Outlook for Formaldehyde and Impact on Methanol Demand

33’rd Annual IHS Chemical World Methanol Conference

IHS - World Methanol Conference
11th – 12th November 2015,
Sheraton Munich Arabellapark Hotel

Lars Axelsen, Dynea
General Manager, Technology Sales & Licensing,
Company overview

• Norwegian Corporate

• Sales 950 mill NOK (2014)

• 210 employees

• 3 own production sites

• 4 tolling sites
Innovation and expansion – Dyno period (1947 – 2000)

Milestones:
- 1947: Norske Kunstharpikser (formaldehyde and resins) established in Lillestrøm


Milestones:
- 2001: Dynea company name and identity launched worldwide
- 2007-2014: IK implementing divestment strategy through a split of the Dynea Group, with assets and activities sold in parts.

Back to the roots – Independent Dynea period (2013 - )

Some milestones:
- 2013: Acquisition by Eltek Holding,
- 2014: Full ownership of and rights to the Dynea name

1947 - Norske Kunstharpikser
1952 – Gullaug Kjemiske Fabrikker
1971 -
2000 –
2014 -
EWS  Engineered Wood Solutions

IWS  Interior Wood solutions

WBPR  Wood Based Panel Resins

Dynoadd  Industrial Coating Additives

Powder Resins

Formaldehyde

Speciality Adhesives and Polymers

Tank Cleaning Services

Technology Sales & Licensing
Formaldehyde plants

Regulatory Services

Analytical Services

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Technology Sales & Licensing

- Silver Catalyst Formaldehyde technology (FASIL) for new plants and revamps.
  - License and Engineering
  - Proprietary equipment & Catalyst
  - Commissioning and Start-up services.
- Metal Oxide Formaldehyde technology (METOX) for revamp and upgrade.
- Resin Batch Reactors for the production of UF, MF, MUF and PF
Formaldehyde and Resin Process Technology

• Dynea have more than 60 years of experience in process development, design and operation of both Synthetic resin production, Formaldehyde Silver and Metal-oxide plants

• Batch reactor design for UF, MF and PF including sophisticated tailor-made simulation tools Phenolsim ® and UF Visualizer ®

• For formaldehyde production, Dynea have technologies for:
  • Silver Contact plants, FASIL ®
  • Metal Oxide plant, METOX

• Dynea have designed, constructed and started up more than 40 Formaldehyde plants world-wide.

• Dynea are a producer of formaldehyde for its own internal use, all improvements are tested in our own plants before offering them to our external customers.
Dynea Formaldehyde Silver Process

Converter

Absorption

Gas recycling (option)

Export Steam
Boiler feed water

Off-gas to treatment

Water

Vaporizer

Steam Drum

Converter

Waste heat boiler

Methanol

Water

Air

Air scrubber

FORMALIN TO STORAGE TANK
**Large Range In Plant Capacity**
From 15,000 – 150,000 TPA FA 100 wt %.

**Selective Absorber**
No Distillation. Selective Formaldehyde absorption, recycling of methanol and water. Result; Improved yield and product quality

**Product Quality**
High formaldehyde concentration, up to 56 w%. Low formic acid concentration in final product. Low methanol concentration in final product.

**Operational Costs/consumption Figures**
Inexpensive catalyst
The low electricity consumption and cooling demand more than compensates the higher methanol consumption compared to the metal oxide technology.

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Key Benefits - Dynea Formaldehyde Silver Process

A Safe Process
Safe during:
- During Start-up phase
- In Operation
- During Shutdown

Safe in Design:
• No hot oil
• Only water/steam cooling which mitigates risks of fire.
• No oxygen in absorber
• Catalyst can be removed without dust and waste in a few hours. Re-catalysis takes less than 24 hours: Small holding tanks are needed to serve customers during re-catalysis.

The Green spot shows the typical operation point:
30% methanol
45% air
25% recycle gas or water

Shutting down the plant will move the process from “Safe to Safer”
Dynea World of Formaldehyde
Production based on Dynea AS Formaldehyde and Resin technology

Silver Formaldehyde plant

Dynea AS locations
• Dynea formaldehyde and resin Licensees

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Typical contract and project phases for Dynea Licensing projects

1. Extended Basic engineering
   - Fixed price

2. Purchasing
   - Proprietary equipment
   - Catalyst

3. Customer Detail engineering

4. Detail engineering
   - Non Prop Eq
   - Review
   - Manhours
   - Hourly rates

5. Customer Purchasing
   - Non Proprietary equipment
   - Dynea condition:
   - Check & Accept equipment

6. Customer Construction

Dynea Supervision for Commissioning & Start-up
   - Manhours
   - Hourly & Daily rates

Customer Commissioning & Start-up

Dynea Technology Package

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Formaldehyde Outlook
A view in to the future
What visions of the future came out of the situations of the past
Past is history – Future is mystery but predictable

