JM

Johnson Matthey
Inspiring science, enhancing life

Informally speaking

A formaldehyde magazine from Johnson Matthey

- Resin plant a perfect fit for ARAUCO Argentina
- New requested features in **JM-LEVO** 2.0
- Bakelite welcomes JM to historic Stirling
- Finding balance in absorption
- Turning 'para' into profit

SPRING/SUMMER 2022

After the woods comes... more trees?

The situation in most countries has improved a lot with regards to Covid, but some areas are still suffering. Like parts of China, for example. Unfortunately, just as we were emerging from the woods some dark clouds rolled in. Like the Russia-Ukraine war, rising inflation, logistics issues, raw material scarcity, and price increases. All making the future look... shall we say, continued cloudy?

A year ago in June, the price of molybdenum took a climb up but has since remained stable at around 19 USD/lb. This of course, has impacted both us and others, and forced us to adjust our prices as well, which our catalyst customers have noticed. Other metals, like nickel for example, have been much more volatile, which, in combination with supply and logistics issues, is influencing plant projects. See Fredrik's commentary on page 18.

One thing we are happy about though, is being able to meet customers in person again. Like we did in April when a team went to Bakelite in Scotland to deliver our first in-person training since the start of the pandemic (see page 7). Customized training via Teams is also still an option, which one customer in Southeast Asia recently took advantage of.

More good news is that we will soon be hosting our highly appreciated Formaldehyde conferences again: Helsingborg in September and Houston in October. And one customer who is looking forward to it nearly as much as we are, is Guillermo Rizzatti, manager of Arauco's resin plant in Santa Fe, Argentina. On pages 10-11 you can read about the value the conferences have had for Guillermo, as well as about Arauco's achievement as the world's first carbon neutral forestry company.

Other items we think may be useful and of interest to you include newly launched **JM-LEVO**™ Formaldehyde features that many of you have asked for, as well as tips on emissions, absorption and preventing HTF fires. Two other typically highly interesting topics for formaldehyde producers are methanol and para, which is why we also have an update on the Methanol market as well as an article about Paraformaldehyde, but mainly as a desired product.

Lars Andersson and Ronnie Ljungbäck
Global Market Managers Formaldehyde

Finally, we look forward to meeting you again, hopefully at one of our upcoming conferences, and to the clouds lifting so that we will have a brighter time ahead, hopefully not too far down the road.

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Liam Condon starts as Johnson Matthey Chief Executive

As we moved into a new year Johnson Matthey welcomed a new CEO, Liam Condon. Liam started as the new Chief Executive at Johnson Matthey on March 1st. He joins from Bayer, where he was President of the Crop Science Division.

Liam says: "I'm incredibly excited and proud to be joining Johnson Matthey with its vision for a cleaner, healthier world. I can see the business is well positioned to accelerate progress across Decarbonisation, Hydrogen Technologies and Circularity – all of which are expected to deliver significant shareholder value and position JM at the forefront of the net zero transition."

Liam has revised JM's strategy and structure. We will serve our global customer base through our four businesses: the current core business of Clean Air, together with our growth businesses, Catalyst Technologies and Hydrogen Technologies, all built on our foundational PGMS (Platinum Group Metals Services), which supplies and enables the others. These businesses are tightly linked by three reinforcing synergies: common customers and partners, shared technology capabilities and a shared PGM ecosystem that enables dependable supply and circularity. JM will catalyse the net zero transition by delivering sustainable solutions to our customers, enabled by our world-class technology and market-leading positions.

Liam takes over from Robert MacLeod, who will stay on to support the transition process until JM's Annual General Meeting on 21st July 2022 when he will then retire from JM.

Our reinvigorated strategy at a glance

Catalysing the net zero transition for our customers in automotive, chemicals and energy, creating value for our shareholders and society

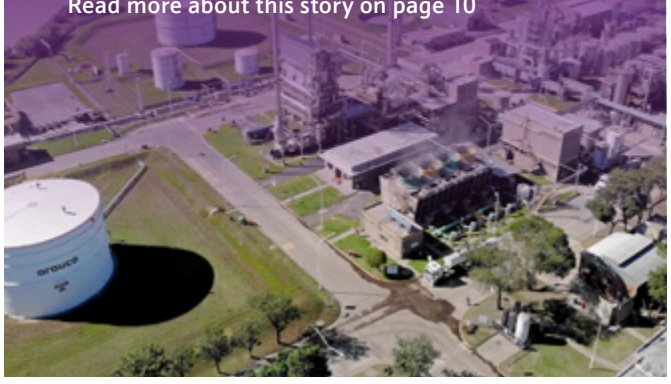
BY

Nicole Watson
Marketing Communications Representative

On the front page:

ARAUCO resin plant in Puerto General San Martín, Argentina

Read more about this story on page 10



Conferences are returning

Formaldehyde Europe
September 12-15th

Formaldehyde Americas
October 10-13th

New release of **JM-LEVO** Formaldehyde introduces enhanced features

After months of continued development following the 2020 launch of our JM-LEVO Formaldehyde Portal, we recently released version 2.0 earlier this spring. The new version includes several new features that our users have asked for and that we were happy to be able to implement.

For the previous edition of Informally speaking some of our customers told us about their experiences with the Portal including ways they are using it besides maximising their yield. For example, one customer explained how the load comparison feature had helped them to onboard a new engineer. The load comparison function is one of the areas that has been further enhanced in version 2.0 and now provides even greater functionality.

Enhanced comparison capabilities

While it has been an important feature from the start, the load comparison function is now more powerful thanks to a higher degree of customization we have introduced for comparing even more data. Users will be happy to notice that they can now choose single parameters. Premium users will have access to an expanded list of parameters (whereas the Included level will offer a shorter list to select from) and will be able to compare up to six different loads in a single view. Examples of the newly added parameters include methanol flow, yield and formaldehyde produced (see Figure 1). They can also do individual comparisons displaying up to four different charts instead of just one. All comparisons can easily be saved for future reference or for including in the customer's internal reports.

Another useful enhancement available to premium users is the ability to change the x-axis in charts. Now instead of only being able to view data plotted against specific production, users can also choose to monitor a parameter relative to days in operation, days since startup or timestamp, a feature that some customers have been asking for.

New visuals for steam production and power consumption

In addition to the above-mentioned enhancements, we have now also added charts to support closer monitoring of key parameters related to the fans, blowers and/or turbocharger operation (Figure 2). These help to track energy consumption and to observe, to some extent, the performance of this equipment. We have focused on the power consumption details since this has been seen as a key issue for the majority of customers. We will most likely incorporate additional charts/graphs to similarly record the production of steam in a future release.

Easier to share data and get recommendations

Already the first version of **JM-LEVO** Portal gave customers a more modern tool for sharing data and getting feedback and recommendations much faster than with our older FPC (Formox Process Control) system, which will be decommissioned at the end of 2022. And along with the new 2.0 version of the Portal, we have made it even easier for you by developing a secure solution for connecting your server containing plant data to a cloud-based data storage. This enables effortless, automatic feeding of data to the **JM-LEVO** database as frequently as you wish.

