A formaldehyde magazine from Formox

INFORMALLY SPEAKING

spring/summer 2012

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Re-energized or revitalized

– one or the other

A few weeks ago, the Formox annual conference took place. This year the venue was Europe, and a record number of delegates from some 35 companies and 22 different countries met in Helsingborg and Perstorp to network and discuss formaldehyde technology. To me this annual event is highly important; it's a good opportunity not only to present Formox, but also to meet face to face with people at the front line of the formaldehyde business. But it is more than simply an opportunity to meet old friends and exchange information; it revitalizes and re-energizes the whole Formox team.

And energy, together with productivity improvements, was the conference theme – be it with developments such as the turbocharger, new catalysts and loading plans or simply improved plant availability. Operational excellence was at the heart of many of the presentations and some of the available techniques and tools were the subject of "hands-on" demonstrations outside the conference room during the breaks as well as during the plant tour in Perstorp.

All-in-all the spirit at this conference was very good and the prevailing atmosphere was one of optimism. And, as last year in San Francisco, Bob Crichton assured us that the future for formaldehyde does indeed look bright, despite the challenges in the legislative landscape well presented by Formacare. But for more information on the conference, please read the summary on p. 4-9. For those interested in meeting us again soon, please mark your calendars for the Asia conference, which will take place in March next year.

Energy was not only a theme at the conference, it is also one of the themes in this issue of *informally speaking*; we are very proud to have commissioned, started and proven at full operation the first turbocharger ever in a chemical plant! We now hope the turbocharger will be an attractive option for most of our new plant customers; it is now available both for single and twin-stream plants and offers substantial power savings. Please read more on p. 10-11.

As already mentioned, the prevailing atmosphere at the seminar was one of optimism, despite the ongoing Eurozone crisis. Certainly we are optimistic as already this year we have contracted to supply 1 m MTPA of new capacity (see p. 19); last year's record (2 m MTPA) might even be broken! This has certainly revitalized us; we are re-energized to do our very best, not only to deliver this new capacity, but also in working with you – all our existing and soon-to-become customers. Our aim, as always, is to assist you to further improve process performance and succeed in these challenging times.

Finally I hope all of you find ways of boosting your energy levels and I wish all of you a good read and an enjoyable summer!

Marie Grönborg
General Manager
Formox AB

CONTENT

Formaldehyde Asia 2013

Mark your calendars for March of next year and make plans to spend a few days in Asia, probably Thailand. We will most likely continue along the track of one day of market updates and Formox news, followed by one day split between in-depth technical discussions and a more general agenda explaining the Formox offer. More details about the location and agenda will be published on formox.com and in the next issue of *informally speaking* later this autumn. Should you need more information beforehand, please contact your Formox representative.

Formaldehyde demand to 2020 & beyond

As you will have seen elsewhere in this issue, Formaldehyde Europe 2012 took place in May. The inaugural event, in 1994, was the first public presentation of my now customary technique of categorizing formaldehyde applications as either wood, plastics (now more broadly termed "chemicals") or others.

The reason for doing this was that the different market sectors had different drivers; factors influencing one sector did not necessarily impact on the other. This remains as true today as it did then. Indeed there is much that is the same; then, as now, we were coming out of recession. But back then the message was that the future would be bright; indeed the penultimate slide in the presentation all those years ago (Fig 1) said as much; but we will come back to that later.

So did the future turn out to the bright? Well after stagnating at just less than 16 m MTPA for much of the 90s, the 1994 projection envisaged formaldehyde consumption rising to 20 m by the year 2000. In fact it reached 24 m (Fig 2) – and a tendency to underestimate was a feature of many of the projections made on these pages over the years. This far at least the future has turned out to be brighter than we thought! So what do we think now? And what do we expect to happen in the longer term?

By the end of 2011, installed capacity had increased to 59 million MTPA; by far the largest capacity growth was in Asia and this continent is now home to 55% of world capacity, most of which is in China (44% of world capacity).

Consumption in 2011 (Fig 2) is thought to have been in the 41 to 42 m MTPA range – slightly up on 2010. The regional split is shown in Fig 3; Asia has by far the largest share – 49% and indeed China has 36% on its own.

Over the next ten years or so the factors driving formaldehyde are likely to be much the same as over the last ten; and in those regions currently driving demand, growth in GDP/capita is the key factor. Beyond 2020 it is a different story; history teaches that fast developing economies eventually mature. And to go back to Fig 1, perhaps today's fast growing chemicals, MDI, POM and Butanediol will become the PF and UF of the past – stabilized and in a niche! Perhaps the "new chemicals" will be formaldehyde free! The last point in that slide is also valid "Wood Products are entering a new phase"; they did with laminate flooring in particular boosting demand over the last 20 years. But products, like economies, mature and with no replacement in sight it is not impossible that growth in formaldehyde demand will slow sometime between 2020 and 2030. So, as in last spring's article, caution is called for and the effect of two widely different scenarios is shown in Fig 4. The top line, the optimistic forecast, is "business as usual", a continuation of global economic growth, continued growth in the chemical sector and further penetration by wood panels in global markets. The lower or pessimistic forecast, assumes wood panel penetration rates will slow as equilibrium is reached and products like laminate flooring mature; lower economic growth rates are also factored into this forecast. As you might expect, the different scenarios lead to widely different conclusions.

The preferred forecast (Fig 5), perhaps reflecting the past tendency to underestimate, errs on the optimistic side. But whatever happens the market will increasingly move east. Around 62% of the 20 m MTPA or so of additional demand projected for the next ten years will arise in China. By the mid 20s China will be consuming around 50% of world demand, compared with 35% today.

Given that the current installed capacity is over 59 m MTPA you would think no new plants would be built for some time. But, of course, formaldehyde is very much a local product; it depends on the local supply and demand situation. And historically the global utilization factor has been, as now, in or around 75%. But to finish as we started, the future is still bright. Though whether it will be as bright as it was following that first seminar in 1994 remains to be seen.

The future is bright

Traditional plastics have stabilized and found market niches

The new plastics are and will continue to benefit from substitution growth

Wood products are entering a new phase

Figure 1: Overhead from the 1994 Seminar.

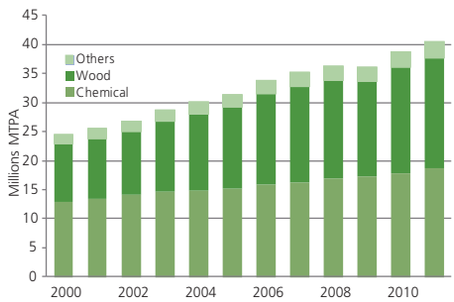


Figure 2: Formaldehyde Consumption (37% Basis) 2000-2010.

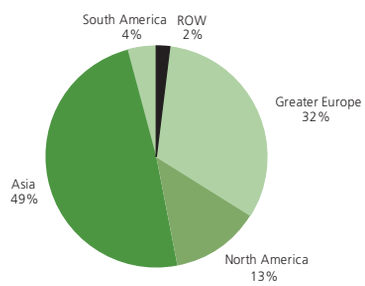


Figure 3: Distribution of consumption by region.

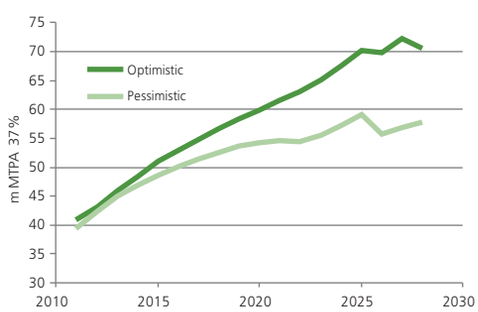


Figure 4: Forecasts; Optimistic or pessimistic?

