Polyamide & Intermediates Markets

Synthetic Fibres Raw Materials Committee Meeting at APIC 2013
Taipei, 10 May 2013

(Grace) Shen Hong
Polyamide 6 Intermediates
- World Caprolactam Supply and Demand
- Polyamide 6 Demand
- Economic Analysis
- Conclusion

Polyamide 66 Intermediates
- World Adipic Acid Supply and Demand
- World Adiponitrile Supply and Demand
- Polyamide 66 Demand
- Conclusion
APIC 2013
WORLD CAPROLACTAM CAPABILITY vs DEMAND

Source: Tecnon OrbiChem
**APIC 2013**

**CAPROLACTAM CAPACITY 2011– 2016**

[Graph showing CAPROLACTAM capacity from 2011 to 2016 with various companies and regions indicated.]

**Source:** Tecnon OrbiChem
APIC 2013
WORLD CAPROLACTAM CAPABILITY vs DEMAND

Source: Tecnon OrbiChem
1,000 Metric Tons

Source: Tecnon OrbiChem
Source: Tecnon OrbiChem
Source: Tecnon OrbiChem
APIC 2013
WORLD POLYAMIDE 6 DEMAND BY REGION

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRODUCTION COST vs OIL PRICE

$/ton Caprolactam

- Fixed costs of supplying plants
- Cost of Production in Asia
- Fixed costs of caprolactam plant
- Energy dependant costs

Cats & Chemicals
Energy related costs (steam, ammonia, etc.)
Delivery
Packing, loading

Brent Crude oil price $/bbl

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRODUCTION COST vs OIL PRICE

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

2008

2009

2010

2011

2012

2013

2014

Profit zone

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecnon OrbiChem

Crude Oil Price $/bbl

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Cyclohexane

Profit zone

Cats & Chemicals

Packing, loading shipping

Delivery

Source: Tecno
APIC 2013
CAPROLACTAM PRODUCTION COST vs OIL PRICE

$/ton Caprolactam

Fixed costs of supplying plants

Energy related costs (steam, ammonia, etc.)

Cats & Chemicals

Packing, loading, shipping

Delivery

Profit zone

Cyclohexane

Cost of Production in Asia

Fixed costs of caprolactam plant

Energy dependant costs

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRODUCTION COST vs OIL PRICE

$/ton Caprolactam

- Fixed costs of supplying plants
- Energy related costs (steam, ammonia, etc.)
- Delivery
- Cost of Production in Asia
- Fixed costs of caprolactam plant
- Energy dependent costs

- Cats & Chemicals
- Packing, loading
- Cyclohexane

Brent Crude oil price $/bbl

Source: Tecnon OrbiChem
### APIC 2013
**TIGHTNESS INDEX**

<table>
<thead>
<tr>
<th>World Capacity Utilisation Rate</th>
<th>World Markets</th>
<th>Tightness Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>96.0%</td>
<td>Very Tight</td>
<td>1.4</td>
</tr>
<tr>
<td>93.7%</td>
<td>Tight</td>
<td>1.2</td>
</tr>
<tr>
<td>90.0%</td>
<td>Balanced</td>
<td>1</td>
</tr>
<tr>
<td>84.0%</td>
<td>Loose</td>
<td>0.8</td>
</tr>
<tr>
<td>75.0%</td>
<td>Over-Supplied (Sloppy)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Source: Tecnon OrbiChem
APIC 2013
TIGHTNESS INDEX

For a given year:

\[
\text{World Tightness Index} = \log_{10} \left( \frac{\text{Capability}}{\text{Capability} - \text{Consumption}} \right)
\]

\[
\text{Capability} = \text{Annual Nameplate Capacity} \text{ less Capacity off line*}
\]

* Due to unscheduled stoppages, not scheduled maintenance turnarounds

Source: Tecnon OrbiChem
**APIC 2103**

**WORLD CAPROLACTAM CAPABILITY vs DEMAND**

- **Source:** Tecnon OrbiChem

**Graph Details:**
- **Y-axis:** 1,000 Metric Tons
- **X-axis:** Years (1984 to 2020)

**Key Points:**
- **Growth Rates:**
  - 3.4% p.a. from 1984 to 1992
  - 3.0% p.a. from 1996 to 2000
  - 2.7% p.a. from 2004 to 2012
- **Tightness Index for 2014:** \( \log_{10} \frac{C}{B} \)
- **Including Uncertain Plants**
- **Including Highly Probable New Plants**
- **Caprolactam Consumption**

**Source:** Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRICE HISTORY - ASIA

Tightness Index

Brent Crude Oil Price $/bbl

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRICE – ASIA – 2010 by month

Tightness Index

Brent Crude Oil Price $/bbl

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRICE – ASIA – 2011 by month

Tightness Index

VERY TIGHT

TIGHT

BALANCED

LOOSE

OVER-SUPPLIED (SLOPPY)