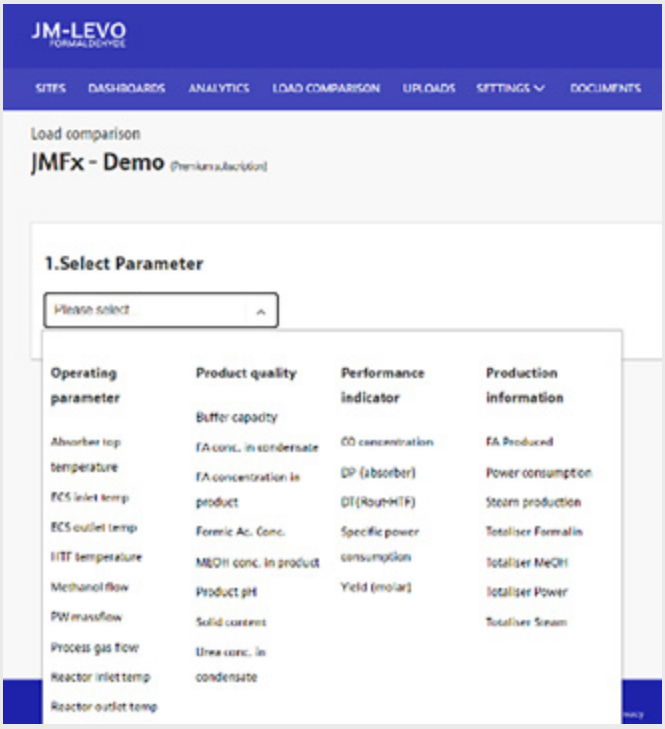


Figure 1: Expanded load comparison capabilities available to Premium users

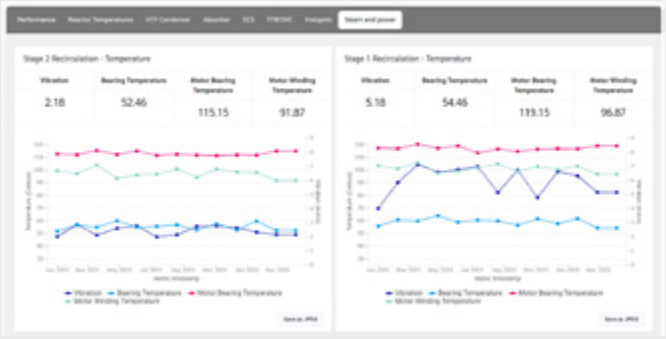


Figure 2: New charts for steam and power, also showing customization of the X-axis from Specific production to e.g. Timestamp

While it has been an important feature from the start, the load comparison function is now more powerful thanks to a higher degree of customization

Along with the new 2.0 version of the Portal, we have made it even easier for you by developing a secure solution for connecting your server containing plant data to a cloud-based data storage

Performance and savings still number one!

Not to be forgotten amongst all this good news are the main reasons why we developed **JM-LEVO** Formaldehyde to begin with – to help you improve performance, manage your formaldehyde production more effectively, and achieve significant savings. See page 8 in the previous issue of Informally speaking to see how a typical FS3 plant may achieve an average annual savings of about EUR 70 000 with a MeOH price at 450 EUR/MT. Therefore, if you have not yet begun to use the Portal, and especially if you are one of the few customers still using FPC to share data, we strongly urge you to reach out to your JM representative to schedule an onboarding to **JM-LEVO** Formaldehyde Portal as soon as possible.

BY

Dr Philippe Thevenin
Global Technical Services Leader – Formaldehyde

Follow us on LinkedIn for further updates or contact Philippe or your Regional Sales Manager or Technical Support Manager if you have any questions.

Emissions what to do?

With the trend towards increasing demands for emission reductions by authorities in almost every region, many of you may be asking, 'What can we do?'.

Fortunately for you, JM has extensive experience in how to reduce emissions in formaldehyde plants that we have gained through our many years of working worldwide.

There are a few different sources for emissions within a plant, and the way to deal with them is different.

Stack emissions after the catalytic incinerator (ECS)

The most obvious emission point is the plant stack. Reductions here are totally dependent on how the catalyst in the ECS is operating.

There are a few ways to improve the ECS performance:

- Change the catalyst more often
- Increase the inlet temperature if the exit temperature allows it
- Operate with a palladium-containing catalyst (e.g. **FORMOX™** PPd-47) as a low-temperature ignition layer on top of the normal platinum-containing catalyst (e.g. **FORMOX** PPt-47) layer if there is a temperature limitation
- Inspect the catalyst to make sure the bed is even and that there are no "rat holes" or net damage
- Add more catalyst if the pressure drop allows it
- Avoid absorber flooding that can contaminate the catalyst bed
- Vacuum-clean the bed if it is dirty

Vent gases from HTF condenser, storage tanks, truck filling stations, etc.

The vent gases can be collected and transported to the ECS catalytic incinerator with a blower. It is extremely important that the system is set up in a way so that the blower cannot create vacuum in vessels that are not designed for that, and that the amount of catalyst in the ECS is sufficient to cover for this additional emission stream.

Fugitive emissions from valves, pumps, etc.

Fugitive emissions cannot be measured. Instead, they are calculated based on the quality and type of equipment.

Typical things that can be done include:

- Better pump seals, e.g. double mechanical seals
- Valves with internal bellows to eliminate spindle leaks
- No leak policy: fix all leaks immediately when found
- Use good gaskets, e.g. spiral wound graphite, etc.
- Plant integrity program
- Develop good sampling procedures and use a pump to return formaldehyde flush liquids to the absorber

Rupture disc and Safety Relief Valve emissions

Calculations can be made of the amount and the composition of the burnt gases after a deflagration. Remember to regularly check the tightness of the SRVs to ensure that no gas or liquid is passing unintentionally. Also, it is important to keep the HTF tank closed and to have the vent cooler in operation.

Interested?

JM has experience of all the above-mentioned possibilities. Please contact your Technical Support representative if you are interested in getting help with any of them.

BY

Ola Erlandsson
Senior Process Specialist

Bakelite welcomes JM to Scotland

Bakelite Synthetics – a global manufacturer

- Facilities: 11 Manufacturing Facilities, 3 Technical Centers and 4 Product Support Labs
- Headquarters: Louisville, KY
- Products: Phenolic, Urea & Melamine Resins, Aromatic Polyols, Molding Compounds, Formaldehyde & Derivatives
- Interesting fact: Bakelite® was developed by the Belgian-American chemist Leo Baekeland more than 100 years ago and was the first plastic made from synthetic components

Note: On May 27 Bakelite Synthetics announced the completion of its acquisition of Georgia-Pacific's chemicals business. This significant expansion of its business is not included in the data above.