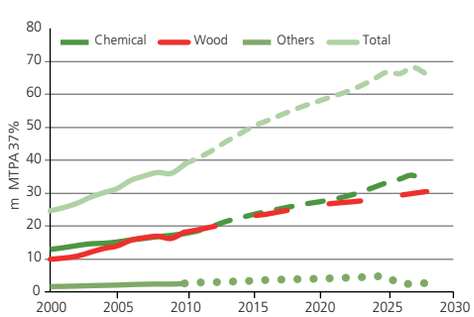


Figure 5: Preferred forecast.

BY

Bob Crichton
Formaldehyde Specialist
R.S Crichton & Associates

Seminar in Helsingborg

Formaldehyde Europe 2012

After a "one off" visit to Malmö for the last Formaldehyde Europe, 2012 saw us back in Helsingborg, the venue for the very first Formox seminar in 1994. Since that time these seminars have become an annual event; last year it was Formaldehyde Americas 2011 and even now Formaldehyde Asia 2013 is at the planning stage. And when Formaldehyde Europe next comes around (2015) the event will be celebrating its 21st birthday!

DAY 1

That first seminar was in the autumn; now it is a spring event, with weather to match – but fortunately there were enough hot topics around to keep the participants warm. Even the rain held off (a rare event in Helsingborg at this time of year), though it was never going to be wet enough to dampen the spirits of the 67 delegates from 22 countries and 35 companies, the best attended seminar ever. With such a large group logistics could have been an issue but credit to the organizers, everything was very well planned. But as someone remarked, "I would expect nothing else; if you can ship Formox catalyst and plants around the world, this must be easy".

Formox & market updates

The attendees were welcomed by Lars-Olle Andersson, his first public outing since his return to Formox last year (and indeed his first Formox seminar as these were not a regular feature of the Formox scene last time around). He was followed by Marie who gave us a rundown of the key events in Formox and Perstorp since the last conference. With record sales over the last 12 months Formox had enjoyed yet another successful year with China very much to the fore. Her main message was customer service, cus-

– a summary

Formaldehyde Europe 2012. Group photo taken just before lunch – in order to get a less "stiff" group photo, everyone was asked to turn around which is why everyone may not be facing the camera.

tomer service and customer service. This is a key aspect of the Formox business model and Marie invited the group to participate in a debate on how Formox should organise technical support to meet the needs of its diverse (and ever growing) client base. She also announced that the further development of this service had been placed in the capable hands of Lars Andersson.

Then it was the turn of Mark Vassar from Mitsubishi Gas Chemicals (MGC), who gave a wide ranging account of MGC's activities before concentrating on its many methanol production and marketing ventures around the world. His data reflected a recurring seminar theme – the significance of China; perhaps we should not have been surprised that of the 17 m MT of new methanol capacity he identified, no less than 11 m were in China. Though formaldehyde was still methanol's main outlet, fuel uses were rising. However, Mark also speculated about another fuel – shale gas. With US gas prices falling in response to increased availability there was the possibility of a resurgence of petrochemical activity on the US Gulf Coast; several mothballed methanol facilities could be restarted.

Bob Crichton then took the stage (and managed to stay on it; according to Bob he nearly fell off at that first seminar back in 1994). Bob's basic message was that these were difficult times in which to make formaldehyde demand projections. And he hedged his bets by presenting both an optimistic forecast (more of the same) and a pessimistic one based on lower growth overall, particularly in the run up to 2030. He confessed to being more optimistic than pessimistic. But according to Bob he could afford to be optimistic as he would soon be retiring; nobody believed him – about the retirement that is! But you can make your own judgement on his projections by reading his article on Page 3 of this issue.

Health, safety & environment... & politics

This concluded the marketing section and we were then on to the first formal session this, on Health, Safety and the Environment (HS&E), was introduced by Ola Erlandsson. Given the first presentation by Phil Hope of Formacare, maybe this session should have been titled HSE &P as it was clear that politics play a very big part in the formaldehyde debate. And Phil is to be congratulated for a concise and very intelligible presentation on the various political machinations. Though the recent Formacare sponsored technical conference in Madrid provided much in the way of defensive arguments, it was

Phil's conclusion that formaldehyde was unlikely to win the political debate. Formacare was already looking into the Risk Management Options (RMO). Ola in his presentation accepted that there would be more regulations surrounding formaldehyde and said that Formox would be ready, willing and able to respond to the challenge. However, as with Bob, he was basically optimistic as for the most part there is currently no economically viable alternative to formaldehyde.

Phillipe Thevenin was next up with an update on "Carbon Footprints" – a subject first raised at the 2009 conference in Malmö. The incentive, at least in those areas of the world where carbon trading was established, was to reduce your carbon footprint and hence accumulate carbon credits to sell on the market. According to Philippe, this was already happening; clients were actively seeking low carbon products for this very purpose. An anomaly noted by Phillipe was that methanol produced from glycerine had a larger footprint due to the higher energy requirements of the manufacturing process – all is not always as green as it seems. The message was clear – best possible yield, lowest possible energy – smallest carbon footprint.

Ola's last contribution to this session concerned a deflagration that occurred in one of the older plants in Perstorp in 2009. The reason for this deflagration was obvious; a leak in the pre-vaporizer had caused para to form, this caught fire leading to a deflagration. The clue was a strong formaldehyde smell after the event. The only problem with this explanation was that the pre-vaporizer was not leaking! The cause was eventually traced to a leaking valve upstream of the absorber. When the line was shut down, formaldehyde liquid leaked back; it vaporized when heat was applied and was deposited as para back upstream – same effect from a different cause. The very clear message was don't jump to conclusions and don't trust automatic absorber valves to be leak-tight – physically isolate the valve using a blind plate. Ola assured us that this would not happen on new plants – that particular system had been in operation for many years and had been used as a test bed for new ideas.

Catalyst news

After the HSE (and P) issues we got to the technical meat of the seminar, introduced again by Lars-Olle who made the very relevant point that the Formox he had rejoined was very different from the one he had left all those years ago – the process was almost unrecognizable and the performance better than ever. And yet here he was introducing a couple of major developments that would further enhance the process; the latest loading plan, CAP 3.0 incorporating a brand new catalyst and the successful full scale trial of the turbocharger.

Ronnie Ljungbäck was first up with CAP 3.0. By way of introduction he showed the development of the CAP concept from its beginnings in 2003 – the aims always being the same, to increase productivity (defined as formaldehyde produced per reactor tube) while reducing both the back pressure and the rate at which it built up. A bonus with CAP 2.0 was increased flexibility; the most recent, CAP 2.0T, offered more of the same but with an increased yield. Though these were all huge steps forward, Ronnie confessed that he had been disappointed that CAP 2.0 had not delivered higher productivity; the methanol inlet was still limited to 10 vol%. This was now about to change as Ronnie announced the development of a new catalyst which, when incorporated into CAP 3.0 loading plans, would allow 11% or even higher. Although the present CAP 3.0 cannot be used in all plants, since it requires certain reactor conditions, a large number of plants will still be able to enjoy the advantages of it; higher productivity and/or lower operating costs.

Higher inlets mean more formaldehyde from the same equipment; but it also means more throughput for the ECS and hence higher exit temperatures – in some cases approaching the maximum temperature for the material used. This was Robert Häggblad's topic and he explained that though mechanical solutions were possible, e.g. change the material of construction and/or use a fan to dilute and hence cool the gas, there was now a better option. This involved using a layer of PPd-47, a new palladium (Pd) catalyst developed by Formox and launched in 2011, and a second layer using PPt-47 (a CAP for the ECS!!). While Pd allows a lower ignition temperature, and hence allows a greater temperature rise, conversion can be an issue; the second Pt layer solves that problem. Robert said

Formaldehyde Europe 2012. Day two was divided into two groups, and this picture shows the group having more in-depth technical discussions at Persgården.

that all new Formox plants designs would use this design, a "start up" layer of PPd-47 to initiate the reaction at a lower temperature and a "mop up" layer of PPt-47 to complete the conversion. Even more importantly, this loading plan could be used on existing plants to remove a potential bottleneck.

