JM

Johnson Matthey
Inspiring science, enhancing life

Informally speaking

A formaldehyde magazine from Johnson Matthey

FORMOX 2.0 – first project underway

Formaldehyde Europe 2018

The role of our Engineering department

Formaldehyde India 2018

Green Policies in China

WINTER/SPRING 2019

Change the new normal?

Dear reader,

So much has happened since the last issue of Informally speaking was circulated! In 2018 we launched our Sustainable Business Framework which is geared towards reducing greenhouse emissions, improving sustainable business practices, doubling the positive impact that our products make towards a cleaner and healthier world and ensuring inclusion and employee engagement. To affectively achieve these goals JM was reorganised into one strong brand, bringing together our expertise to make the most of everything we can offer. And since science and technology is at the core of JM and what we do, we have focused our expertise to solve your complex problems while making the most of our planet's natural resources.

Towards these goals we have taken a great step to be prepared for the future with the release of **FORMOX**™ 2.0, for both new and existing plants, for commercial sale. **FORMOX** 2.0 aims to lower the investment cost per ton of capacity as well as to reduce electrical power consumption. But we haven't stopped there, on-going R&D projects are focused on prolonging the time between catalyst re-load, increasing yield and further reducing investment cost with our eye towards further developments in safety and automation. Within the next year we anticipate the first **FORMOX** 2.0 plant to come online.

As many of you are already operating **FORMOX** plants we want to be sure that **FORMOX** 2.0 can be made available for existing plants and so have brought both Claes Lundström and Birgitta Marke on board to work with plant upgrades. Claes and Birgitta, and our entire JM team, bring many years' experience and knowledge in commercial and scalable solutions for the formaldehyde industry and will work with you to ensure your plants are up-to-date and economically competitive.

We have recently completed a major initiative to predict the future of the formaldehyde industry. The future looks good, even great. Of course, there will be obstacles along the way, but we strongly believe collaborative relationships between customers and suppliers will create a competitive advantage and long-term value.

We encourage you to join us in workshops which support open engagement and dialogue between attendees and industry experts to discuss opportunities and issues as well as safety initiatives. In fact, you will find a good deal of discussion in this release of the Informally speaking newsletter centered around safety topics and concerns.

By the time this newsletter goes to print, I, Andreas, will have left JM for new adventures at TetraPak in my home town of Lund. It has been a pleasure and privilege working with you and my associates at JM and I wish you all the best.

We hope you find this issue interesting and that it provides some helpful insight and we encourage you to let our colleagues know what you would like to read about in our next issue.

Andreas Magnusson and Ronnie Ljungbäck

Global Market Managers
Formaldehyde, Johnson Matthey

Content

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Achieving a better and more sustainable future

It is more than three years ago since the largest call-to-action for sustainability ever was announced. The leaders of 193 nations adopted an ambitious set of global goals to combat poverty, inequality and climate change in the United Nations (UN) General Assembly. At the same time, the United Nations called for governments, businesses, NGOs and citizens around the world to join forces in achieving the 17 Sustainable Development Goals (SDGs) and its associated targets by 2030.

The last quarter of 2018 saw us land the first commercial deal for a brand new JM technology that turns household waste, which would otherwise be landfilled, into transportation fuel. It's technology we developed working together with BP, and our customer, Fulcrum BioEnergy, is planning to build a plant to convert around 175,000 tonnes of garbage into some 11 million gallons of fuel every year – that's enough sustainable fuel to power a plane for over 180 return flights between London and New York – pretty impressive!

This commercial success is the culmination of over a decade of hard work by many people in JM but it is a small step to achieving a bigger goal. As with all big goals, it's the multiplying effect of many smaller efforts that will make the difference. That's why JM, driven by our vision for a cleaner, healthier world, has made sure that our six sustainable business goals are contributing to the global SDGs.

BY

Nicole Watson
Marketing Communications Representative

Goal 1 Aspire to zero harm

Goal 2 Build an engaged, diverse and inclusive workforce

Goal 3 Reduce our greenhouse gas emissions per unit of production output by 25%

Goal 4 Improve sustainable business practices in our supply chains

Goal 5 Double the positive impact of JM's products to a cleaner, healthier world

Goal 6 Give back to our communities through 50,000 cumulative days volunteering.

In 2018 72% of FTSE100-listed companies described in their Annual Reports how their business goals are aligned with the SDGs. JM's commitment to achieve success needs everyone's input, and our business has a key role to play with its talented workforce and global operations.

On the front page:

JM sign first contract for new mono ethylene glycol (MEG) technology

Read more about this story on page 20

Formaldehyde Europe 2018

Helsingborg 28th – 31st May

The Formaldehyde Europe 2018 conference was held, as usual, in Helsingborg in the south of Sweden, and we managed to catch lovely weather in the last few days of May.

The meeting commenced on the evening of May 28 with a simple buffet, where people got a chance to meet and mingle before the event started the following day. Lars-Olle Andersson opened the first day by informing the audience of the itinerary for the next three days of the conference, Mark Danks followed by presenting a safety moment as well as an update on how JM is performing and what the JM business is currently doing. Fredrik Rietz, Ronnie Ljungbäck and Tomas Nelander continued with updates on what JM can offer in terms of **FORMOX** plants, catalysts and technical support.

After a well-deserved coffee break, it was time for the main news during this conference, the launch of the **FORMOX** 2.0 technology. Please see separate article on page six to understand what **FORMOX** 2.0 is offering. The new plant design as well as the new catalyst raised a lot of interest and good discussions took place on the benefits of using it.

The time was now up for lunch and as is custom, to earn the lunch ticket, we should gather for the group photo before enjoying the same.

During the afternoon, Lars-Olle Andersson continued presenting some perspectives on the formaldehyde market, hinting at a bright future for formaldehyde in general. Wolfgang Seuser also outlined the same for methanol when sharing his and MMSA's view on the future. However, Wolfgang also raised the question on methanol's role as an alternative energy source when considering fossil fuels' future and sustainability in terms of going green; which proved quite interesting.

A short break after the market session, gave time for more networking and then the final presentations for day one followed. Mr D Prasad from OFCC shared the views and policies of their company; concerns relating to confined space and

how that influenced the formaldehyde plant operation and maintenance. The day's presentations were concluded by JM presenters Anna Wemby Björk and Ola Erlandsson, sharing JM views about safety in the **FORMOX** plant environment, relating to rupture disc design, reasons for deflagrations, how to mitigate fires and minimising the ignition source. After a great day with a lot of information to digest, everyone made their way to the nearby Sofiero Palace, where a very enjoyable dinner took place.

Day 2 of the conference began with a visit to our Perstorp site where several informative stations had been prepared. After returning for lunch to Helsingborg further presentations were given on upgrades of plants, importance of volume flow, formaldehyde tank considerations and different aspects on catalysts. In the evening we made a classic "tura" meaning dining on the ferry between Helsingborg and Helsingör; we managed to take three turns...