Historical development Formaldehyde volumes in the USA
(Assume same development took place in Europe)
**Formaldehyde to continue as a significant methanol consumer**

Predominantly as a primary derivative

Also as an independent feedstock to other primary methanol derivatives of which MMA is only one example

Actual formaldehyde demand may thus exceed forecasts that do not take these inter-derivative relationships into account
<table>
<thead>
<tr>
<th>Derivative</th>
<th>2015</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea Formaldehyde (UF) Resins &amp; Concentrates</td>
<td>6610</td>
<td>8041</td>
</tr>
<tr>
<td>Phenol Formaldehyde (PF) Resins</td>
<td>2874</td>
<td>3393</td>
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<tr>
<td>Others</td>
<td>1951</td>
<td>2291</td>
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<tr>
<td>Polyoxymethylene/ Polyacetal (POM)</td>
<td>1388</td>
<td>1624</td>
</tr>
<tr>
<td>Pentaerythritol</td>
<td>1006</td>
<td>1212</td>
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<tr>
<td>Methylene Diphenyl Diisocyanate (MDI)</td>
<td>885</td>
<td>1047</td>
</tr>
<tr>
<td>1,4 Butanediol (1,4 BDO)</td>
<td>805</td>
<td>921</td>
</tr>
<tr>
<td>Paraformaldehyde</td>
<td>665</td>
<td>824</td>
</tr>
<tr>
<td>Hexamine</td>
<td>457</td>
<td>555</td>
</tr>
<tr>
<td>Other Polyols (TMP, TME, NPG)</td>
<td>444</td>
<td>518</td>
</tr>
<tr>
<td>Melamine Formaldehyde (MF) Resin</td>
<td>386</td>
<td>463</td>
</tr>
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</table>

**Total 100% formaldehyde (kMT)**

- 2015: 17472 kMT
- 2019: 20889 kMT

**Percentage Distribution:**

- Urea Formaldehyde (UF) Resins & Concentrates: 37.83%
- Phenol Formaldehyde (PF) Resins: 16.45%
- Others: 11.17%
- Polyoxymethylene/ Polyacetal (POM): 7.95%
- Pentaerythritol: 5.76%
- Methylene Diphenyl Diisocyanate (MDI): 5.06%
- 1,4 Butanediol (1,4 BDO): 4.61%
- Paraformaldehyde: 3.81%
- Hexamine: 2.62%
- Other Polyols (TMP, TME, NPG): 2.54%
- Melamine Formaldehyde (MF) Resin: 2.21%
- Others: 19.6%
Formaldehyde Derivatives and End Use Applications

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- **Resins (Adhesives & Coatings) for Wood Products**
- **Textile Treatment**
- **Vulcanization Accelerators (Rubber)**
- **(Poly-) Urethane Foams**
- **Explosives**
- **Paint Resins**
- **Synthetic Lubricants**
- **Plasticizers (Thermoplastics, e.g. PVC)**
- **Elastic Fibers**
- **Household/ Electronic Appliances**
- **Pesticides** (e.g. biocides for oil production)
Expected Growth in Formaldehyde Demand

NORTH AMERICA
- North American demand has recovered since global financial crisis (2013 construction activity)
- Demand primarily from UF & PF resins

There currently are no alternative resins that provide overall better technical performance, versatility and cost effectiveness than formaldehyde-based resins.

- American Chemistry Council
- Demand include 1,4-BDO, POM & MDI
- Markets generally more mature than in Asia, thus slower growth expected

SOUTH AMERICA
- Local formaldehyde production necessitated by impracticalities of shipping
- Mostly used in UF, PF and MF resins
- Relatively small but accelerating demand growth
- Expansion in infrastructure for urethanes and polyesters may render investments in MDI and BDO feasible
Expected Growth in Formaldehyde Demand

**EUROPE**
- Recovery expected to continue
- New world scale facilities not expected
- Capacity expansions & revamps (less developed countries)
- Formaldehyde buyers tendency to install own facilities
- Demand will grow along with wood industry

*Thanks to formaldehyde-based resins, an increasing amount of wood waste is being recycled both for the good of the planet and for the good of consumers.*

– Phil Hope, Formacare Secretary General, August 2013

**RUSSIA**
*Also includes states that became independent from USSR*
- Recovery expected to continue along with that of wood industry
- Significant demand from UF & PF resins, also isoprene manufacturing
Expected Growth in Formaldehyde Demand

MIDDLE EAST
- Relatively small formaldehyde vs. methanol demand
- Traditional wood-related uses for formaldehyde uncommon (no forestry)
- Swift growth in other formaldehyde-derivative facilities, e.g. paraformaldehyde and slow release fertilizers, amongst others

AFRICA
- Consumption limited to basic and traditional uses in resins
- Imports of formaldehyde derivatives such as UF and other resins are heavily relied on by wood product manufacturers
Expected Growth in Formaldehyde Demand