News! Turbocharged plants

Plant design was also the focus of the next presentation by Andreas Magnusson. Having made the first presentation regarding the turbocharger in 2006, it was appropriate that he should announce the successful trial of the turbocharger on a new Formox plant supplied to in Romania. The concept was now fully proven and had reduced power consumption by 30% to around 46 kWh/MT 37%. Moreover, as a pressurization blower was no longer required, no additional power was required for pressurization. As a result power consumption was now independent of the operating pressure; higher pressure operation and higher productivity with no power penalty! Andreas was at pains to point out that though the turbocharger was a simple enough concept, many thousands of man-hours had gone into making it a reality on a Formox plant. But the details of this were left to a later presentation (the turbocharger was a co-operative development between MAN, Formox and EGGER). Instead Andreas concentrated the rest of his presentation on how you could further reduce the power consumption by utilizing the considerable steam produced by Formox designs. He showed variations on two basic concepts – directly with a turbine drive for a recirculation blower or indirectly using electricity produced on a turbine driven generator set. Though both schemes showed short payback, he stressed that much depended on local electricity costs (and indeed regulations). And he cautioned that installations such as these were only really worth investigating if you only have use for low-pressure steam (for example, in another chemical process or for board production) or no use for the steam.

Entropy on the agenda

And then it was over to MAN to describe the turbocharger in more detail. Firstly Jan Felix Schwartz outlined the global MAN business before showing where the Formox application fitted into the MAN range of turbochargers. Given that the main application was in ship engines, where reliability was a pre-requisite, he did not anticipate problems in a typical Formox plant installation. But he left the thermodynamics of that to his colleague Manuel Stork who, for the first time ever at a Formox conference, put entropy into the limelight! His purpose was to explain how it was possible for the turbocharger to work in an application such as Formox where temperatures and pressures were very different from those in a typical engine application. And he succeeded in this task, not only demonstrating the thermodynamic basis but showing that the machine had performed at site very much as in the test lab – though clearly, as Andreas had remarked earlier, there had been many control issues to resolve.

The day finished as it had begun with an emphasis on technical service with Lars outlining progress so far on further improving this important aspect of the Formox product. This is also a topic covered on page 14 in this issue.

This concluded day 1 – time for R&R and a trip on two fishing boats out to the island of Ven in the Öresund between Denmark and Sweden. This was the home of Tycho Brahe, probably the most famous observational astronomer of the sixteenth-century, although given the overcast sky some of us wondered how he managed to observe anything! An entertaining trip illustrated by some of the more colorful aspects of Tycho Brahe's life and death and after an excellent dinner and appropriate refreshments, the trip back was even livelier than the trip out.

Formaldehyde Europe 2012. Everyone was given a tour of site Perstorp and the formaldehyde plant.

DAY 2

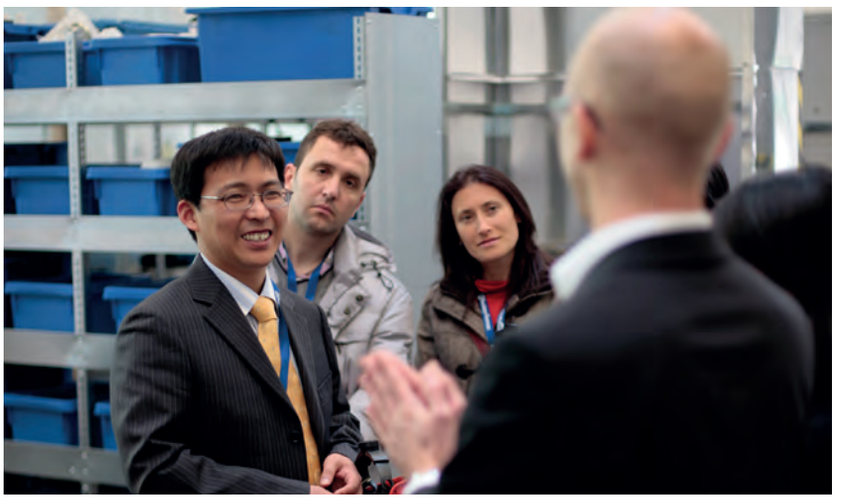
The group was split into two for the second day and transported (more logistics!) to Perstorp to continue the learning process. Existing customers had a talk by Eva Walter on the techniques being used within the Perstorp Group to improve plant availability. It was shown that relatively simple changes could greatly reduce downtime. The group then moved to the plant proper (via a site tour) for a series of practical demonstrations and poster presentations on a range of techniques. There was a sting in the lunch tail with a presentation by Neil Cruise on formic acid – a preview of work presently underway to try and understand how and where formic acid was produced. Johan's theme for the penultimate presentation of the conference proper was CCC, complete, clear and correct. In simple terms, make key decisions based on analytical facts rather than simply impressions. If a result looked wrong it probably was wrong; check and corroborate (the "5c" approach?). The day concluded with two workshops, a session on what customers thought a formaldehyde plant would look like in 2030 and another on technical support – how to further improve the customer experience. Both sessions went well and the mediators, Ola and Lars, reported that many helpful suggestions were made.

The second group also enjoyed a guided tour of the Perstorp site and the Formox R&D center but the day was spent learning in more detail about Formox, the plant range, the catalysts as well as that all important technical support. They also saw how a typical project was handled and shared the experiences of a Chinese company about to install its third plant in the same site – one of many truly satisfied customers.

Marie ended the seminar proper (there was a third day of advanced training for some attendees) by thanking everyone for taking the time to come along. She also congratulated the presenters, both home grown and international and extended a well earned vote of thanks to the organizers. There had been a wide range of topics and Marie hoped that there had been something for everyone. She drew attention to two items in particular, the turbo charger – lower power consumption over the entire pressure range – and CAP 3.0, higher productivity, lower pressure drop – and hence even lower power consumption! But as Marie said, the really big story is yet to be told – the one about a new range of plants encompassing all these new developments. A turbocharged plant loaded with CAP 3.0 will not only consume much less power but will do so at much the same cost per MT of capacity. However, this was very much work in progress but she hoped Formox would be in a position to write the next chapter by the time of Formaldehyde Asia 2013.

Formaldehyde Europe 2012. The practical demonstrations showed some tips for constructing simple, but useful equipment to help plant operation.

Formaldehyde Europe 2012. The practical demonstrations gave many opportunities for discussions.



Formaldehyde Europe 2012.

EGGER, Formox & MAN

make history with world's first "turbocharged" plant

At the 2006 Formaldehyde Europe conference Formox's Andreas Magnusson presented an exciting new idea aimed at helping customers drastically cut energy costs. Six years later to the day, Andreas stood on the podium once again enthusiastically explaining how the idea has now become reality and can reduce power consumption by 30% or more.

The concept Andreas introduced in 2006 was the possibility of integrating turbochargers in formaldehyde plants. Martin Steinhagen, Technical Director at EGGER Technologia SRL in Romania, remembers it well: "I was very inspired by Andreas' presentation and I was convinced that this was an idea we wanted to look more closely at."

Along with customers from five continents, Martin was on hand again at this year's conference in Helsingborg. This time he listened while Andreas described the successful collaboration between EGGER, Formox and MAN Diesel & Turbo, a world-leading manufacturer of turbochargers, which has resulted in the world's first turbocharged formaldehyde plant.

Reducing costs where possible

With 17 production plants in seven European countries, EGGER is among the continent's largest manufacturers of wood-based products. And when it comes to producing formaldehyde, EGGER is basically in the same boat as any other producer in terms of the cost picture.

"Typically, over 90% of the production cost for formaldehyde is methanol," says Martin Steinhagen. "And as there is little we can do about the price of methanol, we have to look at the next biggest cost – energy – which makes up about 5%."