The third and final day of the conference covered technical aspects; pressure drop and pilot tube measurements, as well as CO analysing and describing in depth how to run the absorber optimally.

We thank all participants for their contribution and look forward to the next opportunity to meet with you.

BY

Paul Walter
Regional Sales Manager

Ronnie Ljungback
Global Market Manager

Our next European conference will take place in 2021, but in 2019 you will have the opportunity to participate at our conferences in Malaysia, Brazil or China **(see page 23)**

FORMOX 2.0

Our first project is under way

After the launch and first sale at the beginning of 2018 we are glad to inform you that the first project for FORMOX 2.0 is under way and currently in the engineering phase. Dynea N.V., outside Gent, has selected FORMOX 2.0 technology for the expansion on their site.

A new product on the market

We have been informing you in earlier issues of Informally Speaking that a plant capable of even higher capacity soon be ready for launch. At the beginning of February 2018 this product, **FORMOX** 2.0, was launched on the market. The new plant range is designed to be able to operate at 33% higher capacity (in relation to the previous standard range – **FORMOX** 1.0). This is a ground breaking technology step that has been made possible through JM's unique turbocharger technology.

To further utilise the turbocharger technology JM has, since the first unit was started in 2010, considered higher pressure operation as a natural next step in the technology's development. The launch has been exciting for the whole organisation and we are proud of the accomplishments both in the plant design and catalyst development.

FORMOX 1.0

	FS1:1	FS2:1	FS3:1	FT2:1	FT3:1	FT4:1 TC
Design capacity (MTPD 37wt%)	70-185	110-300	150-418	220-600	300-836	385-1065

- Electric drive for fans and blowers
- Still available with turbocharger

FORMOX 2.0

	FS1:2	FS2:2	FS3:2	FT2:2	FT3:2	FT4:2
Design capacity (MTPD 37wt%)	70-246	110-400	150-556	220-800	300-1112	385-1423

- With turbocharger
- Capacity range 33% higher for peak loads

Table 1: **FORMOX** plant range, 2018

Plant range 2018

The **FORMOX** 1.0 standard plant range includes a standard design with a number of standard options. The turbocharger option has been increasingly popular due to the significant reduction in power consumption. Table 1 above shows the **FORMOX** 1.0 standard plant range that is familiar to many of our clients and its capacities.

Table 1 above shows that **FORMOX** 2.0 also offers the same range of plant sizes, which implies that **FORMOX** 2.0 is the same size equipment, but that is only partly true. An example is the number of reactor tubes, which is the same for FS1:1 and FS1:2. However, the overall reactor design is modified in order to handle a higher capacity. **FORMOX** 2.0 is designed for the higher pressure and higher capacity.

The higher pressure operation also requires a new, recently developed type of catalyst, which is placed in the upper part of the reactor tubes where the new catalyst is needed to efficiently handle the higher operating pressure and methanol load.

Launched and first project underway

The official start date for the sale of **FORMOX** 2.0 was in February 2018, when all milestones in the development program were reached. At our Formaldehyde Europe 2018 event there were a number of presentations on **FORMOX** 2.0 and high pressure operation and we had a genuine interest from several of the customers attending.

The new technology has been offered and discussed with several potential customers and we have seen interest where the new operating point will offer favourable cost savings regarding both capital investment and operation of the plant. However, the maximum capacity operating point that we offer is peak capacity in the beginning, until we have verified the performance in a full-scale plant with the new design and catalyst.

We are very happy that Dynea N.V. (a subsidiary of Unilin BVBA) appreciated the advantages of the new design and selected **FORMOX** 2.0 for their expanded capacity at their site in Gent, Belgium. The new plant is scheduled to start-up during the second half of 2019. We are looking forward to run the new operating point shortly after the start.

It will be important for JM to have a reference plant in operation. We look forward to hopefully reporting back on the results of this in our upcoming issues of Informally Speaking.

BY

Fredrik Rietz
Global Commercial Licensing Manager, Formaldehyde Plants

Update
FORMOX 2.0

NPI process

As you may read in this edition, the FORMOX 2.0 formaldehyde technology was launched at the Formaldehyde Europe conference in Helsingborg in May 2018. The **FORMOX** 2.0 technology delivers significant investment and operational savings on new plants, with highly efficient operation across a wide operating envelope. The technology contains a new catalyst (HP1 INI CAT) at the heart of the process, along with key technical advancements in the cooling reactor and the Emission Control Systems (ECS). This article aims to describe how we worked on this project when developing the new design.

The technology has been developed by a multi-disciplined technical team, operating across our sites in Sweden (Perstorp) and the UK (Sonning, Stockton-on-Tees). Given the wide scope of the technology development, for the first time (for the **FORMOX** process) the technology has been developed and managed using the Johnson Matthey New Product Introduction (NPI) process (stages outlined in figure 1). The process is a stage-gated process where economic and technical goals are evaluated at each stage to minimise the risk to the technology and to allow prioritisation of resource to meet key project milestones.

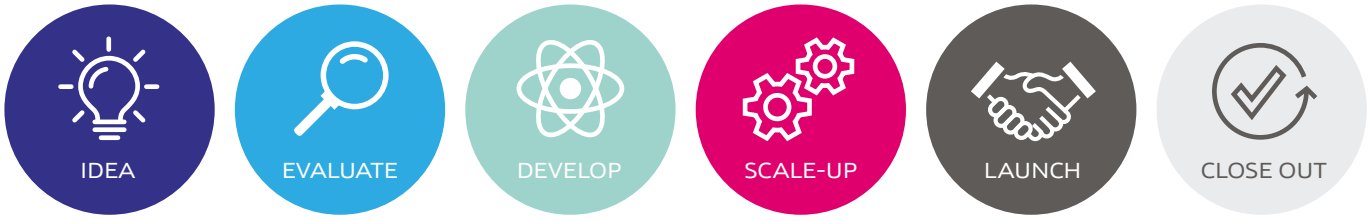
Within the **FORMOX** 2.0 NPI project there have been many workstreams (catalyst development, catalyst manufacturing and scale-up, catalyst loading plan, ECS technology development, basic engineering design and plant layout) and each is assigned a workstream leader, who is responsible for the results of that workstream. The individual workstream leaders report to the technology project manager who, along with a phase review committee, decide whether the project can progress to the next stage. By employing this process, we have been able to develop and finally offer the **FORMOX** 2.0 in 2018.

Several new process models have also been developed to support the technology by the process engineering teams. Both a new predictive model for formaldehyde product absorption and a new model of the reactor catalyst beds have been designed to aid the development of the CAP HP1 catalyst system and reactor cooling design. New Computational Fluid Dynamics (CFD) simulations have been performed to assess flow distribution across the reactor tube sheet inlet and ECS catalyst. In addition, deep scientific insight during catalyst development has increased our fundamental understanding of the catalyst design and operation.