For the first time since the outbreak of the pandemic in 2020, a team from JM visited a customer's site to deliver customized FORMOX technology training. Eight staff members from Bakelite Synthetics Ltd's Cowie site participated in two full days of training this April, which took place at a nearby conference facility in the historic area of Stirling, Scotland. The training was prepared and delivered by Senior Consultant Birgitta Marke and Regional Sales Manager Paul Walter, in collaboration with Bakelite's Site Leader, Doug Paton. On the third day of the visit, the JM team visited the **FORMOX** plant at Cowie.

"Doug arranged a great space for the training and made us all feel very welcome," says Paul. "During evening walks we got a few looks at Stirling Castle and Stirling Old Bridge, known from the Battle of Stirling Bridge and the movie Braveheart. And a monument to the hero William Wallace could be seen in the distance."

A return to face-to-face meetings, and to Cowie

The participants from Bakelite were a mix of relatively new managers and engineers as well as Senior Process Technicians having long experience from the Cowie site. Birgitta Marke, who was involved in the design of the formaldehyde plant which was commissioned at the site in 1990, was pleased to be back. "We covered a lot of topics of specific relevance to the plant which we were able to visit on our final day," she says. "It was very nice to see just how well-kept the plant is after more than 30 years in operation. The personnel obviously take pride in keeping it in superb condition. In total, a very nice visit to Scotland with fruitful discussions both during the days and in the evenings."

Will Breeze, a new JM Regional Technical Support Manager for Europe who joined along with Head of Commercial Sales Chemicals for Europe and FSU, Carl Keeley, was visiting the site for the first time: "Despite its age, it is in great shape and very well run and maintained. And as for meeting face-to-face, I found the level and depth of information from free-flowing conversation amongst the group to be invaluable."

Cowie Site Leader Doug Paton was also pleased, thanking both Paul and Birgitta for "an excellent training event. As you heard from the guys themselves, it was very well received, and we are thankful for your efforts and hard work in preparing the material and delivering it over here."

BY

Charles Hodgdon
Editor

Global methanol five years out: Demand growth slows, meeting slower supply growth

Over the past year, methanol markets around the world have weathered pandemic times, war, and swings in marginal feedstock cost, all of which have methanol prices on a seemingly continual rollercoaster ride. The use of methanol as a feedstock to make olefins in China (via methanol to olefins (MTO) processes), is now a major feature of global markets and larger than the use of methanol to make formaldehyde.

MTO affordability often defines the ceiling of prices, and currently, methanol prices are quite affordable for MTO manufacturers. For formaldehyde producers, these developments suggest that, until MTO economics return to typical levels, MTO manufacturers will be able to afford higher methanol pricing. However, note that despite the current affordability status, operability of MTO facilities is currently hampered by downstream logistical issues, and the typical market response of increased methanol demand for MTO may be slow in materializing.

China continues to drive methanol demand growth (see Figure 2) as it develops the use of methanol in MTO as well as traditional sectors of demand. Figure 1 segments the major uses; note the current dominance of MTO versus formaldehyde. While MMSA forecasts the need for 25.5 million metric tons of new methanol demand, this pace is slower than that forecast in previous years. Importantly MMSA sees the potential for a swift increase in methanol demand into marine fuel applications, however those markets will depend on a combination of factors to develop from what is currently a relatively small scale.

One of those factors is regulatory assistance. At present, only certain types of methanol will qualify as a cost-effective means of lowering marine fuel carbon, and conventional ("grey") methanol is not one of those types. As such, MMSA has omitted this sector of demand in its forecast, although it is monitoring