To test the idea of reducing energy costs using a turbocharger, EGGER agreed to a pilot project involving a new formaldehyde plant for its chemical production facility in Radauti, Romania. The principle behind the solution was to replace a conventional, power-consuming pressurization blower with a turbocharger powered by exhaust gas from the ECS (Emission Control System) – see figure 1.

Reliable technology a top priority

As technology partner, Formox chose to work with the Turbocharger Business Unit of MAN Diesel & Turbo, based in Augsburg, Germany. "Our customers need to be able to trust the robustness of any solution we recommend," says Andreas, "which is one reason why we chose MAN."

Manuel Stork, Application Expert at MAN, explains that the technology is very reliable for this application because it was originally designed for far more demanding operating conditions.

"Our turbochargers have been widely used for many years for the propulsion of heavy seagoing vessels," he says. "The process gas at a formaldehyde plant is very clean compared to the corrosive exhaust from a diesel engine burning heavy fuel oil on a large tanker ship. And, in the formaldehyde plant, the turbocharger runs at a very low speed compared to on a ship, so there is little stress. It's like running your car engine on idle."

New focus for MAN

Dr. Herbert Schmuttermair, Senior Manager Application at MAN, says that the company is now expanding its business by bringing its well-proven turbochargers to industrial applications. Power plants and process industries are two areas MAN is focusing heavily on. Dr. Schmuttermair says the installation at Radauti is a perfect example of how industrial processes can benefit from this technology.

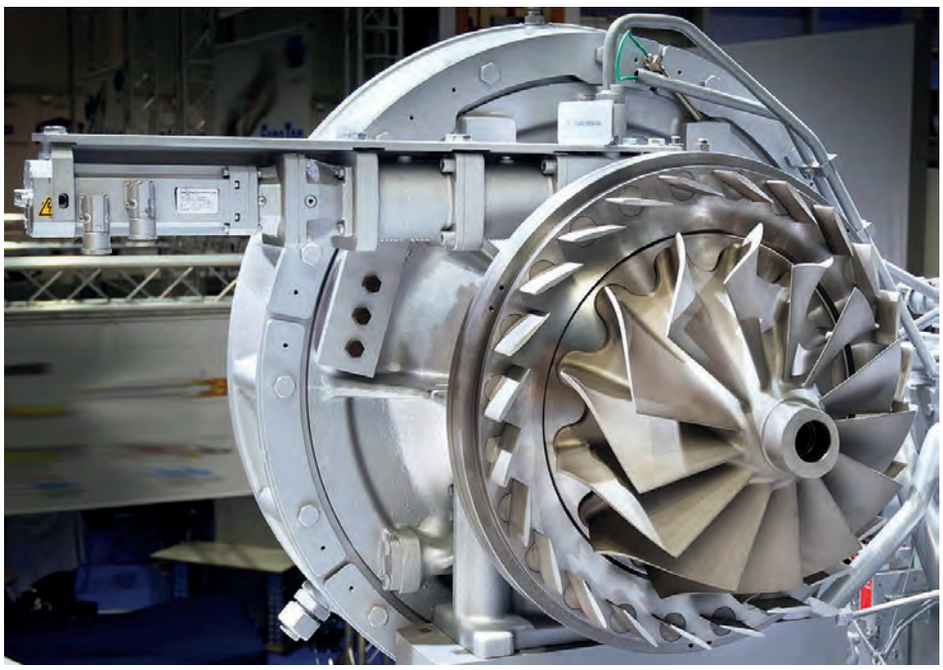
"Formox has worked hard over many years to reduce the power consumption of its plants by 50% compared to the designs of 30 years ago," he says. "Now, with a turbocharger, the consumption can be reduced by one third of today's levels in a single step."

An evolutionary step?

Jan Felix Schwartz, who works with Sales at MAN, compares this advancement to what has happened in the auto industry over the past two decades.

"Twenty years ago a 2-liter diesel engine in a passenger car generated about 75 horsepower. Today you can have a 2-liter turbodiesel delivering more than 200 horsepower with less fuel consump-

Three key people at Formox who have been crucial to the success of the turbocharger project are Henrik Hansson, Michel Bellais and Krister Forsman.



Example of a MAN Turbocharger. At the front, with housing dismantled, the turbine wheel with the adjustable inlet guide vanes (VTA).

tion. The standard for automotive diesel engines has changed. So perhaps we're looking at the new standard for formaldehyde plants of the future, including a turbocharger for increasing output and saving energy."

Thanks to the pilot project carried out at EGGER's Radauti plant, Formox and MAN have gained valuable knowledge concerning the necessary conditions for optimal operation of the turbocharger in a formaldehyde plant. As a result of the lessons learned, Formox is now able to offer the turbocharger for energy-saving at new plant installations.

Nearly 3 million fewer kWh = fast payback

Asked about how the potential savings for a new plant, Andreas Magnusson explains that an FS3 size plant operating at normal capacity can be expected to cut energy consumption by as much as 2.8 million kWh per year.

"The exact savings to the customer will of course vary depending on a number of things, especially the cost of power at the site," he says, "but there's no question that the initial investment pays off within a relatively short time."

Part of a bigger picture

Martin Steinhagen at EGGER believes that in addition to a good ROI, there are also other significant benefits to consider. "And it's also about environmental savings, he says. At EGGER we have planned several steps to significantly reduce our good CO_2 footprint until 2020, and the turbocharger is one of many other innovations, that help us to meet those goals."

Asked about how it compares to operating a conventional plant, Martin says, "No more difficult than our other plants. With the first change of the catalyst, we will inspect the unit together with MAN, but we don't expect any problems. The turbocharger really makes sense, especially if you want to run your plant at maximum capacity."

To find out more about possibly turbocharging your plant, contact Andreas Magnusson at andreas.magnusson@perstorp.com. You can also visit www.mandieselturbo.com if you want to know more about MAN Diesel & Turbo.

Pressurization 'for free'

– how the turbocharger works

Traditionally, oxide plants only recover the thermal energy – by means of the ECS steam generator. The turbocharger now advances energy efficiency even further. How?

Assume your plant is running at 0.5 bar g absorber top pressure with 10 vol% inlet. Energy consumption is then approximately 57 kWh/MT when the catalyst is fresh, and 65 kWh/ MT 37% after half the catalyst lifetime. Under these conditions the turbocharger will reduce the power usage by 19 kWh to 46 kWh/ MT 37% at mid cycle – about 30% less.

How the turbocharger is powered

The turbocharger is driven using the pressure of the gas leaving the absorber plus the heat generated through the catalytic combustion in the ECS (Emission Control System). Together these drive the turbine unit, which in turn directly drives the compressor. In addition, the Variable Turbine Area (VTA) feature enables efficient control of the compressor pressure output according to the plant's needs.

"As a result," says Andreas Magnusson, "the cost of powering the turbocharger is limited to a 30-40 °C drop in the temperature of the gas leaving the ECS reactor. This translates into a 3-4% reduction in steam production, meaning pressurization is achieved more or less for free."

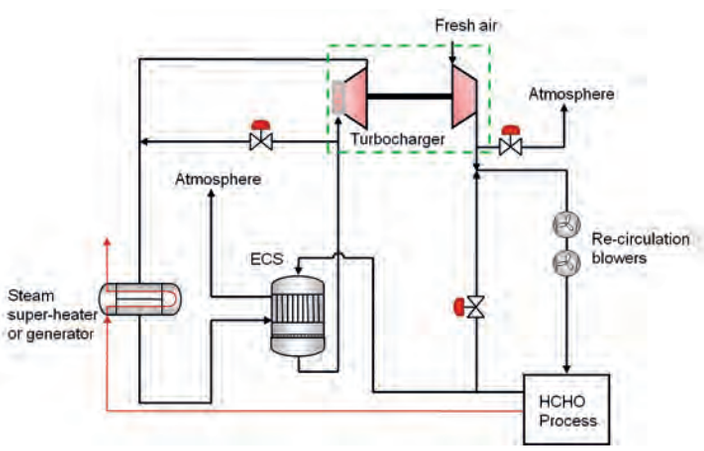


Figure 1. Replacing the pressurization blower with an energy-saving turbocharger.