BY

Darren Gobby
Principal Process Engineer

Figure 1: The Johnson Matthey NPI process



Deflagrations

There are many systems to protect the formaldehyde plant from deflagrations.

- Methanol flow meters during start-up
- Oxygen meters during normal operation
- Temperature measurements to detect fires
- And as final safety: the rupture discs

The instruments are there to prevent a deflagration. However, we know from reported statistics that the instruments fail once every 15 reactor years. The rupture discs (pictured in Figure 1) will then protect the plant. JM is continuously working on how to reduce the number of incidents and the present rate is much less than it has been historically. There has never been any damage to a protected vessel in a formaldehyde plant due to a deflagration.

It is important to follow some general guidelines to minimise the deflagration risk.

- Oxygen meter – calibrate, check response time, no under pressure in vent line
- Process gas flow meter – clean element
- Methanol accumulation – drain below the vaporiser, check methanol valves for leaks
- Fire – keep the system clean from paraformaldehyde, wood etc., find HTF leaks
- Catalyst – no exposed catalyst on the tube sheet after reloading

The sizing of the rupture discs is calculated so that the deflagration pressure never goes above the design pressure. In most formaldehyde plants the following equation is used to calculate the relief area.

$$F = \frac{100 \cdot V_L^{1/3} \cdot V^{2/3} \cdot \left(\frac{dp}{dt}\right)_{max}}{k \cdot \left(\frac{2}{k+1}\right)^{\frac{1}{k-1}} \cdot \sqrt{\frac{k}{k+1} \cdot \frac{2 \cdot R \cdot T}{M}} \cdot \alpha \cdot P}$$

The higher pressure system in the modern plants has made it necessary to take in the dp/dt value´s dependence on initial pressure. This will result in slightly larger discs in a new higher-pressure plant. A general check of the older designs has shown that there were sufficient margins to cover these cases.

JM has participated in many deflagration investigations together with clients. We aim to find the root cause and to suggest changes that would prevent incidents in the future.

The investigations are typically based on:

- DCS trend curves
- DCS event lists
- Construction drawings
- Interior photos from reactor, vaporiser, pipes, etc.
- Burst disc inspection
- Catalyst inspection
- Reactor leak testing
- Disc holder torque test
- Operating procedures

It is a good idea to inspect the installed rupture discs during every catalyst reload. Pay special attention to the integrity of the plastic liner, the disc position in the holder and for possible signs of metal fatigue. You can expect many years of operation from a correctly handled disc.

Figure 1: Rupture discs

BY

Ola Erlandsson
Senior Process Specialist

Engineering – with the customer in mind

Just a few days after the ink has dried on the signed contract between the customer and JM the Engineering team start working on shaping the customer's formalin plant. A project manager is appointed and the team is nominated to carry out the project. Now Engineering starts a 15-18 month long journey through the project - from the initial meeting right up to a plant being in operation. Customers are situated in all corners of the world, which can be a challenge both technically and logistically, but our knowledgeable team is comprised to work with you to meet your challenges head on and deliver to any location.

The strength is in our employees

Engineering consists of two engineering groups – Mechanical & Piping and Automation. In total, the department has eleven engineers. Five belong to Mechanical & Piping and six are part of Automation. External consultants are involved when the allocation of resources so requires. Together we have about 170 projects behind us and +100 years of experience to deliver formaldehyde plants. The experience of our people is probably, by far, the greatest strength we have. It secures the know-how and the opportunity to not only carry out projects efficiently and develop technology in the plants, it also creates an opportunity, in the future, to recruit young engineers into the project execution organisation. Engineering does not only execute plant projects to customers they also support other functions within the formaldehyde business, such as Commercial, Operations, Technical Service and R&D.

Figure 1: Engineering team at Perstorp

The process is the key to success

In order to keep several projects running in different project phases at the same time, and to deliver on the agreement while maintaining quality, it is fundamental that we have a clear methodology in how we execute projects (Figure 2). During recent years we have put a lot of effort into quality assurance of our project model. In all different types of project, it can be said that "the process is the key to success". Poor and undefined conditions often give an unwanted or bad result. The scope of engineering and supply in the plant projects varies for Engineering, from standard plant to tailor-made detail engineering and from full scope to split scope hardware delivery.

What does engineering contribute to our projects?

Engineering is involved in all phases during the project execution, but focus is mainly in the phases Engineering, Purchasing and Commissioning and Start-up.

With an engineering basis from the Process group, detail engineering is performed in all three disciplines: Mechanical & Piping, Electrical and Instrument & DCS. Detailed engineering drawings, specifications and other documents produced in the project are used for calculations, third party approvals, procurement of equipment/services, construction/installation and operation/maintenance of the plant. Plants are engineered in ASME/ANSI/IEC or in EN/PED/IEC depending on the agreement with the customer. The initial meeting with the customer at the beginning of the project is one of the most important milestones throughout the whole project. This is the opportunity to work together with the customer and calibrate all important conditions that are agreed, including the conditions prevailing on the site where the plant will be constructed.

Automation equipment is purchased by Engineering and delivered to the customer. To eliminate any problems after delivery from the manufacturer Factory Acceptance Tests (FAT) of critical equipment at manufacturers workshop are performed. The strategy is to facilitate for the customers maintenance activities by delivering automation equipment from established manufacturers that are represented globally. Local support and equipment documentation from suppliers is important when handing over the plant to the customers plant management. A goal is to work towards having a green profile through all project

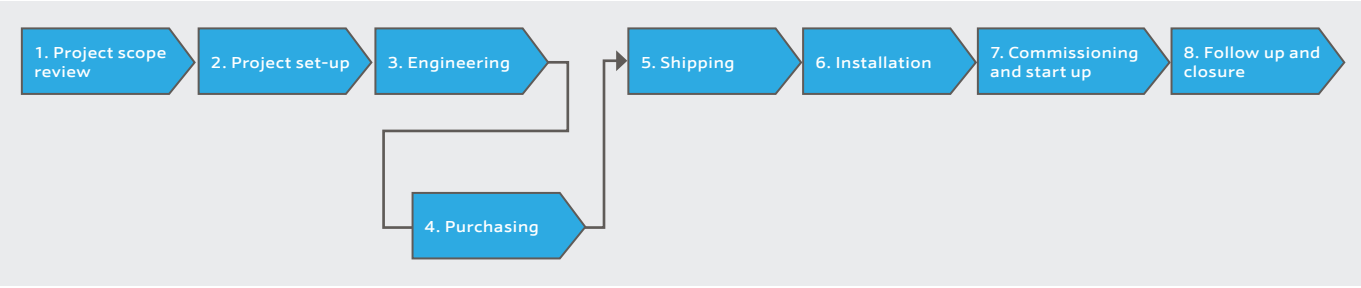


Figure 2: Worksheet for the delivery of the technology and plants

phases. One example of this is that all project documentation is now more often delivered in digital format only. When the equipment is inspected and packed it is transported to the port from which the goods are to be delivered.

