consumer - about 65% of world’s total consumption
China – a major importer
About 2.0 million tons of capacity is being added in China itself and expected to be on stream by 2015

Source: Researchpub
## 2-EH Upcoming Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity MTPA</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baling Petrochemical Corp</td>
<td>China</td>
<td>250,000</td>
<td>Under construction</td>
</tr>
<tr>
<td>China National Petroleum Corp - (CNPC)</td>
<td>China</td>
<td>80,000</td>
<td>Under construction</td>
</tr>
<tr>
<td>Indian Oil Corp - (IOC)</td>
<td>India</td>
<td>140,000</td>
<td>study</td>
</tr>
<tr>
<td>PetroChina Sichuan Petrochemical Co - (PSP)</td>
<td>China</td>
<td>80,000</td>
<td>study</td>
</tr>
<tr>
<td>Shandong Hualu Hengsheng Chemical Co Ltd</td>
<td>China</td>
<td>140,000</td>
<td>Under construction</td>
</tr>
<tr>
<td>Shandong Lanfan Chemical Co Ltd</td>
<td>China</td>
<td>100,000</td>
<td>Under construction</td>
</tr>
<tr>
<td>Shandong Luxi Chemical Co</td>
<td>China</td>
<td>140,000</td>
<td>Under construction</td>
</tr>
<tr>
<td>Wison Nanjing Chemical Co</td>
<td>China</td>
<td>125,000</td>
<td>study</td>
</tr>
<tr>
<td>Xingxia Petrochina</td>
<td>China</td>
<td>140,000</td>
<td>Under construction</td>
</tr>
<tr>
<td><strong>Total Upcoming Capacity by 2015</strong></td>
<td></td>
<td><strong>1,195,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Source: ICIS*
Applications

- Textile manufacture and impact modifiers for rigid polyvinyl chloride (PVC)
- Water-based coatings formulations
- Plasticizers, amino resins and butylamines
- Solvent in the purification of polyolefins etc.

Global production capacity – 3.57 MTPA
Output – 2.94 MTPA with operating rate of 82.5%
Asia, North America and Western Europe having 38%, 31% and 18% of world total production capacity respectively
Asia is the largest consumer with >53% of world’s consumption
## n-Butanol Upcoming Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity MTPA</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>China Petrochemical International Co</td>
<td>China</td>
<td>115000</td>
<td>planned</td>
</tr>
<tr>
<td>PetroChina Sichuan Petrochemical Co - (PSP)</td>
<td>China</td>
<td>210000</td>
<td>study</td>
</tr>
<tr>
<td>Saudi Kayan Petrochemical/SAAC/Saudi Aramco-Dow Chemical/ Tasnee</td>
<td>Saudi Arabia</td>
<td>330000</td>
<td>study</td>
</tr>
<tr>
<td>Shaanxi Yanchang Petroleum Yanan Energy and Chemical Co Ltd</td>
<td>China</td>
<td>206000</td>
<td>planned</td>
</tr>
<tr>
<td>Tianjin Bohai Chemical Group - Tianjin Soda Plant</td>
<td>China</td>
<td>85000</td>
<td>engineering underway</td>
</tr>
<tr>
<td>Wison Nanjing Chemical Co</td>
<td>China</td>
<td>125000</td>
<td>study</td>
</tr>
<tr>
<td><strong>Total Upcoming Capacity by 2015</strong></td>
<td></td>
<td><strong>1,481,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: ICIS
i-Butanol

Producers
• BASF, Perstorp, Dow, Oxea, Formosa, LG, Eastman, Hanwha, Andhra Petchem, Oxochimie, Sasol, Tianjin Bohai Chemical Group, Asahi Kasei, Zaklady

Applications
• To manufacture Plasticizers, Amino Resin, Isobutyl Acetate and Solvents

