Global Trends on Acrylic Acid & Acrylates Markets

Adhesive & Sealant Council Annual Meeting
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Agenda

• IHS Markit – Who are we?
• Market outlook
  > Propylene
  > Acrylic Acid
  > Butyl Acrylate
  > 2-EHA
• Implications

![Diagram of chemical structures: acrylic acid, 2-hydroxypropyl acrylate, acrylic acid, acryloyloxypropionic acid, 2-ethylhexyl acrylate, and n-butyl acrylate.](attachment:image.png)
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300+ Chemicals

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Resource
Energy
Base Chemicals
Commodities
Specialities
Conversion
Consumption

Completely Integrated Forecasts

Supply

Energy Forecasting
Feedstock Forecasting

IHS Chemical Market Forecasting

Downstream Market Forecasting

Macroeconomic Forecasting

Demand

GLOBAL INSIGHT
GDP
CSM AUTOMOTIVE

Construction
Auto
Packaging
Consumer Products
Electronics
Pharmaceuticals

Growth
Population

Global
Insight

IHS EXPERTISE

CMAI
SRIC
HARRIMAN CHEMISLUT

Margin/Cost
Chemical Prices
Plant Capacity
Production/
Consumption
Trade

Energy
Gas
Oil
Biofuels

Biomass
Refinery Feedstocks
NGL

IHS Chemical Market Forecasting

Conversion
Consumption

Resource
Energy
Base Chemicals
Commodities
Specialities

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Value Chain

- **Crude Acrylic Acid**
  - Propylene
  - Caustic Soda
    - Glacial Acrylic Acid
      - N-butanol
        - 2-ethylhexanol
          - Methanol
            - Ethanol
              - Specialty Acrylates
              - Methyl Acrylate
              - Ethyl Acrylate
              - 2EH Acrylate
  - Super Absorbent Polymers
    - Diapers, adult hygiene
    - Dispersants/antiscalants, anionic polyelectrolytes for water treatment, rheology modifiers, flocculants
    - Others
      - Surface coatings, textiles, paper coatings, adhesives and sealants, plastics, etc.
Propylene

Two questions on everyone’s minds:

1. Why are propylene prices so volatile?
2. How long does this volatility last?
Key Routes to Produce Propylene

- **Crude Oil**
  - Crude Unit
  - FCC Unit
  - Naphtha, Gas Oil

- **Natural Gas**
  - Nat Gas Processing
  - Ethane, Propane, Butane
  - Propane
  - Nat Gas
  - Propane Dehydrogenation
  - Methanol-to-Olefins
  - Methanol-to-Propylene

- **Coal**
  - Coal-to-Olefins
  - Coal-to-Propylene

- **Refinery Grade Propylene**
  - Propylene Splitter

- **Polymer/Chemical Grade Propylene**
Global Propylene Value Chain

- **Refinery FCC/Coker**: 30% – 35%
- **Steam Crackers**: 40% - 45%
- **On-Purpose**: 25% - 30%

**Fuel**: 33%
**Direct**: 16%
**Splitters**: 51%

- **Cumene**: 48%
- **Oligomers**: 31%
- **Isopropanol**: 21%
- **LPG/Fuel**: 35%
- **Polygas/Dimersol**: 15%

**Global Propylene Value Chain**

- **PP**: 68%
- **Metathesis**: 14%
- **PDH**: 43%
- **CTP**: 4%
- **MTP**: 2%
- **Others On-Purpose**: 2%
- **MTO**: 7%
- **Olefin Cracking**: 2%
- **HS FCC**: 12%

**Alkylation**: 50%
**Others**: 3%
**Acrylic Acid**: 4%
**Acrylonitrile (ACN)**: 6%
**Cumene**: 4%
**IPA**: 1%
**2-EH**: 3%
**Butanol**: 3%
**P Oxide**: 8%
Price Forecasted to Moderate with Improving Supply

US Pricing now at premium to rest of world before returning to discount after new PDH comes online

Propylene Prices

Supply constrained

Falling propane, improved supply

Enterprise PDH starts

Source: IHS Markit
Propylene Production by Type

*On-purpose increasingly part of propylene supply recipe*

### US Total Propylene Qrtly Production by Type

<table>
<thead>
<tr>
<th>Year</th>
<th>RG Direct</th>
<th>Steam Crackers</th>
<th>Splitters</th>
<th>Metathesis</th>
<th>Propane Dehydro</th>
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</thead>
<tbody>
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<td>2011</td>
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<td>2016</td>
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<tr>
<td>2017</td>
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</tr>
</tbody>
</table>