Engineering carries out the configuration of the Distributed Control System (DCS) application to match the design and hardware of the DCS and to monitor and control the process as well as safety functions. Emerson DeltaV is chosen as the DCS in-house system. But, other vendors can be offered if the customer prefers. Configuration of the project specific application is prepared in the office. Verification and simulation of the application is always done before travelling for pre-commissioning. Once on site, the application is loaded into the target system. To support this an investment into the project environment was done previously. This applies to not only configuration activities, but also training and valuable hardware tests.

The customer erects the plant itself. A site advisor from JM visits the customer during the construction/installation phase to provide support and good advice. When the plant is mechanically and electrically completed, a JM team travels to the site for pre-commissioning and commissioning. Even some equipment suppliers join to perform the Site Acceptance Test (SAT) on site. The JM team works closely together with the customers team. This provides an opportunity to inspect the installation, correct any shortcomings and instruct and educate them in the equipment. An important part of the commissioning is to carry out a final validation of the DCS application, such as alarm limits, logics, interlocks and safety functions. During the pre-commissioning and commissioning the safety on site is important. Several weeks ahead of departure the customer must verify that they have the safety procedures that are required and confirm the safety on site is sufficient.

A key strength to achieve successful projects, is that we always try to have the same team of engineers working on project from start to finish. This helps in continuity and our relationship with the customer is not compromised

Development in design

Bringing in technical design news is always interesting, and part of the development for technology driven companies. We want our business to stand for robustness and reliability and are therefore a little conservative in technology changes, so these are only implemented after careful consideration and decision making. However, it is also essential to be at the forefront of innovation to be attractive to customers. We are always listening to what customers are asking for and we aim to continuously improve. During the last year the automation design has become more modern, simpler, less components that can create faults, easier to understand, safer with less installation material for the customer.

Collaboration over technologies

Engineering is a department that works closely with EP (Engineering & Procurement). During the last year technologies from other businesses within JM have collaborated with our Engineering department, for instance we recently worked with our Methanol business which has resulted in the signed agreement for a new MEG plant. We hope more success stories will follow ...

The market in China is demanding

Requirement for more local presence in all project disciplines in China has increased over the last year. The market for our products is large in China and we are, in fact, currently looking at how we can strengthen our project organisation in China, in a sustainable way. This is a challenge for us, but also necessary to keep our position as a market leading supplier.

Conclusion

It is a privilege to manage a department like Engineering, with so much knowledge and experience and with the attitude to always do a good job and have the customer's requirements in mind. The entire world is our workplace, which means that we travel quite a lot and that requires flexibility, not only from the employees themselves but also from their families.

BY

Stefan Wedman
Engineering Manager

New green policies in China

For a better environment, replacing outdated Silver technology with modern Oxide technology

The chemical formaldehyde has been known for nearly two centuries. BASF began the first industrial production at the start of the last century in connection with the invention of methanol synthesis. The first process used crystalline silver as the catalyst, and today the technology is referred to as Silver technology. The application of catalyst has been improved over the years, but the technology is still based on a silver catalyst.

In the 1950s, a new technology using a molybdenum-based catalyst was invented. Known as Oxide technology, this became the new standard for producing formaldehyde in a robust process with outstanding yield and high product concentration. The Oxide process has been constantly improved ever since, offering high performance and

cost-efficient technology. One example of the development of this process is the breakthrough **FORMOX** technology by JM, using turbocharging together with higher process pressure to further increase efficiency, conserve energy and lower operating costs.

Today Oxide is the preferred technology and dominates the global formaldehyde industry, representing nearly two thirds of the global output. A distinct exception from this global trend is China, where about 75% of all formaldehyde is still produced using Silver technology.

Although Oxide technology has been successfully introduced in China over the last decades, until now it has mainly been used for the Chinese high-performance chemical industry typically producing BDO, MDI and POM.

In the traditional wood segment, however, Silver technology still dominates in China, providing formaldehyde for local resins producers of boards and surface materials. Why is this so? The board industry for housing and furniture consists typically of small enterprises with low or medium size consumption of formaldehyde. Adding a small, cheap unit for producing formaldehyde for resins adjacent to local board production has historically been the common practice in China. In general, the technology used has been low-ranked silver technology with low efficiency and mostly without emission control, often located close to residential areas and villages. It is estimated that the number of these small units could be as high as 700. Driven by overcapacity and the rising cost of raw materials for boards, the consolidation process, making the wood industry more efficient, is growing. Yet no real step change in this area has been spotted so far.

Nevertheless, the situation regarding China's formaldehyde industry is about to change dramatically. The Chinese government, in its 13th five-year plan, laid out the strategy and pathway for development, including concrete environmental and efficiency targets for carbon emissions, energy and water consumption. Green development establishes requirements and constraints for future industrial development, and a series of policies regarding energy consumption, resources and efficiency utilisation, safety and innovation, have been put in place. It is supported by the "Made in China 2025 strategy", an action plan for implementing the first decade of this "manufacturing power" strategy.

A consequence for the chemical industry is the need for Chemical Industrial Parks that will adopt advanced process equipment and control systems, abandon high-energy, implement a recycling economy and achieve safe and sustainable development. For the formaldehyde industry in China, this puts increasing pressure on small-scale capacities with poor yield and energy efficiency, and inadequate emission controls. Of further concern is safety and the existence of hazardous chemical enterprises located in populated urban areas. These small-scale capacities will gradually be forced to shut down and relocate.

The new policies and reforms are already becoming a reality for many formaldehyde producers, and will certainly affect many more in the years to come. We will likely observe one of the most dramatic changes in the formaldehyde industry ever seen sweeping through China for upgrading technology and creating a better environment.

The Chinese government has adopted green development as a concept and made it a requirement for the future development of China's industry. Through a series of guiding policies, China is determined to crack down on pollution. And while these measures will serve a tough blow to the chemical industry, including the formaldehyde industry, they will also create opportunities for new technological innovations.

BY

Lars-Olle Andersson
Formaldehyde Expansion Project Lead

Formaldehyde India 2018

This year Johnson Matthey arranged the first formaldehyde conference in India, primarily to introduce our most cost-efficient plant yet; the FORMOX 2.0. The conference also provided a great opportunity for us to meet our customers and discuss any questions they had regarding formaldehyde technology.

The conference was held 13th to 14th of March, 2018 at the ITC Maratha hotel in Mumbai, India. Representatives from Balaji Formalin, Kanoria Chemicals, Jubilant Life Science, Atul, DF PCL, Adani, Reliance, Rashtriya Chemicals & Fertilizers Ltd and Libra Techon Limited participated in the seminar.

The main topic presented and discussed at the conference was **FORMOX** 2.0 technology. Other subjects presented included how to boost your plant capacity further, safety philosophy and optimal and trouble-free plant operation. A lot of examples of incorrect plant operations were presented and opportunities were given for the participants to ask questions and to join discussions in workshops.