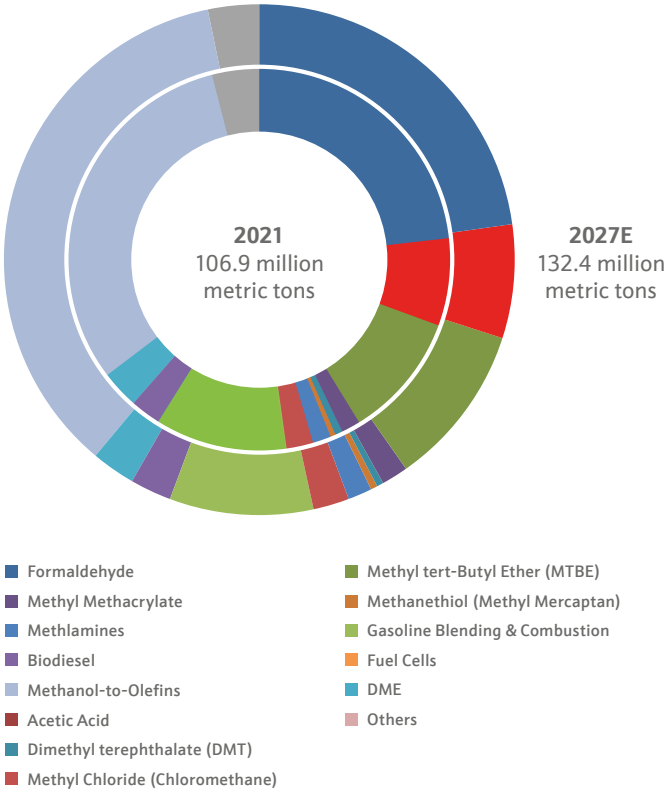


Figure 1 - Methanol use world, by derivative

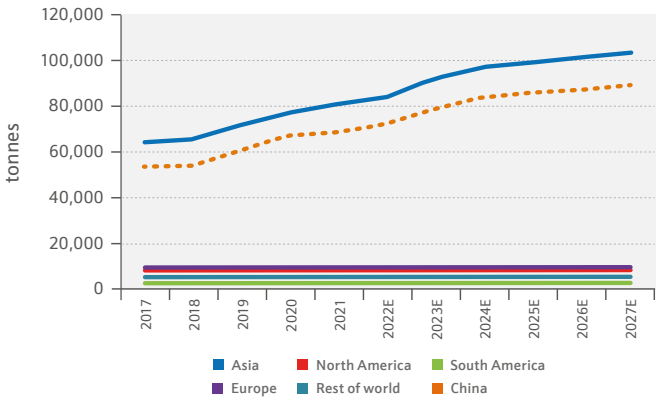


Figure 2 - Demand for Methanol 2017 - 2027E

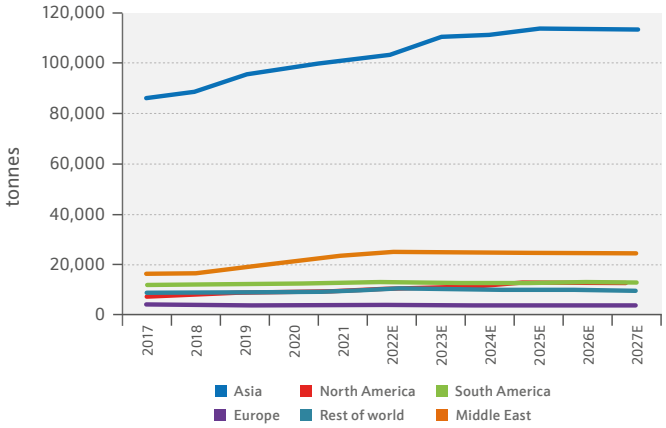


Figure 3 - Supply capacity for methanol by region 2017 - 2027E

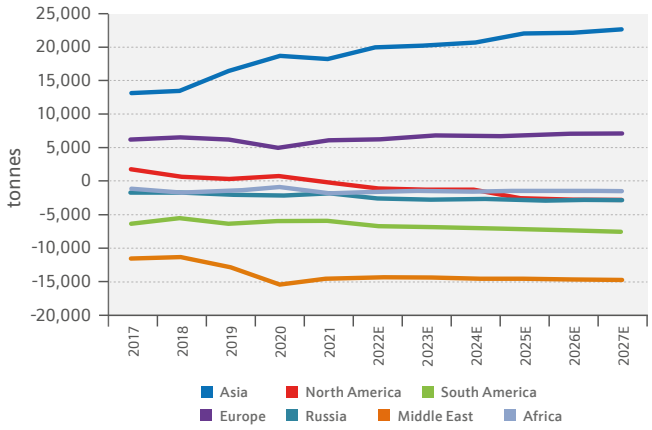


Figure 4 - Net methanol trade by region 2017 - 2027E

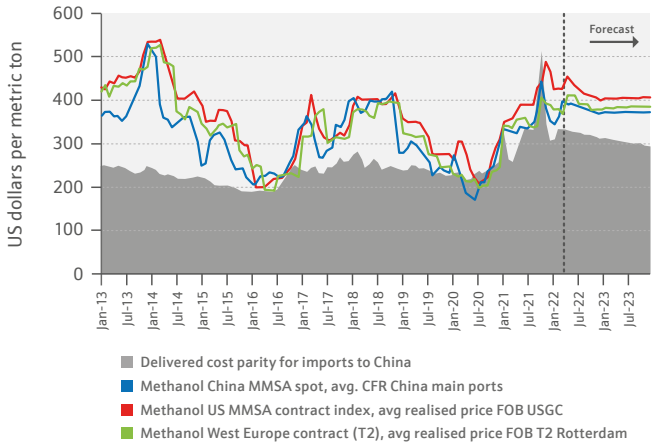


Figure 5 - Global methanol pricing - History and forecast

the situation vigorously and can adjust its outlook accordingly.

The trend of increasing methanol demand driven by MTO will continue. In fact, in 2020, MTO displaced formaldehyde as the number one use of methanol globally. MTO will consume 37.6 million metric tons of methanol by the end of 2022. With such substantial volume, and as Figure 2 shows, China demand dwarfs rest of world. China does, and will continue to, dictate the price of methanol.

Methanol supply additions (Figure 3) continue to lag behind demand growth expectations. China and the Middle East had dominated new methanol production facilities, yet new projects from these regions are not expected to issue en masse in the next five years. One new US methanol facility is forecast to commence operations during the same period. Even though margins for methanol producers in the USGC have been substantial, the cost to build there remains high, driven by increasing requirements to limit CO_2 emissions and adding risk and deliberation in the project development stage. Iranian projects to issue are on a less predictable schedule, restrained by many needed upstream investments.

As US production expands, global trade flow patterns have shifted, and will continue to do so. Figure 4 shows MMSA expectations of increased Americas net exports to Asia (China and India) and Europe, with Asia by far the most in need of foreign molecules.

Global prices and margins continue to be framed by affordability in China MTO consumers on the top, and economic feasibility of China production on the floor. Current methanol cash margins are elevated, yet MTO demand growth is slowing. Methanol prices and margins will waver between the floors and ceilings as methanol demand from MTO and spot methanol supply to China ebbs and flows. Figure 5 shows MMSA expectations going forward; the grey area a proxy for cost. Margins stay positive in the forecast, with prices moving down on lower coal costs until steadying as China returns from a temporary slowdown related to COVID lockdowns. Please see MMSA for details.

BY

Mark Berggren
Managing Director,
Methanol Market Services
Asia (MMSA)

Resin plant contributes to cost-efficient and sustainable operations for ARAUCO

With over 50 years of sustainable forestry and innovative product development, Arauco is a top global player in both of its strategic business segments, Pulp and Wood products. The company operates multiple facilities across the Americas and Europe and offers a comprehensive selection of composite panels including MDF, particleboard, HDF, premium plywood and millwork, as well as lumber and wood pulp.

In South America, where Arauco was first established, operations today are spread across Argentina, Brazil, Chile and Uruguay and include numerous forestlands, sawmills, pulp plants and wood panel plants. They also include a 60,000 tpa resin plant in Puerto General San Martín, Argentina, a site where **FORMOX** technology has played a role since 2007.

An ambitious modernization

Located on the banks of the Paraná River, the site was originally started in 1990. Following its acquisition by Arauco in 2005, an ambitious 2-year modernization plan was set in motion.

Guillermo Rizzatti, Plant Manager

"That period was quite eventful," recalls Guillermo Rizzatti, Chemical Plant Manager at the facility since October of 2005. "We started up a new effluent plant in 2006, and in 2007 a fourth resin reactor and a second UFC plant went into operation. I remember thinking, 'How exactly are we going to get all this done on time?'"

The UFC plant he is referring to was a new **FORMOX** FS1 plant completed and started up in time to meet a critical target date.

Resin plant facts & figures

- Facilities: 50 kTPA Methanol plant, 44 kTPA Sadepan FA plant, 56 kTPA FORMOX FA plant and 52 kTPA UF/MUF Resin plant
- Products: UF, MF and HR resins for paper impregnation and production of various composite panels

"Incredibly, the people at JM, then Perstorp Formox, made it happen," he says. "The plant was started up in December, 2007, just a few weeks before we would have run out of formaldehyde supply. I am still amazed at the efforts JM made to make it all happen on such a tight schedule."

A leading player in pulp and panel markets

Arauco's latest figures from 2021 show that it is #2 in the world in global capacity for both pulp production and composite panels, impressive achievements that no doubt are the result of its long-term sustainable development efforts. And according to Guillermo, who has over 30 years in the industry, it also comes from being a leader in terms of production quality and costs, which, he says, is where the resin plant plays a vital role:

"Having our own resin plant to supply Arauco's two panel manufacturing facilities here in Argentina helps in both of those aspects. First, it gives us much greater control over the quality of our resin and thus our panels. Secondly, it makes procuring raw materials much more efficient, which reduces costs."

Guillermo adds that, based on the good results achieved through this vertical integration, Arauco is constantly seeking opportunities to have its own resin facility in other countries where it manufactures panels.