**Shrinking**

Source: IHS Markit
EIA Inventories were historically high but now rapidly dropping
High level of planned maintenance in Q1-2017 which requires higher inventory to meet commitments

**US Propylene Production Capacity Loss**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Steam Cracker</th>
<th>FCC Unit</th>
<th>PDH Unit</th>
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<td>15</td>
<td>M</td>
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<td>400</td>
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<td>200</td>
<td>300</td>
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</tr>
</tbody>
</table>

Source: IHS Markit
NAM Propylene Short Term Outlook:

*Tight 1H17 continues to prime volatility until new PDH comes up*

1H17 Market Drivers

- Heavy turnaround schedule – US PDH, China PDH, FCC
- Falling propane –March/April
  - LPG feeds may push out ethane adding incremental supply
  - Potentially higher RGP supply (no blend)
  - Competitively priced PP imports
- Demand destruction due to rising prices – no exports
- Possible commitments to higher propylene export level
- *Net effect: Tight market with US price at premium to rest of world*

2H17 Market Drivers

- Enterprise 750 KTA PDH online 3Q17 …..ramp up rate sets price expectations
- Idling of Motiva FCC– eliminating 200 KTA RGP
- *Net effect: Shift to balance, price moderates….exports increase on oversupply*
Price impact on Acrylates
Acrylates Price increase in Q1-2017

- US Acrylates prices up in Q1-2017
- Increased Raw Material cost (Following Propylene increases)
- Tight Market (Supply and Demand factor)

North America Price Snapshot
US Dollars Per Metric Ton

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Mar-17</th>
<th>Chg vs. Feb</th>
<th>Q1-16</th>
<th>Q2-16</th>
<th>Q3-16</th>
<th>Q4-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl Acrylate</td>
<td>Contract, Delivered</td>
<td>1,710</td>
<td>130</td>
<td>1,215</td>
<td>1,234</td>
<td>1,292</td>
<td>1,390</td>
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<tr>
<td>Cash Margin</td>
<td></td>
<td>472</td>
<td></td>
<td>347</td>
<td>342</td>
<td>282</td>
<td>408</td>
</tr>
<tr>
<td>2-EthylHexyl Acrylate</td>
<td>Contract, Delivered</td>
<td>2,030</td>
<td>180</td>
<td>1,435</td>
<td>1,490</td>
<td>1,568</td>
<td>1,672</td>
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<tr>
<td>Cash Margin</td>
<td></td>
<td>774</td>
<td></td>
<td>556</td>
<td>587</td>
<td>544</td>
<td>678</td>
</tr>
<tr>
<td>Glacial Acrylic Acid</td>
<td>Contract, Delivered</td>
<td>1,780</td>
<td>165</td>
<td>1,370</td>
<td>1,395</td>
<td>1,433</td>
<td>1,447</td>
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<tr>
<td>Cash Margin</td>
<td></td>
<td>749</td>
<td></td>
<td>662</td>
<td>662</td>
<td>611</td>
<td>648</td>
</tr>
</tbody>
</table>
Acrylic Acid
Example Cost Curve (CCMA) – NAM Advantage

World Cost Curve: Acrylic Acid

(Cost Basis = Plant Gate, Operating Rate Basis = IHS Baseline, Integration Basis = On)

Source: IHS Markit

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Global Acrylic Acid Demand 2016

World: 2016 Acrylic Acid Demand

- Glacial Acrylic Acid 54%
- Butyl Acrylate 26%
- 2-Ethyl Hexyl Acrylate 4%
- Ethyl Acrylate 5%
- Methyl Acrylate 6%
- Multi-Functional Monomers 5%

Source: IHS Markit
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World: 2016 Acrylic Acid Demand by Region

- NE Asia 49%
- W. Europe 19%
- N. America 20%
- SE Asia 5%
- Other 7%

Source: IHS Markit
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Demand = 4.8 Million Metric Tons

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North America Acrylic Acid Demand

2016

- Glacial Acrylic Acid: 52%
- Butyl Acrylate: 25%
- 2-Ethyl Hexyl Acrylate: 6%
- Ethyl Acrylate: 6%
- Methyl Acrylate: 6%
- Multi-Functional Monomers: 5%

Domestic Demand = 1.1 Million Metric Tons

Source: IHS Markit © 2017 IHS Markit

2021

- Glacial Acrylic Acid: 52%
- Butyl Acrylate: 24%
- 2-Ethyl Hexyl Acrylate: 5%
- Ethyl Acrylate: 7%
- Methyl Acrylate: 7%
- Multi-Functional Monomers: 5%