ASIA

- Growth primarily from UF & PF resins
- BDO & MDI sectors also contributes increasingly
- MMA may contribute to a more significant extent than expected, depending on the production technology
- China remains center of global formaldehyde demand
- Chinese demand to grow at slightly lower pace than previous 5 yrs

*At present, China’s economy has entered a state of new normal – the gear of growth is shifting from high speed to medium to high speed.*

– Li Keqiang, January 2015

- Indian growth rates expected to increase, though no big announcements yet
- Demand still outpaces capacity addition
**Expected Growth in Formaldehyde Demand***

<table>
<thead>
<tr>
<th>Region</th>
<th>2015E</th>
<th>2019E</th>
<th>Growth (%)</th>
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<tbody>
<tr>
<td>North America</td>
<td>2462</td>
<td>2722</td>
<td>10.6%</td>
</tr>
<tr>
<td>Europe</td>
<td>3721</td>
<td>4029</td>
<td>8.3%</td>
</tr>
<tr>
<td>Middle East</td>
<td>275</td>
<td>328</td>
<td>19.4%</td>
</tr>
<tr>
<td>Africa</td>
<td>80</td>
<td>93</td>
<td>16.3%</td>
</tr>
<tr>
<td>South America</td>
<td>566</td>
<td>674</td>
<td>19.2%</td>
</tr>
<tr>
<td>Russia</td>
<td>724</td>
<td>836</td>
<td>15.5%</td>
</tr>
<tr>
<td>Asia</td>
<td>9645</td>
<td>12207</td>
<td>26.6%</td>
</tr>
<tr>
<td>China</td>
<td>3282</td>
<td>3998</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>357</td>
<td>466</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>497</td>
<td>548</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2080</td>
<td>2166</td>
<td></td>
</tr>
</tbody>
</table>

*Thousands of Metric Tons as 100% Formaldehyde

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References

- Methanol and Derivatives Analysis 2014, Methanol Market Services Asia Pte Ltd, Singapore

- www.formaldehydefacts.org

- https://agenda.weforum.org

New EU classification for formaldehyde

An association between FA exposure and carcinogenicity has been studied globally for decades. What has changed?

New classification from 1.1.2016

- **Carcinogenicity**: cat. 2 → cat. 1B (“suspected of causing” to “may cause”)
- **Mutagenicity**: cat. 2

The rational for this classification was not based on new evidence but was due to a change of the classification criteria and their interpretation under REACH.
Formaldehyde Reclassification timeline

- December 2012: RAC adopts reclassification opinion
- June 2014: 6th ATP with new FA classification published in the Official Journal
- March 2013: ECHA publishes RAC opinion on its website
- July 2013: COM notified 6th ATP to WTO
- December 2013: REACH 133 committee adopts 6th ATP
- June 2014: 6th ATP with new FA classification published in the Official Journal
- 1 January 2016: New FA classification applies in the EU

**CLP RECLASSIFICATION**

**TRANSITIONAL PERIOD:** new classification does not apply

**From OJ publication:** manufacturers, importers and downstream users may already apply the provisions of the 6th ATP, on a voluntary basis.
### Which legislations are affected?

From entry into force of CMR 1B classification (01.01.16)

<table>
<thead>
<tr>
<th>REACH</th>
<th>CLP</th>
<th>Other Legislations</th>
</tr>
</thead>
</table>
| - Carcinogen 1B can lead to proposal as SVHC “substance of very high concern” under REACH  
  - Possible “fast-track” restrictions on consumer uses | - New labelling and Safety Data Sheet requirements for mixtures | - Carcinogen and Mutagen Directive  
  - Biocidal Products Regulation  
  - Cosmetics Regulation  
  - National Regulations |
What are the current practical safe levels?

- Formaldehyde has been Registered under REACH with a DNEL (Derived No-Effect Level) for inhalation, workers, 8h shift of 0.4 ppm. Formaldehyde can be handled safely.

- Based on the most recent scientific research, industry supports an occupational exposure limit of:
  - 0.3 ppm Time-Weighted Average (TWA)
  - 0.6 ppm Short-Term Exposure Limits (STEL)

Formaldehyde is produced naturally by all living organisms; it is a critical molecule for the formation of proteins, DNA and RNA. Formaldehyde is quickly metabolised.

Formaldehyde is present in many different foodstuffs, such as apples (up to 20 mg/kg), pears (up to 60 mg/kg), and lobster (up to 100 mg/kg).

Formaldehyde is naturally emitted by vegetation (leaves and wood) – up to 10 million t/a globally; less than 1% of the emissions come from manufacture & use of industrial formaldehyde.
Every day, people benefit from products that contain formaldehyde. This chemical is a critical, commercially valuable, and basic building block in our modern society.

http://www.formaldehydefacts.org/economy