MDI – a key link between polyurethanes & formaldehyde

In the last issue of i*nformally speaking* we took a special look at BDO, a downstream product that is a major consumer of formaldehyde. Like BDO, MDI is another downstream product expected to consume more and more formaldehyde over the coming years. Here we take a brief look into MDI and its main uses.

MDI is an isocyanate used in the production of one of the most versatile families of chemicals – polyurethanes. Polyurethanes are more 'polymer systems' than individual chemical products such as PVC, for example. They are used to create widely varying products ranging from flexible and rigid foams, to non-foam applications such as coatings, sealants, adhesives, elastomers and fibers.

Polyurethanes are basically produced by reacting an aromatic isocyanate, generally either TDI (toluene diisocyanate) or MDI (methylene diphenyl diisocyanate), with a polyol. The specific isocyanate, polyol and additional additives to be used are selected depending on the desired properties for the application.

From mishap to success

The commercialization of polyurethanes is said to have begun after a small incident back in 1941 in which moisture accidentally came in contact with a diisocyanate. This caused the formation of pockets of carbon dioxide in the product. It would be another decade before the potential for foams made from polyurethane would start to catch on.

At one point it was believed that flexible foams made from TDI-based polyurethane represented the greatest potential for polyurethanes. But history shows that MDI has played perhaps an even more significant role, partly due to the emergence of Spandex fibres in the 1960s.

Complex, but flexible MDI production

MDI exists in various forms, crude, pure and polymeric, but the most commonly used commercial grade is mixture of 4,4´– methylenediphenyl diisocyanate and its isomers. Formaldehyde is used in the synthesis of MDI by reacting with aniline to produce diphenylmethanediamine (MDA), which in turn is treated with phosgene to produce polymeric MDI.

The actual production is rather complex, but it also enables manufacturers to modify and develop different grades to suit the specific requirements or needs of the user or end application. Major producers, such as Bayer, BASF, Huntsman, Yantai Wanhua and Dow, generally modify MDI to create different products optimized for different applications.

Rigid foams biggest application for MDI

Foam is by far the largest application area for polyurethanes, and therefore also MDI. MDI polyurethanes can be used to make both rigid and flexible foam, but rigid foams represent the largest application for MDI worldwide.

Because rigid polyurethane foams provide good thermal insulation, the construction and appliance industries are two major market drivers for MDI. These foams are very widely used in the production of modern refrigerators and freezers, as well as the construction of new buildings where energy savings is a growing concern.

Responding to global needs

Polyurethanes made from MDI are proving helpful to many companies working to improve sustainability. By developing alternative products that help to conserve energy, lower the consumption of natural resources, improve safety and manage water supplies, many manufacturers are taking action to respond to the needs of an ever-increasing global population.

One area where this is being seen more in more is the design and construction of energy efficient housing and other buildings in response to EU regulations on energy-neutral buildings for 2020.

Cars interiors, rollerblades & adhesives

In addition to applications for the construction and appliances industries, top manufacturers provide solutions aimed at many other common uses for MDI-based polyurethanes. These often include applications closely related to comfort, leisure and more fuel-efficient cars.

Examples from all the bigger producers include a diversity of applications ranging from high-tech jogging shoes, rollerblades, boats and decorative molding, to instrument panels and interior trim in cars. Binders and industrial strength adhesives are other applications for which manufacturers have created special MDI-based formulations.

Tremendous growth

MDI has experienced tremendous growth over the past two decades. In fact, potential consumption of formaldehyde for the production of MDI has virtually doubled every ten years during that time, from just under 400,000 MTPA 37% formaldehyde in 1990 to over 900,000 MTPA in 2000, and just above 2,000,000 MTPA in 2010. According to industry forecasts, this is a trend that is expected to continue even for the period from 2010-2020.

The last decade most of the new capacity has been added in Asia with China as the biggest rising star. Today about 40% of all MDI capacity is in Asia. Currently the global MDI production uses about 5.5% of the world's production of formaldehyde.

Formox part of expansive trend

Naturally, Formox is glad to be part of this expansion. At Yantai Wanhua in China, which has greatly increased its MDI capacity since 2000, over 90% of the formaldehyde used for MDI production today comes from the Formox process. Formaldehyde based on Formox technology will also be used as raw material for the MDI both in the large investment by BASF in the Chongqing area in China, as well as in another huge investment in Asia. Both these investments are expected to start-up sometime in 2014.

This is indeed a good verdict from the industry and encourages us to continue the development of our process for even better safety, higher reliability and lowest possible cost of ownership.

Formox CAP™ concept

Last year we launched our CAP 2.0T concept in San Francisco and this year, just as planned and hoped, we were able to launch our CAP 3.0 concept at our Formaldehyde Europe conference in Helsingborg in May.

CAP 3.0 is yet another step along the path to higher capacity and better performance in terms of lower direct variable cost (DVC). As you will find out, this development is pushing the limits further and we are very proud to announce that within this development we also are launching a new catalyst – the Formox KH-CAP 3.0 INI CAT! And since all good things come in threes, we also introduced our new logotype for the CAP concept as seen in the headline.

CAP 2.0T has taken us a step further on the performance curve, but in terms of productivity (capacity per tube) we have not been able to move forward with the CAP 2.0 concept. Luckily we are persistent and above all determined to find a way to stretch the limits even further.

With the CAP 3.0 concept and the new KH-CAP 3.0 INI CAT catalyst we are at last able to increase productivity and achieve higher capacity. This comes about because we are now able to operate CAP 3.0 at 11 vol% in methanol inlet – and even higher. Thanks to better control of reaction rates, lower reaction temperatures and better heat distribution, we also get even less catalyst ageing compared to CAP 2.0. So besides the above mentioned higher productivity, the pressure drop increase will be even slower.

When CAP 3.0 is operated at 11 vol%, the yield may suffer somewhat (compared to CAP 2.0 operated at 10 vol%), and here the system pressure plays an important role. Operating CAP 3.0 at 11 vol% at atmospheric pressure, the yield is expected to be marginally lower but at 0.5 bar g the yield can be up to 0.5 % lower – again compared to CAP 2.0 at 10 vol%. On the other hand, CAP 2.0 cannot or should not be operated at 11 vol% anyhow, so it is somewhat difficult to compare the two.

However, you do not have to operate CAP 3.0 at 11 vol% – if you choose to operate at 11 vol%, then you get the highest possible capacity, but in the event you are limited by e.g. the plant design to a maximum of 10 vol%, then you will get the same yield as CAP 2.0 but gain the other CAP 3.0 benefits of a higher specific production and longer catalyst lifetime – and a better result overall. Also, due to the low initial pressure drop and slower build up, the average pressure drop is expected to be 20% (!) lower than for a CAP 2.0 load. Thus, operating CAP 3.0 at 10 vol% in methanol inlet could, for a 300 MTPD plant, be converted into yearly power savings of kEUR 50!

So can any plant use our new KH-CAP 3.0 INI CAT and the CAP 3.0 concept? Unfortunately this is not the case, at least not yet. At this stage, only plants with a sufficient tube length and cooling are suitable. For example, Formox reactors which have tubes longer than 1400 mm can use our CAP 3.0 concept; needless to say we are, of course, working on developing CAP 3.0 loads for other reactors in order to widen the range of users. As always, it is important to have the correct plant data, particularly regarding the reactor, when designing a CAP 3.0 load. Please contact your Formox representative to discuss whether your plant is suitable or not.
Furthermore, in case you will operate at higher capacities such as 10 vol% and 0.5 bar g or at 11 vol% you need to make sure that your plant can handle the higher capacity. You should also make sure that your ECS unit can handle the higher load; more combustible compounds in the tail gas means a higher ECS delta temperature. We can possibly help you increase the operating window – please read Robert Häggblad's article about our ECS catalysts.