First in carbon-neutral forestry

Arauco's leadership is reflected also in its efforts to protect ecosystems and to use resources in a responsible and sustainable way, which has led to yet another impressive achievement – becoming the world's first carbon neutral forestry company. In Argentina, Chile and Uruguay, Arauco is completely self-sufficient in net electricity consumption, and even sells surplus energy to the local power grids. Some of the ways it achieves its cost-saving and sustainability goals is through cogeneration plants and by generating renewable energy from forestry biomass to power its production processes. Other ways are by realizing efficiencies in the supply chain and, as Guillermo explains, getting more from less:

"Here at the resin plant, we help lower Arauco's overall carbon footprint in small ways only, but every little bit helps. Our contribution comes mainly from making our own methanol, so we don't have to ship it in from somewhere else. That helps to keep CO_2 emissions down. We have also made improvements to the facility that have reduced natural gas consumption by 10% when producing methanol."

Appreciate JM's support and FA conferences

Looking forward to a return to in-person formaldehyde conferences following the pandemic, Guillermo fondly recalls the many he has been to over the years.

"I went to several from 2005 to 2010 to learn more about the formaldehyde business as it was new to me then. They were great experiences and wonderful networking opportunities for sharing knowledge. Years later I asked if I could give a presentation at the 2015 conference about an issue we experienced with our **FORMOX** plant. The JM team said 'Of course,' and to me that said a lot about JM's openness, even when it comes to problems."

Guillermo also remembers being approached by another attendee who was concerned about experiencing the same problem if his company should choose JM's technology.

"He asked if I thought it would be better to go with a different supplier. I told him he should absolutely go with JM! Every company can make mistakes or run into issues, I told him. But in my experience, the way that JM handles them and the personal support they give is always excellent. That, to me, is especially important and worth a lot."

Biodiversity and carbon-neutrality at Arauco

A few of the ways Arauco is leading the way in stewardship include:

- Protecting flora and fauna present in over 400,000 hectares of native forest
- Managing biodiversity and ecosystem services in forestlands by identifying and protecting High Conservation Value Areas (HCVAs)
- Offsetting about 650,000 tons of CO_2 annually via 6 power plants registered as Greenhouse Gas (GHG) emission reduction projects
- Contributing up to 219 MW to Chile's national energy grid as a primary producer of Non-Conventional Renewable Energy (NCRE)

For more examples visit www.arauco.cl

From left to right: Emiliano Racca, Chief of HSE; Natalia Domenech, Chief of HR, HSE and administration; Claudio Bulla, Chief of Maintenance and projects; Guillermo Rizzatti; Edgardo Magadan, Chief of production; German Gilli, Chief of Port and Production control and logistics

BY

Charles Hodgdon
Editor

Paraformaldehyde, to hate or to love?

Most of you, if not all, who have operated a formaldehyde plant have experienced the annoyance of paraformaldehyde, or 'para', being formed in various places within the plant. For others, it is a welcome source of revenue.

⊗ HATE IT

Para is commonly formed in the absorber but also in many other places throughout the plant, not forgetting inside the storage tanks. This white nuisance affects the function and performance of the plant negatively and is often very difficult to remove. Or at least requires a fair amount of hard work to do so! We have several tips on how to avoid or minimize the effects of these problems, but that is not what this article is about. If you need more information on how to tackle this problem, talk to your JM Technical Support representative for help.

♥ LOVE IT

For other customers, paraformaldehyde is in fact a product they can sell and make money on. So instead of being this annoying white stuff to deal with, it is instead something of value. The global market for the product paraformaldehyde is nearly 900,000 metric tons on a yearly basis, which is a fairly big chunk of the total formaldehyde market. But more about that later.

What is it?

As is often the case, we tend to have many different names for the things we love. That is why you will also see paraformaldehyde referred to as para, paraform, polyoxymethylene, polyoxymethane or formagene.

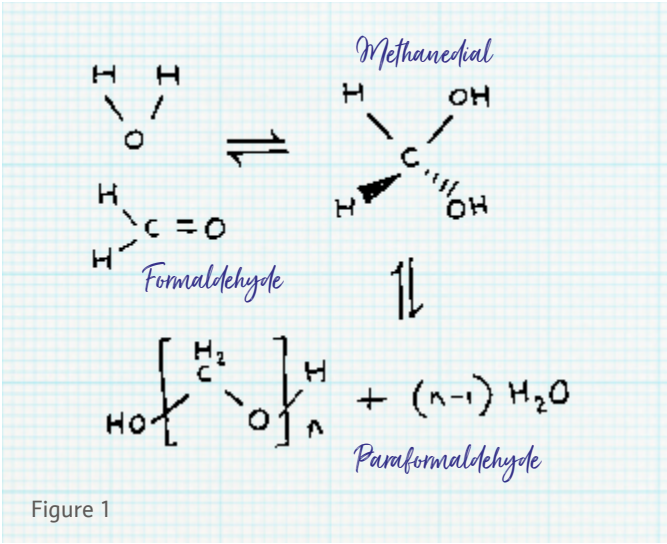


Figure 1

Paraformaldehyde is by definition a white crystalline solid substance that is formed by polymerization of formaldehyde. It is the smallest polyoxymethylene and is, in fact, a polyacetal. The generic formula is $HO(CH_2O)_nH$ which is the same as for POM, a very interesting polyacetal that we wrote about in

the Autumn 2021 issue of Informally speaking. When the n variable in the formula is in the range of 8 to 100, the product is paraformaldehyde. But when above 600, it is an acetal.

As you know, paraformaldehyde is slowly formed as a white precipitate by condensation from methanediol in formalin under certain conditions (see fig.1). The solution is predominantly made up of oligomers, but when n becomes large enough the material becomes sufficiently insoluble for it to precipitate. The reaction is driven to the left by a low concentration of formaldehyde in an effort to release formaldehyde, and is accelerated by acidic or alkaline conditions.

Manufacturing in large scale

Looking at the para forming in your plant and storage tanks some of you may think you are producing it on a large scale. But actually, you are not. There are several different industrial production methods and product types. Manufactured paraformaldehyde typically comes in the form of flakes, granules/prills or powder, depending on the manufacturing method. The solid content for the final product normally lies within the range of 89 to 96 wt%. The higher the concentration, the more pure, exclusive and expensive the product.