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gevo</td>
<td>Malaysia</td>
<td>study</td>
</tr>
<tr>
<td>Gevo</td>
<td>US</td>
<td>planned</td>
</tr>
<tr>
<td>PetroChina Sichuan Petrochemical Co - (PSP)</td>
<td>China</td>
<td>study</td>
</tr>
<tr>
<td>Shaanxi Yanchang Petroleum Yanan Energy and Chemical Co Ltd</td>
<td>China</td>
<td>planned</td>
</tr>
<tr>
<td>Wison Nanjing Chemical Co</td>
<td>China</td>
<td>study</td>
</tr>
</tbody>
</table>
n-Butanol and 2-EH - Supply and Demand

Supply and Demand of World OXO Market - 2010

OXO Supply and Demand in China during 2008-2015 (in ‘000 tons per year)

<table>
<thead>
<tr>
<th>Name</th>
<th>Item</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Butanol</td>
<td>Capacity</td>
<td>365</td>
<td>365</td>
<td>550</td>
<td>1185</td>
</tr>
<tr>
<td></td>
<td>Demand</td>
<td>632</td>
<td>890</td>
<td>850</td>
<td>1100-1150</td>
</tr>
<tr>
<td>2-Ethylhexanol</td>
<td>Capacity</td>
<td>540</td>
<td>540</td>
<td>875</td>
<td>1375</td>
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<tr>
<td></td>
<td>Demand</td>
<td>829</td>
<td>940</td>
<td>900</td>
<td>1200-1300</td>
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</tbody>
</table>

Source: Finance Research, Vol1 No.2, March 2012
ISO-PROPYL ALCOHOL
IPA World Capacities

IPA Global Capacity – 2.703 million TPA

 IPA Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Region</th>
<th>Capacity</th>
<th>Capacity Type</th>
<th>Completed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang Chun Plastics Co Ltd</td>
<td>China</td>
<td>Panjin, Liaoning</td>
<td>80000</td>
<td>Total</td>
<td>2013/14</td>
</tr>
<tr>
<td>Novapex</td>
<td>France</td>
<td>Roussillon</td>
<td>20000</td>
<td>Expansion</td>
<td>2013/14</td>
</tr>
</tbody>
</table>

Source: ICIS
IPA Asia Capacities

IPA Asia Capacity – 1.13 million TPA

China Plants

<table>
<thead>
<tr>
<th>Company</th>
<th>Region</th>
<th>Location</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang Chun Plastics Co Ltd</td>
<td>Liaoning</td>
<td>Jinzhou</td>
<td>100000</td>
</tr>
<tr>
<td>CNPC Jinzhou Petrochemical Corp</td>
<td>Shandong</td>
<td>Dezhou</td>
<td>50000</td>
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<tr>
<td>Dezhou Detain Chemical</td>
<td>Shandong</td>
<td>Dongying</td>
<td>50000</td>
</tr>
<tr>
<td>Dongying Hi-Tech Spring Chemical Ind Co</td>
<td>Zhejiang</td>
<td>Jiande</td>
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</tr>
<tr>
<td>Jiande Xinhua Chemical Co Ltd</td>
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<td>Yancheng</td>
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<tr>
<td>Super Chemical Corp</td>
<td>Jiangsu</td>
<td>Yancheng</td>
<td>50000</td>
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<tr>
<td>Taixing Jianye</td>
<td>Jiangsu</td>
<td>Taixing</td>
<td>30000</td>
</tr>
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</table>

Source: ICIS
Propylene-Isopropyl Alcohol Price Trend

IPA VS. PROPYLENE PRICES
USA-REGION USD/MT

Source: USITC, ICIS
Conclusions

• Propylene to show reasonably good growth in future
• Asia to lead future growth with better growth prospects in most of the derivatives, mainly in China
• While growth in BPA for Polycarbonates may plateau, epoxy demand could compensate, thereby keeping Phenol-Acetone sector growing
• Demand for Acrylic Acid likely to grow while Acrylonitrile growth may not keep same pace
• Growing demand for Polyols for PUs to drive demand for PO
• While the traditional sectors may show lower growth rates for Oxo-alcohols, coating applications could turn out to be more promising
• IPA economical based mainly on Refinery Grade Propylene