Brent Crude Oil Price $/bbl

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRICE – ASIA – H1 2012 by month

Tightness Index

VERY TIGHT

TIGHT

BALANCED

LOOSE

OVER-
SUPPLIED
(SLOPPY)

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM PRICE – ASIA – 2012 by month

Source: Tecnon OrbiChem
APIC 2013
CAPROLACTAM 2013 PRICE FORECAST – ASIA (Dec 2012 Forecast)

Tightness Index

Very Tight

Tight

Balanced

Loose

Over-Supplied (Sloppy)

Forecast by the US Energy Information Administration

Source: Tecnon OrbiChem

Brent Crude Oil Price $/bbl

2013

$3400

$3200

$3000

$2800

$2600

$2400

$2200

$2000

$1800
APIC 2013
CAPROLACTAM 2014 PRICE FORECAST - ASIA

Tightness Index

VERY TIGHT
TIGHT
BALANCED
LOOSE
OVER-SUPPLIED (SLOPPY)

Source: Tecnon OrbiChem

Forecast by the US Energy Information Administration April 2013
APPIC 2013
CONCLUSIONS - POLYAMIDE 6 INDUSTRY

- World caprolactam consumption showed little growth in 2011, then returned to growth in 2012 – but only in China
- Caprolactam consumption has grown about 18% in 2012 in China, a bounce-back after stagnation in 2011, boosted by both textile applications and engineering plastics applications
- Outside China, caprolactam growth has been zero or negative in 2012
- Six new 100 ktpa caprolactam units have been brought on stream in China in 2012, by Haili (2), Hengyi (2), Hongye (1) and Sinopec (1), doubling China’s capacity within 12 months
- These additions have moved the world caprolactam balance into over-supply, yet more capacity of 400 ktpa will come on stream in H2 2013 and various other projects are under construction or planned in China
- World caprolactam over-supply is thus inevitable over the next few years, possibly mitigated by closure of some old plants
- This has dire consequences for caprolactam industry profitability over the next few years
- Caprolactam producers need to develop and promote PA6 engineering plastics applications in order to boost consumption

Source: Tecnon OrbiChem
APIC 2013
WORLD ADIPIC ACID CAPABILITY vs DEMAND

Capability to Produce

Forecast Growth 2.7%

Invista closes 450 ktpa at Wilton & Maitland, rebuilds Orange

Growth 4.0%

Adipic Acid Consumption

Source: Tecnon OrbiChem
APIC 2013
WORLD ADIPIC ACID PRODUCERS

Source: Tecnon OrbiChem

1,000 Metric Tons

China

- 2011 →
- 2013 closure
- Additions 2012
- Additions 2013

Invista
Rhodia
Ascend
BASF
Asahi Kasei
Lanxess
Ukraine
Liaoyang Petrochemical
China Shenma
Shandong Hongye
Shandong Haitai
Dushanzi Tianli
Hualu Hengsheng
Chongqing Fuxiang
Yangmei Fengxi
Kailuan Energy
Zhejiang Shuyang
APIC 2013
WORLD ADIPIC ACID CONSUMPTION BY END-USE

Source: Tecnon OrbiChem
APIC 2013
WORLD ADIPONITRILE CAPABILITY vs DEMAND

Source: Tecnon OrbiChem

BASF closes 116 ktpa at Wilton, UK
Growth 3.1%

Invista’s 254 ktpa unit at Orange, USA out of action
Forecast Growth 2.8%

Adiponitrile Consumption

Capability = 0.95 x Nameplate Capacity
Source: Tecnon OrbiChem
APIC 2013
WORLD POLYAMIDE 66 DEMAND BY REGION

Source: Tecnon OrbiChem
The world adipic acid market is seriously oversupplied. China has the biggest adipic acid capacity of any country, but the average utilisation rate in China is now as low as 50%.

Adipic acid demand for both polyurethane and polyamide applications will grow steadily, with major increases taking place in China.

However, fierce competition will lead to low profit, even for top quality adipic acid producers. A reshaping of the adipic acid industry is possible if the global economy stays volatile in 2013 and beyond.

If adiponitrile capacity is not increased in the near future, adiponitrile will be extremely tight from 2016, possibly earlier.

PA66 producers have to grapple with high and volatile costs which are likely to persist and may damage long term PA66 growth.

Polyamide 66 resin demand in engineering plastics applications shows more dynamism than polyamide 66 fibre.

PA66 faces substitutional pressure from PA6, due to the widening pricing difference.

Source: Tecnon OrbiChem
Tecnor
OrbiChem

...your source of expert chemical industry knowledge