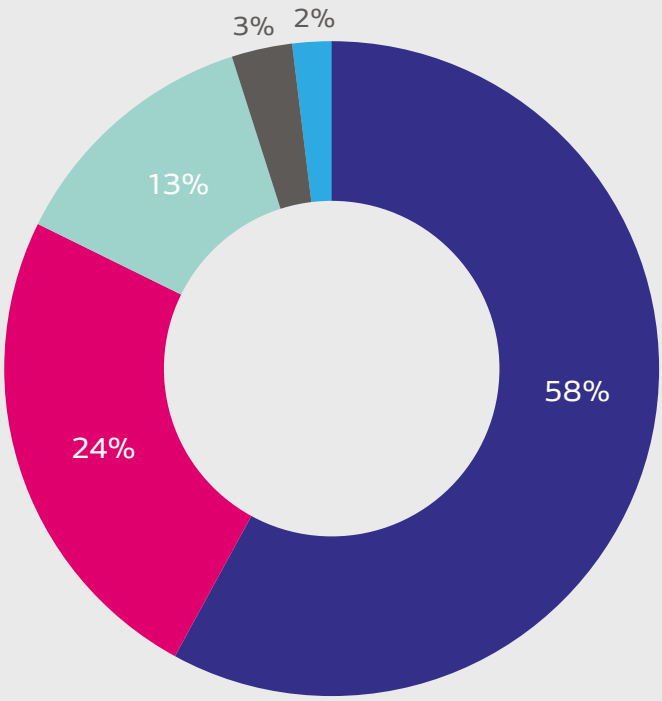
All manufacturing methods use formalin of various concentrations as a starting point, and the first step is to remove water at "suitable" temperatures through vacuum distillation or similar. During this stage the temperature is critical. If too high, it will speed up the polymerization too quickly, resulting in high losses of formaldehyde. If too low it will lead to a slow dehydrating process, creating hard paraformaldehyde. This is undesirable as it is difficult, if not impossible, for it to dissolve back into formalin.

Following the initial concentration step, various methods are then used to complete the drying process depending on the desired form for the end product. For example, rotary vacuum drying, rake vacuum drying or fluidized bed drying can be used to produce granules/prills, and spray drying to produce powder. Flakes are produced by using a cooled conveyor belt after the evaporation process.

What is it used for?

Commercially available paraformaldehyde dissolves rapidly in water as it is a condensed form of formaldehyde. Hence it has the same characteristics as formaldehyde, but with a wider range of applications. Interestingly, solid paraformaldehyde has a slight odor because of its slowly ongoing decomposition to formaldehyde.

One of its advantages, of course, is that, unlike formalin, it can be transported over long distances and stored for longer periods. One of the more important uses of paraformaldehyde is as a source of formaldehyde in the manufacturing of different resins. Especially for applications where excess water is non-desirable. Other uses are for agrochemicals such as herbicides, coatings in the automotive industry, resins for textile processing, as adhesive agents, and for inks used to print everything from dollar bills to books and lithographs. Other less common areas include the manufacturing of vitamins and as a biocide in oil drilling and fracking operations. Fracking activities in the USA have increased over the last 10 years in an attempt to lower energy prices, reduce CO_2 emissions and pollution by replacing coal. This activity represents abundant opportunities for market growth.



The current market situation

As mentioned earlier, the current global market for paraformaldehyde is about 900,000 tons per year, which corresponds to approximately 4% of the global formaldehyde demand. The most important region is APAC with 58% of the total demand and China as the main player. Europe is second with 24%. Agrochemicals is the largest application with approximately 45% of the total paraformaldehyde segment share, and is also one of the fastest growing application areas. Overall growth potential for paraformaldehyde is considered healthy with average annual growth assumed to be 4.5-5.5% over the next 10 years.

BY

Lars Andersson
Global Market Manager
Formaldehyde - Plants

HTF fires present biggest risk to your reactor

Although a lot of the safety focus in a formaldehyde plant is placed on the methanol, it is important to stay aware of the large risks that the Heat Transfer Fluid (HTF) present. Particularly when it comes to reactor fires. This applies to both salt-cooled and oil-cooled reactors, although the paths and sequences will differ for each type. Hence, for this discussion we will focus on the situation in an oil-cooled reactor.

The methanol inventory of a running formaldehyde plant is in the range of only 5-10 kg. This will only burn for a few seconds before the methanol trip system is activated and the methanol shut off valve is closed. This is not long enough to cause any significant damage to the plant. The HTF oil, on the other hand is a much larger risk as the inventory in the plant is always several tons, independent of whether the plant is running or not. If all this HTF was to be combusted, the whole plant would be destroyed.

Starts out small

The typical HTF fire starts as a pinhole leak in one of the reactor tubes due to metal fatigue, broken welds, corrosion or overheating. This will normally not start to appear until after 5-10 years of operation. It is very important that the first commissioning of the reactor includes stress tests and leak detection to find any manufacturing weaknesses.

A pinhole leak will normally not result in a fire, and if found early, typically during the catalyst reloading, then it can be fixed before any fire occurs. If not, the hole can get larger and HTF can leak into the catalyst filled tube if the HTF pressure is higher than the process gas pressure. This typically happens during the latter part of the catalyst lifetime when the HTF temperature and pressure are higher. The catalyst can ignite the HTF in the tube and a resulting tube fire will enlarge the hole even more.

Can get dramatic

Eventually the whole tube can burn off, resulting in a dramatic HTF flow into the process gas side of the reactor. The burning tube will get very hot and expand, putting additional stress on the surrounding tubes that could give more leaks. The HTF surrounding the burning tube on the shell side will start coking and form a layer around the tube. This layer can in some cases reach the surrounding tubes and cause them to overheat as well. The catalyst in the burning tube will melt and may block the tube. The leaking HTF can then fill the broken tube and eventually overflow to the surrounding tubes where it can start more tube fires. In reactors that have had HTF fires, we have seen how several adjacent tubes have typically been damaged.

8 things you can do to mitigate a reactor fire

1. Always leak check the reactor during the catalyst reloading
2. Always inspect the reactor after a high-temperature multitube trip
3. Trip the plant if you observe a strong indication of a fire from multiple transmitters
4. Close the oxygen valve and cover the air intake to prevent a draft from feeding a fire
5. Relieve the HTF pressure
6. If the rupture discs are open, activate the firefighting system as soon as the blowers have stopped rotating
7. Call the firefighting team
8. Train the operators on how to respond to different scenarios

Multitubes and clear indicators

The multitubes measuring the reactor temperatures are set to cover the cross section of the tube plate. They are programmed to detect whether several measuring points have elevated temperatures, which indicate a reactor fire. The trip system will then close the methanol and stop the recycle blowers, causing the HTF fire to die out as the oxygen inside the plant is consumed. An inspection of the reactor will then reveal the area where the fire has been, and the smell should indicate the HTF leak.

The multitubes can only detect the fire if close to it. The HTF fire can then burn for some time, giving high CO values, disturbing the HTF pressure control, lowering the HTF level in the condenser, causing high temperatures after the reactor, etc. It is important to be aware that an HTF fire may be happening if any of these phenomena are observed. A clear indication of a reactor fire is if the reactor dome temperatures rise above the HTF temperature after the plant has been stopped.

Most dangerous scenario

The most dangerous situation is if the HTF fire causes a methanol deflagration that opens the rupture discs. The fire can in this case sustain itself even after the plant has shut down. The fire will then use one of the rupture disc openings as a chimney and the other as a fresh air intake. The only way to stop it then is to activate the N_2/CO_2 firefighting system. The local firefighting team must also be called in to do the final check that the fire is completely extinguished.