The conference was very much appreciated by the participants who enjoyed the discussed themes and all the opportunities provided for informal networking. The customers valued the chance to meet other delegates within the same industry, sharing experiences, successes and challenges of formalin production. A lot of opportunities for discussions occurred throughout the conference, and especially during the informal evening dinner event, as well as for individual discussions with JM representatives.

BY

Tomas Nelander
Global Technical Support Manager

"This successful event will surely be repeated in the future, the date for next conference in India is not yet agreed but planning is ongoing for future conferences in Asia"

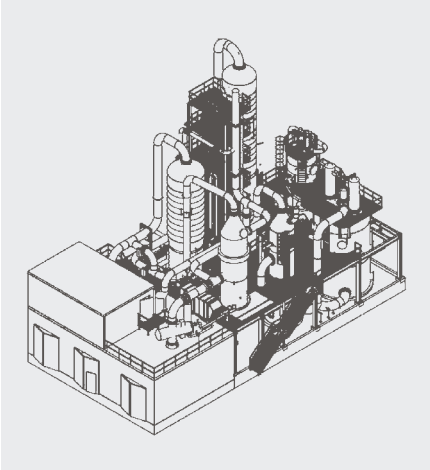
Tomas Nelander,
Global Technical Support Manager

"The formaldehyde market in India is growing and we need to show our presence in the market. We are responding to an increased interest in the Oxide technology for the Indian market going forward."

Fredrik Rietz,
Global Commercial Licensing Manager, Formaldehyde Plants

Upgrades

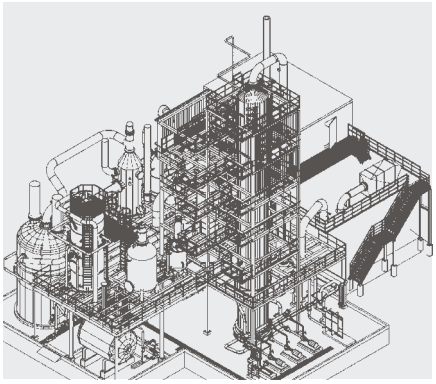
For many years JM has been offering its customers various ways to upgrade their existing formaldehyde plants, often initiated by the customer for reasons such as change in demand, changed legislation or new technology introduced to the market. Lately, JM has been actively working with upgrades as it is an excellent way for our customers to stay competitive. It is also a way to work for a circular economy by prolonging the lifespan of old plants.



Under normal circumstances, JM conducts a feasibility study before an upgrade offer is made. The aim of the feasibility study is to identify bottlenecks in the plant and find the most cost-effective way of reaching the objective of the upgrade.

As an example, if the customer's target is to increase the production by 20%, an outcome of a feasibility study could suggest that the investment cost to reach 15% increase is "X" but to reach the 20% production increase the investment cost goes up to "4 times X" e.g. due to a major piece of equipment that has to be replaced. In such a case it is likely that a 15% capacity increase is the best option for the customer.

In most cases, a feasibility study includes an indicative budget price for a selection of upgrade options as well as an estimation of the delivery time. A feasibility study might also include a site visit, in order for us to check the actual status of the plant (changes compared to original design are not unusual if the plant has been in operation for the last 10-20 years or more) and to have an in-depth discussion with the customer about the plant performance.



In principle, we can investigate any ideas our customers might have, but we have identified a few main upgrade options to focus on (including some examples);

a) capacity increase

i. pressurise the plant or increase the pressurisation pressure (even above 1.5 bara)

b) additional product

i. e.g. production of UFC85 by installation of a separate UFC tower in parallel to existing formaldehyde absorber

c) energy efficiency improvements

i. replacement of blowers with fans
ii. increased inlet
iii. install methanol pre-vaporiser
iv. upgrade ECS with steam generator

d) replacement of old equipment

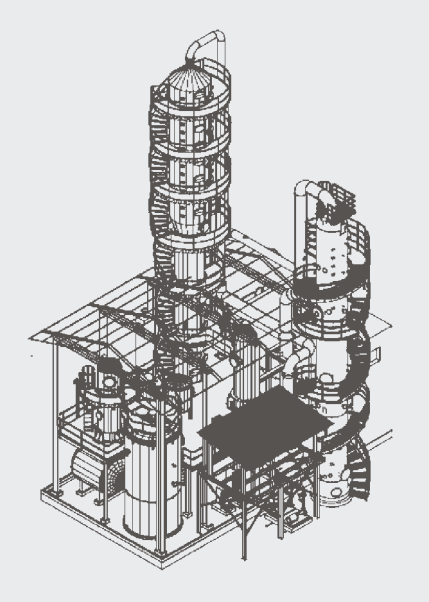
i. often done in combination with any of the other options

e) upgrade to comply with new legislation

i. reduced waste gas emissions.

In rare cases, JM can also assist in relocation of plants and upgrades of non-**FORMOX** plants. In addition, we also supply spare parts to our **FORMOX** plants.

For JM, it is important that our customers can stay competitive for the lifetime of the plant (first installed plants based on **FORMOX** technology date back some 60 years) and make use of the developments and improvements to both the plant and catalyst technology made by JM's formaldehyde business. We execute upgrade projects, from small scale equipment replacements to rather large projects like additional absorption tower for UFC or pressurisation of the plant. Upgrades are also a good way for JM, together with "early adopters", to introduce new technology and have it verified in an operating environment



A critical factor for all upgrades is the installation down-time for the implementation of the upgraded parts of the plant as most customers are depending on the plant output for its downstream production or external sales. This will put high requirements on good planning of the installation and commissioning phases as well as selecting an experienced partner for the project execution. JM's experience in project execution of both new and upgraded plants is essential for making our customers' projects successful.

BY

Andreas Magnusson
Global Market Manager,
Formaldehyde Plants

How clean is your absorber?

One of the most common operational inhibitors encountered on JM's FORMOX plants is the sticky, white polymer of the very product that is being produced – paraformaldehyde. This can have a range of effects depending on the extent of the build-up – from reduced performance in the absorber to seizing of rotational equipment, with even the increased risk of fire. Fortunately, with proper routine maintenance and correct cleaning procedures, these problems can be easily avoided.

How does paraformaldehyde form?

As formaldehyde is absorbed in water, its forms a liquid methylene glycol solution. This is the desired method of product formation in the FORMOX process. However, during polymersation, soluble oligomers of increasing chain length are formed in equilibrium (see figure 1 below). Once these chains develop lengths of 10 or more units, they begin to precipitate out and form solid paraformaldehyde, or para for short.

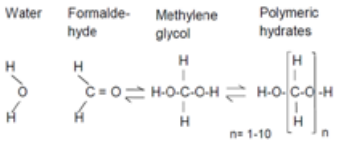


Figure 1: Liquid phase

The most common cause of para formation is low temperatures relative to the weight percentage of formaldehyde in solution. The rule-of-thumb for safely avoiding para dropping out of solution is:

>50 wt.% (wt.% + 7) °C

<50 wt.% (wt.% + 5) °C

If you are still unsure of the correct temperature, always err on the side of caution and select a higher temperature.

