Global Chlor-alkali Market Outlook

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Overview
The big picture
Chlor-alkali Market Outlook

...strong demand growth combined with lack of capacity expansions will drive higher asset utilization and increased profitability through 2023.
2018 Chlor-alkali capacity: Approximately 90 million metric tons

Chlorine basis

Intercontinental Caustic Soda Trade = 9.3 Million DMT

Source: IHS Markit Chlor-alkali World Analysis

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What’s changed since last year?

- **Chlor-Alkali capacity**
  > Mercury-cell conversion is complete in Europe
  > New capacity announcements emerging for Europe and US

- **Caustic soda**
  > Prices moved higher, although excess product in regional spot markets has stalled upward momentum
  > Alumina producers are optimizing bauxite vs. caustic price
  > Limited uncontracted volume heightens spot market sensitivity

- **Chinese environmental policy expanded**
  > Renewed inspections are impacting chlorine and caustic demand
  > Chinese economy has cooled a bit
  > Production from carbide-based PVC capacity is stalled … at least for now
Four key drivers support strong market conditions in the global caustic soda market

- Strong economic activity is supporting caustic demand in all segments
- Key consumption segments are exploring optimization alternatives for caustic soda cost mitigation
- E-commerce is changing the comparative structure of pulp consumption segments
- Chinese production and consumption dominates global market structure, magnifying impacts of changes underway in the domestic market
Americas
South America caustic and chlorine demand continue to diverge
4.7% AAGR of SAM caustic demand for pulp production

- 5 year SAM caustic production AAGR = 1.8%, constrained by chlorine outlets

Source: IHS Markit World Analysis 2019
SAM caustic demand for alumina production continues to grow

- 5 year SAM caustic demand growth for ALA = 4.5%, net of projected Alunorte refinery operating rate recovery

Source: IHS Markit World Analysis 2019
US net caustic exports are growing, raising production demand
US operating rates increase – new capacity projected isn't enough to temper increasing operating rates

US Caustic Soda Supply / Demand and Operating Rate

Additional new capacity is needed to meet 5-year demand

Source: IHS Markit World Analysis 2019
## North America market outlook summary

### Domestic Demand
- Strong domestic demand through 2023; Vinlys and MDI are stand out chlorine growth segments; inorganic chemicals, organic chemicals and pulp are standout caustic growth segments

### Net Exports
- 2018 caustic exports slightly lag 2017 exports due to Alunorte; 2019 – 2023 caustic exports grow in spite of Australian producers optimizing bauxite grade

### Production & Trade
- Shintech adds 270 kdtma in 2021; additional hypo capacity assumed in 2023
- South American pulp growth and alumina rebound fuel USGC export growth

### Operating Rates
- Average operating rates climb to 90% in 2021 – new Shintech capacity moderates rise until 2023

### Prices & Margins
- Prices rise modestly to peak as global market awaits Asia recovery
- Low natural gas prices support continued globally advantaged economics
Europe
European chlor-alkali market: refreshed by new, modern capacity

- Operating rates have risen
- Significant market shift from short to balanced after mercury-cell phase-out completion
- Better balance is repositioning continental pricing
- Participation in the export spot market participation is providing continental price support
- River system issues are keeping the market tight
Improved reliability has stabilized the market balance …

- **Force Majeure**
- **Technical Issue**
- **FM or technical issue linked to ethylene**
New capacity announced for Europe nearly off-sets demand loss from conversions, but not enough to cover growth

• 2017 capacity loss exceeds 900 kmt chlorine
• Numerous capacity debottlenecking projects announced for short to medium-term
  > New capacity announced for start-up by 2022 equals 75% of lost capacity
• Additional hypothetical expansions forecast to sustain balance

![2015-2021 European Chlor-Alkali Capacity](chart)
European operating rates increase until new capacity is on-stream

WEP Caustic Soda Supply / Demand and Operating Rate

Source: IHS Markit Chlor-alkali World Analysis 2019
Europe market outlook summary

**Capacity**
- Market impact of 900,000 mt net chlorine capacity closures 2015 – 2017 is offset by higher operating rates. 2015 – 2016 mercury-cell plants operated at 62-66% of capacity.