Since we have just launched the CAP 3.0 we do not yet have too much data from plants using it, but you can rest assured that there will be more details regarding full scale results for CAP 3.0 (and indeed CAP 2.0T) in future issues.

Summary of CAP 3.0 pros and cons*

At 11 vol% methanol inlet

- Higher capacity
- Higher specific steam production
- Lower specific electricity consumption
- Maintained specific production
- Slightly shorter catalyst time
- Slightly lower yield (up to 0.5%)
- Higher ECS delta temperature

At 10 vol% methanol inlet

- Longer catalyst lifetime
- Higher specific production
- Lower specific electricity consumption
- Maintained yield

*compared to CAP 2.0

What do the tubes in our logotype mean?

CAP – Catalyst Activity Profile – is a concept we have been using at Formox since 2003. To strengthen our brand we have now chosen to trade mark CAP and to include a logotype. The three tubes in the logotype symbolize the development from the very first CAP (first tube) to CAP 2.0 (second tube) and finally to the ideal CAP with an infinite number of layers. This also illustrates and symbolizes a continuous improvement in CAP performance.

BY

Ronnie Ljungbäck
Product Manager Catalysts
Formox AB

Making technical support even better!

Background

Soon after Formox started with licensing and catalyst manufacture we realized that we had to support our customers with our specialized knowledge. Now, over 50 years later, it is an integral and very important part of our business. The challenge has been to maintain personal contacts and be responsive to customer needs against a background of an expanding plant and catalyst customer base – and ever growing product portfolio. But how can we achieve that?

What is TS?

This is not so easy to answer as Technical Support (TS) covers a broad range of activities (see box). TS is also intangible. Why? Because it depends on the individual needs of the client, which in turn depend on many different factors. The needs of an individual well served with in house specialists can be very different from those who, for whatever reason, have to be multi-tasking. Many other issues, for example, language can also come into play. As we see it, flexibility is the key, one size does not fit all; but organizing to achieve this is not easy.

The organization

We hear time and time again, and the recent seminar was no exception, that clients want more face to face time, more personal contact. And though we try hard to oblige (our seminars are a case in point), it can be difficult. However, we make the effort to meet every client at least once a year. Also every customer has a single point of contact. This is the role of the Account Managers (AM) and the Regional Sales Managers (RSM). Currently we have seven people in this global group and all have a technical background, in most cases acquired in other parts of Formox. We have recently strengthened our support by adding more resources in China, with a clearer focus on TS; other changes to further strenghten the TS are also on the way. Our aim is that your Formox representative should be able to answer most questions; but if more specialized knowledge is needed there will be a process engineer teamed up with each AM/RSM's; these "mini teams" will serve you as necessary. Bigger tasks require more resources in these cases we form a team and run the task as a project. All requests, no matter how small, are monitored to ensure nothing falls by the wayside.

What should it be?

We don't only want to maintain our already high support levels; we want to make it better to give you even more added value. So we would like you to help us shape the future for our technical support. For example, in addition to telephone calls and e-mails, our on-line Customer Center is available 24/7 to help you find answers to typical questions. But from what we can see the site is not used as much as we expected. Why is that? If you have any views on this or any other aspect of the TS function, please do not hesitate to get in touch. Please take this opportunity to let us know your ideas and suggestions. We can build the future together!

Formox technical support

Training

- **Training courses**
  On site – customized to your needs
  In Perstorp – basic and advanced refresher training courses in connection with all new plant projects
- **Seminars**
  Annual conference – Europe, Asia, NAFTA
- **Communications**
  Regular updates – through *informally speaking*
  Customer Center on Formox webpage – information 24h/day
- **Technical bulletins**
  Newsflash about technical updates, regulations/legislations, analysis etc.

Performance review

- **Optimization and trouble shooting**
  Detailed operating instructions of the catalyst
  Fast support for trouble shooting
  Analytical service (catalyst, methanol, waters etc)
- **Plant**
  Plant performance and safety audits
  Process updates
  Maintenance routines
- **Technical information**
  Process upgrades, equipment suggestions, spare parts, storage, utilities etc.
  General information for formaldehyde production

Feedback

- **Technical meetings**
  Follow up and review of plant and catalyst performance at site
  Process parameter measurements (flow, dP, gas analysis)
  Energy management
- **Process data**
  We give regular operating recommendations based on customer's plant operating data
  This information, which is treated strictly confidential, enables us to give prompt recommendations for process adjustments
- **Load performance report**
  Review of finished load and conclusions for future recommendations
  Customer survey

BY

Lars Andersson
Plant & Catalyst Sales Manager
Formox AB

Testing fans
– a vital step in the delivery of a plant

Fans are extremely important to the Formox process. By simulating operation and testing the fans at the manufacturer, potential problems can be avoided and the time it takes to start up a new site is considerably shortened.

Formox works with a number of highly regarded fan manufacturers including companies like Siemens and Finland-based Fläkt Woods. Because fans are of such vital importance to the process, Formox requires all of its fan suppliers to thoroughly test the equipment before shipping it to the destination site.

This testing, generally known as a 'Factory Acceptance Test,' or FAT test, is essential to ensuring that potential issues are detected and dealt with before the fans ever leave the factory. As a result, the FAT test helps to prevent any issues from possibly developing into problems for customers later on.

Simulating operation of a real plant

Formox has been doing business with Fläkt Woods for nearly 20 years, and FAT tests have been a part of the picture from the very start. Peter Lönnqvist, a project manager at the manufacturer, explains what the process involves for his company.

"We manufacture the fans, but we also supply the motors and frequency inverters needed to drive them. Because we have everything here, we can connect all these components just like in the final installation," says Peter. "The only difference is that we need to supply the power and attach vacuum pumps at the right places so that we can simulate operation in a real plant."

Measuring performance

Every FAT test is performed in the presence of a mechanical engineer and an electrical engineer from Formox. According to Peter, once everything is set up correctly the fans are put through a series of tests taking them from 0 rpms to maximum operating speed. Advanced equipment is used to take measurements at several agreed rpm levels, or measurement points, and the results are compiled in a detailed test report signed by both Fläkt Woods and Formox.

Recent case illustrates importance

Gert Svensson, a project manager at Formox, recently travelled to Finland together with one of Formox's customers to take part in a FAT test.

"In this particular case there were several factors that differed somewhat from the norm," says Gert. "And what we found through doing the factory test was slightly higher than acceptable vibrations at one of the measurement points."

According to Gert, this example illustrates exactly why Formox insists on carrying out FAT tests.

"These vibrations may never have actually become a problem during the normal operation," he says, "but by detecting them early Fläkt Woods was able to make the necessary adjustments and remove any uncertainty for us and especially for our customer. It's really about us being able to take full responsibility for the quality of what we deliver."

Peter Lönnqvist agrees. "We have a very long and positive cooperation with Formox," he says. "We know how important peace of mind is to their customers, so that's what we always strive to deliver."

Shorter start-up

Peter says that in addition to the sense of security that FAT testing provides, there is yet another very important advantage not to be overlooked.

"By finding and correcting any issues at the factory, the installation at the site also goes much smoother and faster," he says. "With the fans, motors and frequency inverters already tested and fine tuned before being shipped, the critical schedule during commissioning can be kept".

A visit to test fans.
Gert Svensson is inspecting fans with one of Formox's customers in Finland earlier this year.

Problems with high ECS temperatures?

Formox has the solution for you!

In recent years, Formox has put a huge amount of effort into finding innovations that enable our customers to increase their production capacity. Although the outcome has been successful, one side effect has been that the energy flow to the Emission Control System (ECS) has increased, taking the exit temperatures close to, or above, the vessel's maximum temperature limit as determined by the construction material. Therefore, in order to be able to reach the full potential of your formaldehyde reactor, it may be necessary for you to cool the ECS reactor.