Unfortunately, para formation is self-propagating. This means that if para were to begin forming, even in small quantities, then this can rapidly build to large quantities, especially on large surface areas. Depositions can be avoided by tightly controlling the temperature and avoiding any form of standstill of formaldehyde solutions in significant quantities, even at appropriate temperatures.

Removal procedure

Absorber – packed sections

The quickest and easiest way of removing para is to react the solid with caustic solution during a shutdown. The reaction is initiated in a warm environment and is exothermic, so a control over the ratios of components must be maintained.

Initially, isolate the absorber from the process gas lines with blind flanges to prevent any formaldehyde or caustic solution travelling backwards. Several manholes on the absorber should be opened to prevent pressurisation of the column and to provide ventilation. Please note that paraformaldehyde fumes effect people in the same way as formaldehyde, and caustic comes with its own handling concerns. Always remember to wear appropriate safety equipment and follow a safe operating procedure.

Fill the absorber bottom with 60°C water and begin circulation over packed section 1; for packed sections higher up, the closest collector and related pump can be used for circulation. It is advised the absorber is fully drained before commencing.

Control the temperature at 60°C. Feed your caustic solution (typically 50 vol.%) to the bottom of the absorber to achieve a 1-2% solution. Circulate the solution over the packed section and monitor the temperature. NOTE: it is advised not to add 50% caustic directly to para as this may produce undesired side reactions and gas formation.

The rate and extent of the cleaning reaction can be followed by the temperature change; an initial temperature increase displays at the beginning of cleaning, and no further increase highlights the end. Rapid increases in temperature require a slower addition of caustic. pH value should be kept at 11 throughout the procedure for optimal conditions, and formaldehyde content in the cleaning fluid must be less than 15 wt.% - above this cleaning halts. Finally, rinse the column 2 – 3 times with clean water to remove any residues.

Vaporiser

If para forms on the shell side of the vaporiser exchanger, after the reactor, caustic circulation can be used to remove the stubborn polymer.

Isolate the reactor inlet and outlet from the region to be cleaned by installing blind flanges. Using the cleaning nozzle on the bottom shell side of the vaporiser, slowly fill the vessel with warm water. Add caustic solution until a concentration of approx. 1-2 wt.% is reached. Circulate the caustic solution over the tube bundle. The formaldehyde-caustic solution can be removed via the 100 mm nozzle on the top side of the tube bundle. Ensure the vaporiser is open to the atmosphere as identified before.

Plate exchangers

Typically, the packed section coolers can be cleaned at the same time as caustic solution is circulated over the packed sections. However, it is possible using the nearby drain connections to circulate only over the plate exchangers using the pumps and the caustic cleaning tank. Follow the same procedure as highlighted in the absorber routine.

For more information on the causes and effects of paraformaldehyde, or if experiencing any difficulties with removing the deposits, please contact your Regional Technical Support Manager. More detailed procedures for cleaning can also be provided in one of JM's technical information documents.

BY

Mike Brown
Process Engineer

Ion exchanger

The product specification of formaldehyde produced by an oxide plant will typically contain 150-300 ppm (in 37wt%) of formic acid. For most down-stream processes this is an acceptable level, but some, mainly for historical reasons, would require lower level. Over the years JM has been questioned on how this level can be reduced. The traditional way is to install an ion-exchanger unit. An ion-exchanger is a fairly simple piece of equipment that consists of two main vessels installed in parallel, filled with resins and piping/controls for making flushing/regeneration possible. The main design challenges are to choose the correct type of resins and design the capacity such that the running time and regeneration time are optimised in terms of installation and operation cost. A further challenge is to minimise the waste streams and chemical demand as well as to recover useful product. Typically, a system is designed with one line in operation and the other one in regeneration mode. For regeneration, the vessels are first back-flushed with water to recover the formaldehyde hold up. This is then regenerated with caustic and a sodium formate solution is formed. An acid is later used for neutralisation of the excess caustic in the flush liquid.

JM are cooperating with some ion exchanger unit vendors and can supply from basic engineering to a EP scope (including the resin and site service). Further, we have started a project to see if we can make changes in the process or catalyst to reduce the amount of formic acid level in the product leaving the plant.

BY

Andreas Magnusson
Global Market Manager, Formaldehyde Plants

Sub-cooled HTF

In FORMOX design plants, the HTF oil temperature will always differ at some point, between its liquid and gas form, i.e. in the inlet and the outlet of the reactor. This difference is very small or negligible in plants with the present design, but for the ones with designs older than 1986, the year the new HTF condenser was implemented, it can reach about eight degrees of difference, or even more in cases where certain technical problems come up.

In the older designs, which consist of two horizontal vessels (a gas separator and a condenser), the HTF is often sub-cooled in cases where it condenses at an earlier stage in the condenser vessel. Therefore, its temperature becomes lower than it should when getting into the reactor tube shell. The lower the outlet temperature in the condenser, the higher the sub cooling.

In the new design, however, the contact between vapour and liquid phases of the HTF oil is very good, and the moment in time where it condenses doesn't affect the outlet temperature.

The consequence of incoming sub-cooled HTF oil in the reactor can be its delayed boiling, meaning that in the lower areas it will be in liquid form, which diminishes the heat transfer significantly. Due to this, the cooling of the reaction will be less effective and there will be an increased risk for overheating, which will have a negative impact on the performance and on the catalyst, which could be damaged because of high temperatures.

This problem can be sometimes mitigated by increasing the vapour pressure in the condenser, but this solution is limited by the fact that this pressure can't be increased at any rate.

Many of the plants where the old design is still used work perfectly fine, but in cases where performance is affected significantly, it's profitable to upgrade it to the new one, as many have already done.

BY

Alejandro Perez
Technical Support Manager

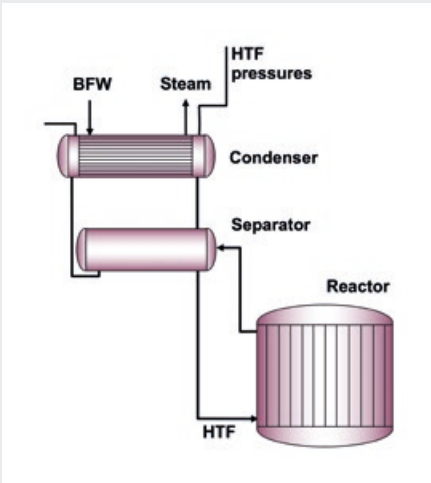


Figure 1: Old design (pre 1984)

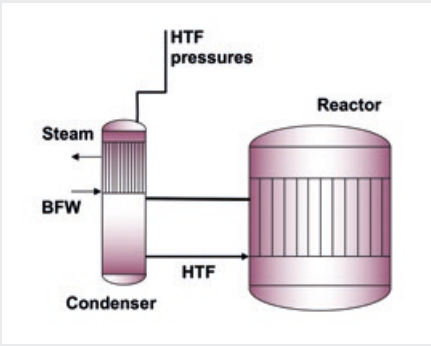


Figure 2: New design (post 1984)

Mo update

In the previous edition in December 2017, I commented on the good times in Europe which we noticed by a high utilisation rate and also that molybdenum had a healthy outlook due to various usages in different industries, meaning the demand should increase over time. I also predicted that the Mo price should increase to a level of 8-12 USD/lb, and since March 2018, the level has been stable at 11-12 USD/lb.