BY

Ola Erlandsson
Senior Process Specialist

Process Safety follow up

A year ago we wrote about JM's huge investment in process safety training for its employees around the globe. In the article, "JM Elevates Process Safety to new heights" (see Winter/Spring 2021 issue), one colleague, Lorentz Rensfelt, also mentioned a few examples of some of the improvements we have made over the years to make our plant designs safer.

Being informed about the latest improvements is especially important if you are operating an older plant design. So as a follow-up to that article, I would here like to point out a few more examples of improvements we have made in the name of process safety.

BY

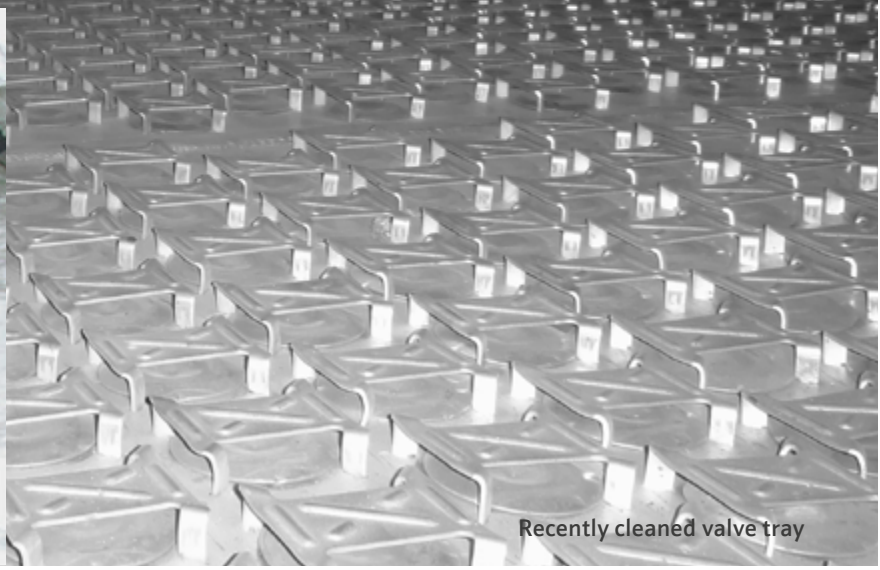
Ola Erlandsson
Senior Process Specialist

10 improvements you should know about

1. The HTF level alarm is now a floating alarm that will react also if HTF level is too low at a higher operating point or if HTF oil is lost during operation
2. The multitubes in the reactor are now placed so that there is always at least one element in the area where the lowest HTF level is expected
3. A blast zone has been defined above the rupture disc vent pipes where no walkways should be and where equipment must be protected
4. A training program regarding the procedures for vessel entry has been completed
5. All formaldehyde pumps now have double mechanical seals instead of hydrodynamic to minimize leaks
6. A zero tolerance of formaldehyde smell in the plants has been introduced
7. ECS catalysts beads with low pressure drop enables higher catalyst loading to reduce emissions compared to earlier CTP catalyst type
8. A catalyst system with a lower ignition temperature, which involves adding **FORMOX** PPd-47 separated by a net on top of the traditional **FORMOX** PPt-47, is now available so that the ECS can handle higher delta temperatures
9. An updated "block and bleed" design will make maintenance easier and safer
10. A start up draining procedure of the vaporizer has been clarified to minimize the risk of deflagration

Absorption and the importance of pH control

Absorber plugged by UFC resin



Recently cleaned valve tray

Formaldehyde absorption can be thought of at first as a thermodynamic equilibrium between formaldehyde in the gas phase and formaldehyde in the liquid phase. However, reality is more complex and formaldehyde absorption is largely influenced by the rate of polymerization reactions between formaldehyde, water and methanol.

Formaldehyde forms methylene glycol in water, which subsequently polymerizes into poly(oxymethylene)glycols. The same type of reactions occur between methanol and formaldehyde leading to hemiformal and poly(oxymethylene) hemiformals. These reactions are important for formaldehyde absorption as they consume pure formaldehyde in the liquid, thereby driving more formaldehyde from the gas phase into the liquid phase.

This is why pH is an important parameter for absorption. Hydroxide ions, dominating at a pH above 7, catalyse the polymerization reactions. At pH 9, the reaction kinetics can be several orders of magnitude greater than at acidic pH, strongly enhancing absorption, especially on the top trays of the absorber where reaction rates are slowest due to low temperature and concentration.

Caustic – to add or not to add?

Adding a small caustic flow on top of the absorber improves absorption. The absorber can be made shorter, which decreases the pressure drop and the power consumption of the recirculation fans. Yield will also be slightly higher. Unfortunately, it is generally not possible to add caustic to formalin due to specific requirements on low ash content from downstream processes. Our standard non-caustic absorber is therefore designed with more trays to compensate for the lower absorption efficiency.

If you have the possibility to run with caustic, then you should do so at full capacity, especially if the formaldehyde concentration is in excess of 1 wt% on the top tray. Check that you have the right caustic flow and pH in the top of the absorber. The pH should be between 8.5 and 9 in the tray below the feed point.

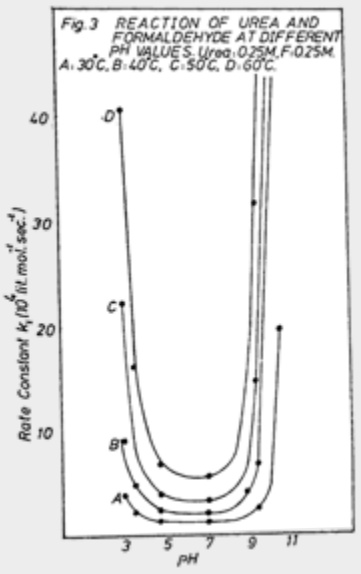


Figure 1: Rate constant of condensation of urea and formaldehyde as function of pH and temperature. From Nair, B. R., Kinetics and Mechanism of Urea-Formaldehyde and related Reactions. Doctoral thesis, Department of Applied Chemistry, University of Cochin, 1981.

What could happen if pH is too low in a plant designed for caustic?

Degraded absorption results in higher concentration of formaldehyde in the top tray and the leaving gas. It will impact the yield, but only slightly. Worse is the possibility of formation of paraformaldehyde in the recirculation fans or blowers. This can unbalance the fast-rotating parts and create vibrations, and also become a breeding ground for corrosion. Shutdown of the plant is then necessary for cleaning.

UFC producers wary of pH

UFC producers are certainly the most concerned about pH control. Condensation reaction between formaldehyde and urea drives most of the formaldehyde out from the gas phase, leaving only water and inert gas in the section above the urea feed trays. The condensation reaction is strongly dependent on pH. A decrease from 10 to 8 will slow the reaction to the point where significant formaldehyde concentration will be measured in the upper section of the absorber. In a **FORMOX** designed plant in balanced mode this can result in paraformaldehyde formation before the ECS. In excess mode formaldehyde will be lost to the excess condensate stream, lowering the yield by as much as 2%.