How do you cool an ECS reactor?

There are a few options to consider. One is to add an extra blower to introduce dilution air at the ECS inlet. A second is to replace the existing ECS with a vessel able to withstand higher temperatures. Both of these options require investment in new equipment, which can make them unattractive from an economical point of view.

In our view, these should only be considered if you need to reduce the temperature by more than 30°C. As long as the cooling demand is moderate, the solution recommended by Formox is to combine two types of catalysts with different characteristics, namely PPt-47 and PPd-47.

A winning combination

PPt-47 is a well-known Formox product used for many years now to effectively convert carbon monoxide (CO), dimethyl ether (DME), methanol and formaldehyde to carbon dioxide and water. A drawback of this catalyst, however, is that CO at low temperatures effectively blocks the catalytically active component, platinum (Pt), which makes it almost inactive at temperatures below some 180°C.

Therefore, to enable ignition at lower temperatures, it is necessary to use a low-temperature active catalyst. Our candidate for doing this is our PPd-47 – a palladium (Pd) based total oxidation catalyst. By using the PPd-47 catalyst you will be able to operate your ECS with a significantly lower inlet temperature. However, though the ignition temperature is lower, PPd-47 is less efficient than PPt-47 at higher temperatures – enough to make it difficult to achieve the required conversion – when used alone. Therefore, the best option is to combine the two catalysts:

- Use the low-temperature active PPd-47 as the "start-up" catalyst to enable a low inlet temperature to the ECS, and
- Use the high-temperature active PPt-47 as a "clean-up" catalyst to guarantee a satisfactory degree of conversion.

The results

Figure 1 compares the CO ignition curve of a pilot-scale reactor loaded only with PPt-47, to that of a reactor loaded with a relatively small amount of PPd-47 positioned above the PPt-47. This illustrates how combining the two catalysts can achieve a 30°C lower ignition temperature.

So if you have limitations in the operation of an existing ECS unit that is of Formox or similar design, Formox can offer a choice of solutions. Some alternatives require greater investment, but there is also a simple solution using PPd-47 in combination with PPt-47.

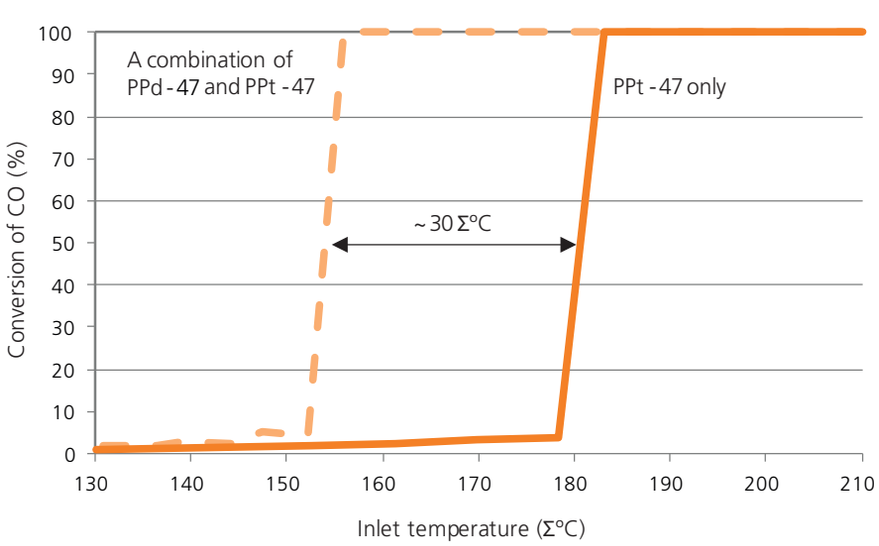


Figure 1. Conversion of CO as a function of the temperature in an atmosphere containing CO, DME, methanol, H_2O, O_2 and N_2 for a pure PPt-47 loaded reactor (solid line) and a reactor combined with PPd-47 and PPt-47, respectively.

BY

Robert Häggblad
R&D Associate
Formox AB

Check tube diameter

The loading profile you receive from your Formox representative is calculated for your reactor and optimized for the production rate of your plant. So why does the calculated amount of catalyst not always match the real amount loaded in your reactor? Minor differences in the inside diameter (ID) of the tubes may be the reason!

Take a Formox FS3 reactor for example. It has 17,400 tubes with a specified ID of 21 mm. If the average tube ID instead is 21.5 mm, the amount of catalyst and ceramic rings loaded in the reactor will be several hundred kilograms more than calculated. As a result, the supplied material might not be sufficient to complete the load. If the average tube ID instead is smaller than specified, it will result in a load that would contain too little catalyst. Since the catalyst loading profile is optimized for the production rate of your plant, a loaded amount that differs from specification will affect the overall catalyst performance such as yield and catalyst lifetime.

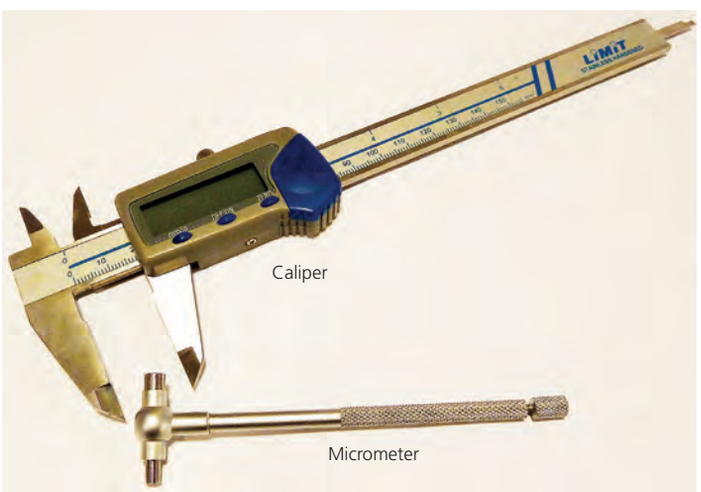


Figure 1. Example of tools for measuring of tube ID.

What to do?

Understanding how the accuracy of the tube ID impacts catalyst loading, what should we do about it? The answer is simple – measure the reactor tube ID!

One example of tools you can use to measure the tube ID is a micrometer together with a caliper (Fig 1). It is important to make the measurement below the tube sheet to avoid being influenced by the tube weld and tube end (Fig. 3). The tube end is slightly expanded and has a larger ID than rest of the tube.

A check of the average reactor tube ID can be done either during the manufacturing stage of the reactor or during the commissioning of new plants. For existing plants, the measurement can be performed during reloading of the reactor. The reactor tubes should then be cleaned with a brush before being measured. To obtain a representative average of the tube ID, the measurement should be repeated for at least 200 tubes at various sections across the entire reactor. Please be careful as to not drop the measuring device in the tube; put a string around it to not get any expected surprise.

So, during your next reload, measure the tube ID and send the reactor average to your Formox representative. In this way, a catalyst loading profile optimized for your actual tube ID can be supplied and you will maximize the performance of your next catalyst load.

By Daniella Cheng
Process Engineer
Formox AB

Figure 2. Alternative to micrometer.

Figure 3. Sketch of tube and tube sheet.

Mo update

The price of molybdenum (Mo) has been very stable since the previous edition of *informally speaking*. At the end of last year, the price hovered around 14 USD/lb and it has remained there ever since. According to analysts, the price is expected to stay at this level, or within 12-17 USD/lb, for quite a long time, although sudden increases in demand due to market changes could push the price over the USD 20/lb mark.