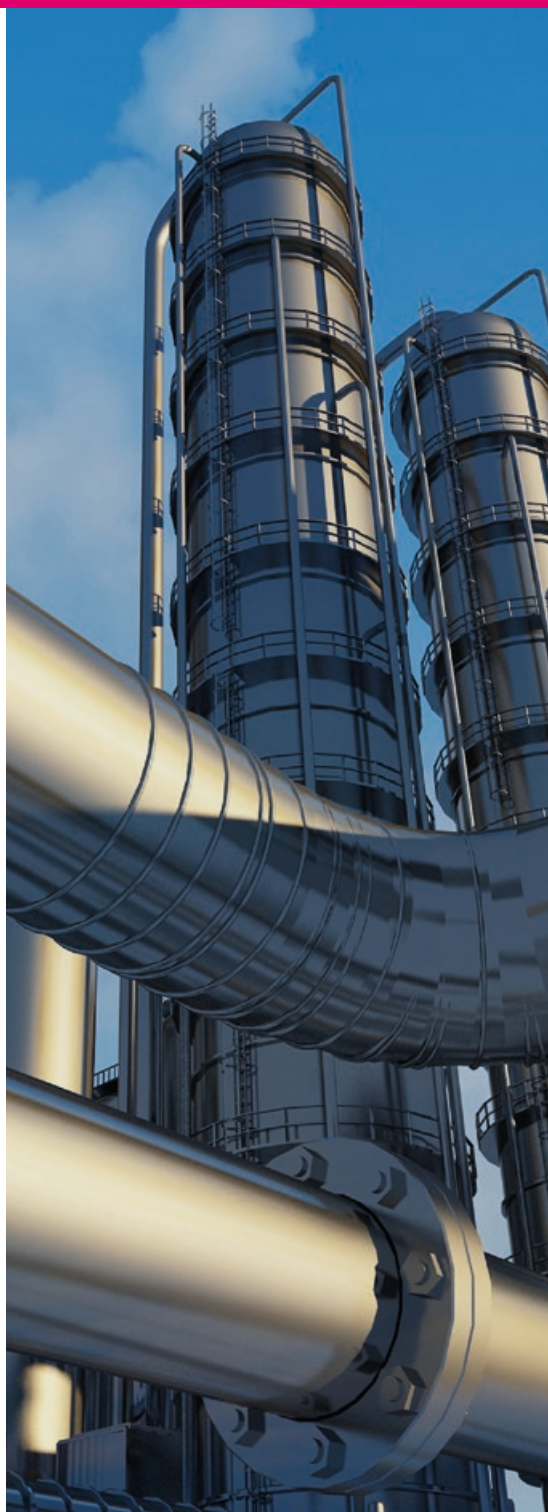
Following what has been happening during 2018, and trying to get an understanding of how the molybdenum market looks going forward, reviewing different analysts' opinions, the outlook still indicates a strong demand and need for steel, including special steels with high molybdenum content in the coming years. It is in the traditional construction and automotive industries, but also in the energy sector, (especially the renewable sector) where much of the special steels with higher molybdenum content are utilised. China, India and also South Korea are areas where particular growth is foreseen. The analysts are pointing towards demand growing faster than supply, indicating new capacity will not balance in the near future.

Thus, based on these general analysts' views, we should probably not expect to see lower prices in the years to come (up to 2027), but rather we will see this as a new 'normal'. Pre-2002, the price was stable at 4-5 USD/lb – now we are likely looking at a new base level of 11-12 USD/lb for a longer period of time, which also includes a gradual increase over the years up to 14-18 USD/lb. I believe we will see price levels remain around 12 USD/lb in the first part of 2019, but then supply will not keep up with demand, pushing the price a bit higher to 13-14 USD/lb in the latter part. There are, of course, many uncertainties related to regional economical and political developments, as well as new ways to utilise molybdenum, which can influence the world economy and the demand for the molybdenum. However, with no major changes, we should expect the molybdenum price to continue to grow slowly upwards rather than returning to earlier lower levels.

This is my current view, but as always, we continue our strive to keep reasonably stable net prices regardless of the market changes. Your efforts to return spent catalyst in good condition to our catalyst recycling system has a strong influence. By treating it as a valuable raw material and according to our specifications, you help keep catalyst prices stable!

BY

Ronnie Ljungbäck
Global Market Manager
Formaldehyde Catalysts



New colleagues

Adnan Ghani

I am a chemical engineer. I graduated from the University of Bahrain in 2004.

Before joining JM, I worked in Yokogawa as a process control systems engineer and as a sales and technical manager in upstream business in Schlumberger Well Services.

I joined JM in 2011 and have held various roles notably in providing technical support to our Syngas customers operating large scale gas-based ammonia and methanol plants. I then moved to a technical/marketing role responsible for Gas processing plants in the MEA region, with a specific focus on purification.

> I love traveling and meeting new people and would always prefer a job which can provide the same.

I am always looking to learn new things and develop myself, to benefit me and the company. I am very excited by the challenges in my new role as Regional Sales Manager (MEA & Turkey) for JM's formaldehyde team.

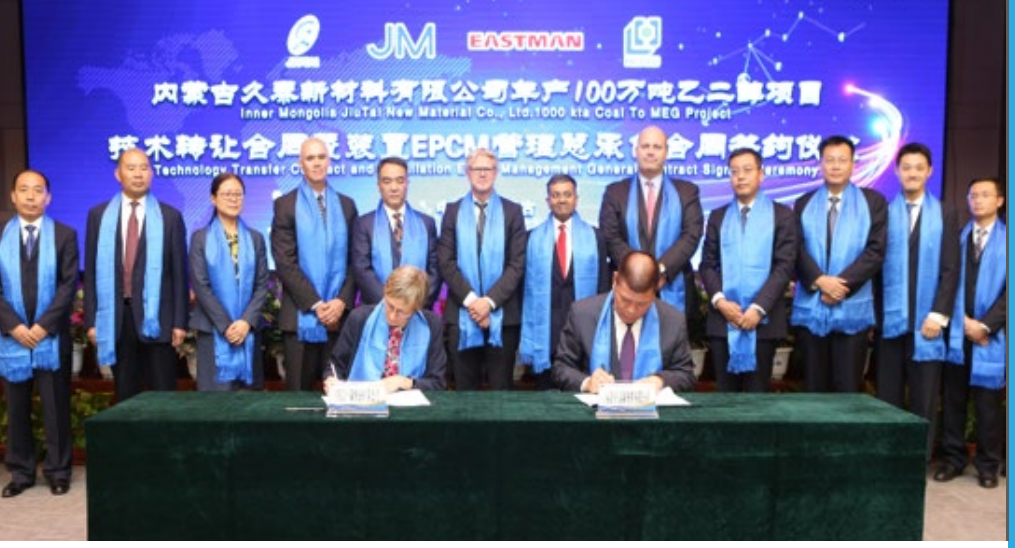
Vladislav Ksenofontov

In 2000 I graduated from Moscow State University, Chemistry Faculty, Catalysis specialty. In 2003 I gained my PhD in Chemistry and several weeks later joined JM. Fifteen years later I am still with the company.