**Operating Rates**
- Operating rates rise from 80% in 2016 to peak at 88% in 2020; new capacity on-stream gradually reduces rates to mid-80s% by 2023

**Production**
- New capacity will not mitigate high operating rates – 75% of demand growth is offset

**Prices**
- Higher operating rates and dependence on imports bias the European market to more than historical price volatility
Asia
Asia leads the world in per capita caustic soda consumption growth rate …

- Chinese per capita consumption increases by almost 60% over the next 10 years
- Korean and Japanese per capita caustic consumption exceeds that of West Europe
- Chinese per capita caustic consumption approaches that of US by 2028

![Per Capita Caustic Consumption Graph]

Source: IHS Markit Chlor-alkali World Analysis 2019

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... But current market dynamics are mixed in China

- Chinese environmental inspections will continue to contribute to regional instability
  - Widespread plant inspections impact caustic and chlorine demand (Jiangsu, Shanghai and Shandong)
  - Recent unusual market dynamics have pressured caustic soda demand and price
  - Mandated chemical plant relocations will contribute to unstable demand through 2020
- Shifting trade flow patterns – possible further shifts due to new tariffs
- Alumina demand is key to the caustic balance
  - China domestic alumina price is less than LME price; sustained differential provides catalyst for increased Chinese operating rates
  - Guinean bauxite imports have not negatively impacted caustic consumption yet … continued upgrading could lead to lower unit caustic consumption
Uncertainty factors

- Impact of trade disputes – short-term or long-term?
- Environmental initiatives – short-term or prolonged?
- Increasing energy prices
- Capacity increase when plants are “moved” to industrial parks?
- Low cost construction v. higher operating costs
- Political / geopolitical issues and government interventions
Northeast Asia caustic demand for alumina production continues to grow

- New alumina capacity must be added to meet global aluminum demand growth
- Forecast new alumina capacity adds 2.7 Million dmt caustic demand

Alumina Production & Caustic Demand

Source: IHS Markit Chlor-alkali World Analysis 2019
NEA caustic exports rise in 2019, then decline as Chinese operating rates increase

NEA Caustic Soda Export Volume

Source: IHS Markit Chlor-alkali World Analysis 2019

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Northeast Asia operating rates rise to unprecedented levels

NEA Caustic Soda Supply / Demand and Operating Rate

Source: IHS Markit Chlor-alkali World Analysis 2019
## Asia market outlook summary

### Domestic Demand, AAGR
- Overall caustic demand growth rate exceeds chlorine demand growth rate

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<thead>
<tr>
<th></th>
<th>NEA</th>
<th>SEA</th>
<th>ISC</th>
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</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>2.9%</td>
<td>0.7%</td>
<td>5.8%</td>
</tr>
<tr>
<td>Caustic</td>
<td>3.1%</td>
<td>2.2%</td>
<td>5.1%</td>
</tr>
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### Capacity
- Potential for small plant closures in China; some increase in India
- Seasonal variations in operating rates; Northeast Asia operating rates go from 86% in 2018 to 94% in 2022

### Operating Rates
- Production rises with operating rates
- Exports rise, but then decrease when constrained by high operating rates needed to accommodate domestic growth

### Production

### Prices & Margins
- Increasing demand, especially as caustic consumption rises faster than chlorine with no significant capacity increases, will push prices up. Some seasonality of caustic pricing may occur.
- ECU margin increase is countered by energy cost increases
Summary
Globally, the 5-year demand growth trajectory continues to support increasing operating rates

- GDP growth rate ≥ 2.9 AAGR through 2020 supports healthy manufacturing and key consumables demand growth
- IHS Markit projects ~ 2.3-2.4% global demand AAGR for chlorine and caustic through 2020
- 2018 global chlor-alkali operating rate is ~ 84%, with significant differences by region
- Cycle peak operating rates are still projected in 2021-2022
- Global cycle peak operating rate exceeds all prior global operating rates since 1990, including historic 2007 peak of 89%.

Source: IHS Markit World Analysis 2019

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WEP, NEA and global chlor-alkali operating rates reach record levels

Global and Select Regional Chlor-alkali Operating Rates, %

Source: IHS Markit 2019 World Chlor-alkali Analysis

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Relative investment costs influence capacity addition geography

Construction Location Factors (2016)

Source: IHS Markit 2016

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2023 Chlor-alkali capacity = approximately 99 million tons
Chlorine basis

Intercontinental Caustic Soda Trade = 10.4 Million DMT

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