A further decrease in pH induces cross-linking of the methylolureas into insoluble resins, plugging the valve trays and packed sections in the absorber. This makes UFC producers very wary of pH in the urea feeding point. UFC absorbers of **FORMOX** design are therefore instrumented with pH-meters and alarms.

Paraformaldehyde deposits on fan impeller

Conclusion

Adding caustic to the absorber benefits the formaldehyde absorption by enhancing the underlying polymerisation reactions. It is even critical for UFC production. If you have an absorber designed for caustic, or if you are a UFC producer, keep an eye on your pH!

BY

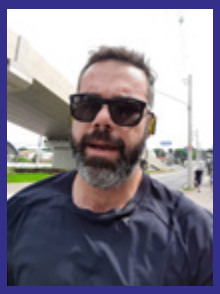
Michel Bellais,
Associate Specialist

Meet Caio

New Senior Regional Technical Support Manager for the Americas

Caio Amorim is a Chemical Engineer with an MBA in Business Management from the Universidade de São Paulo.

"I joined JM in 2013 after first beginning my career with our former sales agent in Brazil. My first role at JM was as a Technical Services Engineer (TSE) for the Refineries Team, with some commercial responsibilities in Brazil and Uruguay. In 2018 I became a Regional Sales Manager (RSM) for South America, covering Syngas, Edible Oils & Oleochemicals, Petrochemicals, Sponge Catalysts and Catalyst sales for the Licensing team."



"I enjoy listening to music, cooking, cycling, running and spending time with my daughter, family and friends. Now in Chicago I want to learn more about brewing craft beer as a hobby. As a new Senior RTSM for the formaldehyde business in the Americas, my aim is to maintain and continue developing our relationships with customers by providing technical support and advice, and in Latin America (due to my background) in their own language."

...and Mohammed

New Commercial team member for MEA & India

Mohammed Rustam is a Chemical Engineer who graduated with First Class Honors from the University of Bahrain in 2017.

"I joined the JM commercial team for the MEA & India region this year with responsibility for the Nitric Acid Catalyst Business. Before that I worked for Yokogawa as a Digital Reality & Simulation Engineer; my main role was building dynamic simulators, mainly chemical industrial plants such as Fluid Catalytic Cracking Units (FCCUs). At JM I also support the Gas Processing team by managing some accounts. And now I am excited to be working together with Ashish Bhave and expanding my responsibility to manage Formaldehyde accounts for the region as well."

"My interests are reading books, especially on engineering and history, as well as travelling and meeting new people and cultures. I am also a horseman and I used to ride and tame horses daily."

NEW FACES

Perstorp

Christina Skitsi
Process Engineer

Conny Ekendahl
Associate Electrical & Automation Engineer

Mats Nilsson
Financial Planning & Analysis Manager

Beijing

Huamin Zhang
Commercial Licensing Manager

Zhixin Wang
Mechanical Engineer

Post-pandemic development impacted by war in Ukraine

Opposite you will find an update on the progress of ongoing projects and recent startups, as well as a list of new projects since our last issue. However, given the dramatic times we find ourselves in, I would like to say a few words about the market situation for JM's FORMOX Formaldehyde Technology.

Today the market is influenced by two major factors: the war in Ukraine and the significant growth in demand for BDO in China. When I began writing this, most of the world had just come out of the pandemic. Or so we thought. New Covid-19 variants and outbreaks are still causing problems in some areas. Nonetheless, after some initial hesitation the wheels had begun to turn fast once again, held back by a few supply issues. And then suddenly the situation changed dramatically again, but for a different reason: the conflict between Ukraine and Russia.

The war and the resulting sanctions imposed on Russia have caused several effects that are also influencing the market for the supply of technology, not least of all for ongoing projects. The dramatic increase in steel prices, delivery times for components to our suppliers, and general price increases are the main factors that are having a direct influence on our business. How this will affect future business is hard to say, but for the moment we have several requests indicating that there is a belief in further growth.

In China, the already strong BDO market has seen additional demand for BDO-based bio-degradable plastics (see related article in the Winter/Spring 2021 issue). High demand and high prices on the products have resulted in numerous new projects for JM, not only for formaldehyde technology, but also for **DAVY**™ BDO licenses according to the maleic anhydride-based route licensed through our JM Licensed Processes team.

The past few years have certainly been dramatic for business as well as for everyone's personal lives. Looking ahead we can probably only expect to look for flexibility and adaptation in our company, and in the collective business that connects us.

BY

Fredrik Rietz
Global Commercial Licensing Manager - Formaldehyde

Projects & start-ups

New Projects

- A customer in Dalian, Liaoning, China has signed an agreement for two FT3 plants.
- A customer in Xinjiang, China, has signed an agreement for three FT3 plants.
- An agreement has been signed for three FT3 plants for a customer in Wuhai, Inner Mongolia, China.
- Another customer in Wuhai, China has also signed an agreement for three FT3 plants.
- An agreement has been signed with a customer in Nantong, Jiangsu Province, China for one FS3 and one FT3 plant.
- A customer in United Kingdom has signed an agreement for an FS1 High Pressure plant.
- An agreement for an FT3 plant to a customer in Hebi, China, has been signed.

Ongoing projects

- The project with **Foresa, Industrias Químicas Del Noroeste, SA** to double the capacity of their plant in Caldas de Reis, Pontevedra, Spain to an FT2 plant is in the design phase.

- The project with two FT3 plants for a customer in Shanxi Province, China is in the design phase.
- The project with one FT3 plant and one FE3 plant for a customer in Xinjiang, China is proceeding well.
- The project with an FS3 plant to a customer in Xinjiang, China is in the design phase with planned start this year.
- Works on an FS1 plant to a customer in Southeast Asia is in the design phase.
- The FS3 plant to a customer in Europe is in the design phase.
- The project with an FS3 plant to Eastern Europe is approaching shipping.
- The project with **Inner Mongolia Jiutai New Material Co., Ltd**. in China is in the construction phase.
- The project with an FT3 plant in Fujian Province, China is proceeding well with scheduled start up next autumn.
- The project with an FT3 plant in Sichuan Province, China is approaching commissioning.
- The FT3 plant, built in **Qinyang Yongrun Technology Development Co., Ltd**, Qinyang city, Henan province, China, signed with China Chemical Sedin Ningbo Engineering Co., Ltd is approaching commissioning phase.

Start-ups

- The FT3 plant to **Wanhua Chemicals (Ningbo) Co. Ltd**. in Ningbo China, their third **FORMOX** plant on this site, was successfully started in February.
- The project with an Emission Control System to a customer in China went on stream in October.
- After a successful start of the FS3 plant to **Xuzhou Yuanfeng New Material Tech. Co., Ltd.**, China in December, start-up of the FT3 plant is scheduled for this spring. The project with two plants, FS3 & FT3, recently started up December 2021.

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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.
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