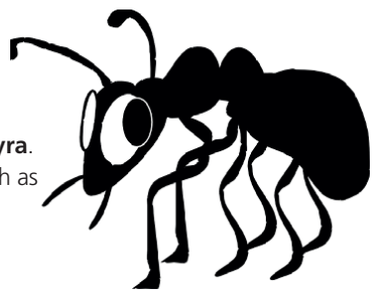
While there is currently a good balance between supply and demand, changes in economical growth or legislation could shift the balance. In China, for example, a resource tax has been placed on Mo which, together with high domestic production costs, could increase the imports of Mo to China. Also, some countries have put bans on or made it more difficult to export valuable resources like Mo, which could also influence the balance of supply and demand.

The good growth seen in China, but also in India, for example, is expected to continue. China is the main consumer and producer of both Mo and stainless and steel alloys that contain Mo, and this will also have a long-term influence on the price of Mo. For these reasons, the price is expected to gradually increase and eventually reach above 20 USD/lb by the end of this decade.

Regardless of the market changes, you can rely on Formox to maintain reasonably stable net prices thanks to your efforts to return spent catalyst and thanks also to our efficient catalyst recycling system!

By Ronnie Ljungbäck
Product Manager Catalysts
Formox AB

Formic acid & ants?



A small piece of trivia: In Swedish the word for ant is **Myra** and the Swedish word for formic acid is **Myrsyra**. The direct translation is **Ant acid**. Ants can defend themselves by injecting or spraying with chemicals, such as formic acid.

Why is formic acid a problem in your formaldehyde?

For resin producers a higher than normal amount of formic acid in the early stages can cause a buffer effect to occur and can affect the post forming properties (scratch and temperature resistance) of the resin.

For polyoxymethylene (POM) producers the formic acid accelerates the cationic ring opening polymerization of 1, 3, 5-trioxane. The formic acid affects the chain length of the polymer giving rise to variations in molecular weight and molecular weight distribution in the POM. Another problem which can be caused by having too much formic acid in your product is possible hydrolysis of the mixed anhydride end group of POM affecting the polymers thermal stability.

For other formaldehyde consumers formic acid is not an issue.

What are we at Formox doing about it?

During start up the amount of formic acid in the formaldehyde is typically somewhat higher compared to after a couple of weeks of operation. After the initial period it normally drops to acceptable levels and remains constant until the catalyst needs to be re-loaded. We would like to reduce or control the formic acid content during start-up with new catalyst. Therefore, we are currently running a project to determine the best way to do this.

Formic acid is a simple molecule and is formed potentially by many different possible reactions, which can occur in many different areas in the process. The key areas are in the reactor, the absorber and in the storage tank.

The Reactor

Here are some reactions that can occur in the reactor to give formic acid:

1. **Over oxidation of formaldehyde**
$CH_2O + ½O_2 \rightarrow HCOOH$

2. **Hydrolysis of methyl formate**
$H_3COOCH + H_2O \rightarrow HCOOH + CH_3OH$

3. **Oxidation of dimethyl ether**
$H_3COCH_3 + 2O_2 \rightarrow 2HCOOH + H_2O$

4. **Disproportionation of formaldehyde**
$2CH_2O + H_2O \rightarrow HCOOH + CH_3OH$

Cleaning the reactor tubes thoroughly between reloads and making sure all catalyst dust below the tubes is swept up or vented away after the reloads has been seen to reduce the formic acid levels. Have you observed this?

The Absorber

Formic acid can also be formed in the absorber. The following are possible reactions that can occur in the absorber to produce formic acid:

1. **"Cannizzaro" type reaction**
$2CH_2O + H_2O \rightarrow HCOOH + CH_3OH$

2. **Hydrolysis of methyl formate**
$H_3COOCH + H_2O \rightarrow HCOOH + CH_3OH$

The storage tank

Formic acid can be formed even in the storage tank. Using the correct storage temperature will help in minimizing formic acid production. The optimal storage temperature depends on the formaldehyde concentration where a span of 35-65 degrees can be applicable, but it also depends on a number of other parameters (storage configuration, usage of stabilizers, days in storage). We therefore recommend our customers to contact us to discuss the specific case.

The more likely route for formic acid formation in the storage tank will be by the Cannizzaro reaction and air oxidation of formaldehyde:

1. **"Cannizzaro" type reaction**
$2CH_2O + H_2O \rightarrow HCOOH + CH_3OH$

2. **Air oxidation of formaldehyde**
$CH_2O + ½O_2 \rightarrow HCOOH$

In summary

As you can see, formic acid can be formed in more than one unit and by more than one reaction. Luckily the side reactions that produce formic acid are not dominating and the amount of formic acid in the product is low. Formic acid in 37% formalin, for example, is typically 0.02 – 0.04% at the start of a new catalyst load and usually 0.01 – 0.02% at the end of a catalyst run.

We are looking into the best way to control/reduce this variation. Our suggestions will be given in subsequent issues of *informally speaking*. So watch this space!

Having a consistently low level of formic acid in your product is important for you and for us!

BY

Neil Cruise
Research Associate
Formox AB

Training & project news

A one-day training was performed in connection to the Formaldehyde Europe conference in Perstorp in May. The training was focused on hands-on exercises to improve operations.

Engineering review meeting with CHONGQING CHANGFENG CHEMICAL INDUSTRY Co., Ltd in April.

new projects & start ups

New projects

- An agreement has been signed for a FT2 plant to be supplied in the Middle East.
- We are pleased to confirm an agreement with EGGER for the supply of a new FS2 UFC plant.
- We have signed an agreement for a new plant to be supplied to a client in the Middle East.
- We are in the design phase of a new UFC plant to be supplied to an existing customer in the Middle East, and we welcome the confidence that this second project demonstrates in the Formox technology.
- Henan Coal & Chemical Industry Fine-Chemical Co., Ltd, Hebi, China, has signed up for a second FS3 plant.
- An agreement has been signed for a FS3 plant to a European customer.

Ongoing projects

- The project with two FT3 plants for CHONGQING CHANGFENG CHEMICAL INDUSTRY Co., Ltd, Chongqing, China, is in progress.
- The FT3 plant for Shaanxi BDO Chemical Industry Co., Ltd, China, in the deign phase. This will be their second Formox plant.
- Works on two Formox plants (FS3 + FT3) for Polyplastics Asia Pacific SDN. BHD, Malaysia, is in the design phase.
- The project on a FS3 plant to be located in Asia, is in the shipping phase.
- Works on the FS3 plant for Tangshan Zhonghao Chemical Co., Ltd, China, is proceeding well with start of installation this summer.
- The project for an FT3 plant for Xinjiang Markor Chemical Industry Co., Ltd in Korla, China, is approaching mechanical completion with scheduled start-up 2012. This will be their second Formox plant in Korla.

Start-ups

- The first Formox FS3 plant supplied to Henan Coal & Chemical Industry Fine-Chemical Co., Ltd, Hebi, China, went on stream in April.
- The new Formox FS3 plant for Nantong Jiangtian Chemical Co. Ltd, Nantong, China, was successfully started in June. This is their third Formox plant on this site.
- The expansion with a second reactor line in an FT3 for Ningbo Wanhua Polyurethanes Co., Ltd, China, is going on stream about time of publication of this issue of *informally speaking*. This is their second FT3 plant on the Ningbo site.

new...

Lars Jennergren
Project Manager

Håkan Svärd
Instrumental & DCS Engineer

Ola Seger
Project Engineer/
Site Supervisor

Anne Rundström Eliasson
Sales Coordinator

Stefan Wedman
Engineering Manager

Camilla Eklund
Process Engineer

Kai Jauhiainen
Process Engineer

Christian Luckman
Mechanical Engineer

Karsten Wilken
Project Engineer/
Site Supervisor

Mariette Walter
Controller

...& left

Patrik Lindkvist
Engineering Manager

Jan-Erik Andersen
Project Engineer

Erik Timander
Project Manager

We are glad to have had Patrik, Jan-Erik and Erik as our colleagues and wish them the best of luck in their coming challenges.

A formaldehyde magazine from Formox

The newsletter *informally speaking* aims to provide information about formaldehyde in an informal forum and is published twice annually by Formox 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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