Domestic Demand = 1.2 Million Metric Tons

Source: IHS Markit © 2017 IHS Markit
Butyl Acrylate
Global Butyl Acrylate Demand

### 2016

- **NE Asia**: 40%
- **W. Europe**: 21%
- **SE Asia**: 3%
- **Other**: 20%

**Demand**: 2.2 Million Metric Tons

Source: IHS Markit © 2017 IHS Markit

### 2021

- **NE Asia**: 42%
- **W. Europe**: 19%
- **SE Asia**: 3%
- **Other**: 21%

**Demand**: 2.9 Million Metric Tons

Source: IHS Markit © 2017 IHS Markit

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Global Butyl Acrylate

World: Butyl Acrylate Supply & Demand

Million Metric Tons

0.0 1.0 2.0 3.0 4.0 5.0
11 12 13 14 15 16 17 18 19 20 21

Domestic Demand
Total Capacity
Operating Rate

Source: IHS Markit
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North America Butyl Acrylate

North America: Butyl Acrylate Supply & Demand

Source: IHS Markit

© 2017 IHS Markit
2-EHA
## Global 2-Ethylhexyl Acrylate Demand

<table>
<thead>
<tr>
<th>Region</th>
<th>2016 Demand</th>
<th>2021 Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE Asia</td>
<td>43%</td>
<td>45%</td>
</tr>
<tr>
<td>W. Europe</td>
<td>16%</td>
<td>15%</td>
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<tr>
<td>N. America</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>SE Asia</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>17%</td>
<td>17%</td>
</tr>
</tbody>
</table>

**2016 Demand:** 579 Thousand Metric Tons

**2021 Demand:** 695 Thousand Metric Tons

Source: IHS Markit  © 2017 IHS Markit

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Global 2-EHA Supply and Demand

World: 2-Ethyl Hexyl Acrylate Supply & Demand

Source: IHS Markit

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North America 2-EHA Supply and Demand

North America: 2-Ethyl Hexyl Acrylate Supply & Demand

Source: IHS Markit

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Trade
2015 Global Acrylate Trade

Exports

Imports

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Butyl Acrylate US Exports

US Butyl Acrylate Exports

Source: IHS Markit
Implications
Operating rates mostly low in 2016…

Source: World Analysis - Acrylic Acid and Acrylates
Overcapacity is not the same everywhere…

Regional Overcapacity

Source: IHS Markit
Fragmented environments require change

- Five producers share 68% of capacity
- Nine other share remaining 32%
BA could benefit

- Top 5 producers share 65% of market
- Nine others share 35%
10% Rationalization on Producers side could help operating rates increase to healthy levels – Recover Margins

Source: IHS Markit
Conclusions

• Demand growth function of GDP globally and regionally.

• US remains advantaged in propylene and thus should be most competitive region for cost in the next five years.

• In order to bring value chain back to sustained profitability will require rationalization in some region(s), plus a rethink of the business model.

• US has propylene advantage and operates at higher rates vs other regions like NEA.

• Acrylates imports into US are expected to increase from oversupplied regions (like China).

• Consolidation of NEA industry could lead to a return to prosperity for producers.
References: Market Advisory Services – Short Term outlook

Clients value Market Advisory Services for chemical price discovery, near-term market analysis and forecasts:

• Negotiate better buy-sell agreements
• Plan inventory positions
• Optimize supply-chain

MAS coverage:

• Market prices (historical, current, forecast) provided monthly, weekly, daily depending upon the service
• Expert market analysis of prices, margins, trade, operational issues
• Future trends impacting markets
• Quarterly supply/demand balances and trade flows
References:
World Analysis – Long Term Outlook

for chemical supply demand and capacity, long-term market analysis and forecasts:

- Constantly updated capacity, supply demand balances and forecasts
- Trade grids at a regional and country level
- Quarterly updated Pricing/cost and margin forecasts
- High-Case and Low-Case Price Forecast Sensitivities

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  > In-depth supply chain optimization
  > Operational support for quarterly business reviews

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- Quarterly updated Pricing/cost and margin forecasts and base case assumptions to see the impact of changing market conditions
- High-Case and Low-Case Price Forecast Sensitivities to base case with price drivers and a qualitative analysis of what could move the market from the base case forecast for price/cost/margin forecast

All this delivered through traditional as well as a new user friendly dynamic interface.

2017 World Analysis – Acrylates