Starting with industrial PGM products, I then moved into a role with Nitro technologies in 2017, being a member of separate project teams from time to time. The biggest single project was on a ECT plant in Krasnoyarsk. A large project for Nitro Technologies in 2013 was a clean-down project of roughly 20 plants in the Ukraine (almost all plants in the territory) which resulted in significant MUSD of PGM collected.

> In 2017 I took the role of Technical Sales Manager in the new JM structure, managing both technical and commercial activities for FA/petrochemical/ chemical catalyst business areas in the FSU region.

Currently my work is focused on JM's formaldehyde business and I am Regional Sales Manager. JM's formaldehyde market share is significant in the FSU, the main users being wood boards producers, but also one of the biggest resins plant in Europe is located here. However, there are also chemical users within the territory (monomers, fertilizers coats). My main concerns within the market are the prevailing market conditions. Despite this, we gained a new plant this year.



JM sign first contract for new mono ethylene glycol (MEG) technology

In September 2018, we signed our first contract to licence our new MEG technology (developed with Eastman) with the Jiutai Group in Inner Mongolia.

MEG is a key industrial chemical and a building block in the production of polyesters for packaging and fibre applications. The majority of the world's MEG is currently produced from ethylene, but our technology allows MEG to be produced from materials such as coal, natural gas or biomass.

Jiutai's coals to chemicals process produces synthesis gas by gasification of coal. We've also licensed to Juitai our world leading technologies and catalysts to produce methanol and formaldehyde in an integrated MEG facility, which will maximise feedstock conversion and reduce utility consumption across the multi-step route from syngas to MEG. They plan to produce 1,000,000 tonnes of MEG per annum.

The methanol plant will be a world scale facility and the formaldehyde plant will have an annual capacity of 1,500,000 tonnes per annum making it one of the biggest formaldehyde production sites in the world.

Jane Toogood, Efficient Natural Resources Chief Executive said

"We're delighted that Jiutai has selected the MEG technology developed through this collaboration between Johnson Matthey and Eastman.

Our focus is to provide highly efficient, sustainable technology and catalysts which enables our customers to maximise their feedstock conversion.

Over the past fifty years, JM has applied its world class science and technology to bring many new process technologies and catalysts to the market which have created significant value for our customers. This new MEG technology is the latest addition to our portfolio and we are excited to bring this to market for our customers."

Celebrating 80 years

On the 5th March, 2018, Max Henning, 'Mr Formox', turned 80 years old.
A group of colleagues from JM's Perstorp site visited and celebrated with him on his big day. Even if it is nearly 15 years since Max retired, he is still in contact with his old colleagues.

Max was involved in the first ever **FORMOX** formaldehyde plant license sale, which was to Foresa back in 1966.

Thank you so very much for all your contribution to our business over the years, Max, and a huge congratulations on your milestone birthday. We just love Max and long relationships.

Training

Top two photos:

JM conducted an onsite training in May at Egger (UK) Ltd's premises in Hexham, Northumberland, for two different teams

Bottom two photos:

JM held on site training for OFCC before the start-up of their new JM Formaldehyde plant; two different teams attended

Projects and start-ups

New Projects

- A client in Eastern Europe has signed an agreement for capacity upgrade of their existing Formaldehyde Production Plant.
- An agreement for an FT3 plant to a client in China has been signed.
- Another agreement for an FS3 plant to a client in China has been signed.
- An FT3 plant has been sold to a Chinese client.
- An agreement has been signed with INNER MONGOLIA JIUTAI NEW MATERIAL CO., LTD. China. The formaldehyde plant will have an annual capacity of 1,500,000 tonnes per annum and will be among the largest single site facility for formaldehyde production in the world.
- Dynea N.V. in Belgium has signed an agreement for an UFC plant.
- An agreement for upgrade of a pressurization unit to a client in Asia has been signed.
- A client in South America has signed an agreement for a capacity upgrade.

Ongoing projects

- The new project to a client in Southern Europe for an FE2 plant is approaching construction phase.
- The new project to a client in China for an FT3 plant is in the design phase.
- Works on a FS1 plant to a client in south east Asia is in the design phase.

Start-ups

- The FT3 plant to KOLON BASF innoPOM, INC (joint venture between KOLON PLASTICS and BASF) was successfully started in April. The plant is located in Gimcheon-Si, South Korea.
- The project to a client in Asia, for expansion of their existing plant with UFC production, went on stream in June.
- The FS1 UFC plant for a client in Middle East was successfully started in July.
- The FS3 plant for Xinjiang Xinye Energy Chemical Co., Ltd, located in China, went on stream in September.
- The FS3 plant to East Europe was successfully started in October.
- The FT3 plant to Wanhua Chemicals Group Co. Ltd., in Yantai China, is proceeding well with scheduled start-up after publication of this issue of Informally Speaking. This will be their second Formox plant on this site.

New faces

Fredrik Bengtsson
Mechanical & Piping engineer

Karl Lundh
Mechanical Engineering Manager

Ronny Böös
Project Manager

Mergim Pacolli
Process Engineer

Kevin Jönsson
Laboratory Technician

David Martin
R&D Engineer

Marko Ristovic
Process Engineer

Victor Åberg
Process Engineer

Catariya Lundgren
Senior Process Engineer

Dean Chu
Process Engineer

Conferences

UPCOMING CONFERENCE

Formaldehyde Asia 2019

April 8-11, 2019 in Kota Kinabalu, Malaysia

Registration open

UPCOMING CONFERENCE

Formaldehyde South America 2019

May 7–9, 2019 in Rio de Janeiro, Brazil

Registration open

UPCOMING CONFERENCE

Formaldehyde China 2019

October dates and venue to be decided

More information to be announced soon.

A formaldehyde magazine from Johnson Matthey

The newsletter Informally Speaking aims to provide information about formaldehyde in an informal forum and is published twice annually by Johnson Matthey for its customers and contacts in the formaldehyde business. The information included herein is part of our customer service and in no way entails or implies any undertakings, legal responsibilities or liabilities.

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