informally speaking

THE FORMALDEHYDE NEWSLETTER FROM PERSTORP FORMOX spring/summer 2005

Passage to INDIA

The earth's second most populous country is growing economically too. Some think India could become "the next China". Perstorp Formox has been well-established there as a supplier of technology and catalysts for years, and we felt the readers of ***informally speaking*** might find it interesting to take a look.

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Load right! **page 8**

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in this issue...

Control issues

Most of us like to be in control – of our bodies, our minds, our surroundings, our formaldehyde plants, our worlds, our lives.

Then reality keeps crashing in to remind us how limited we are. The tsunami in the Indian Ocean brought untold tragedy to hundreds of thousands of people, from Indonesian fishermen to Swedish tourists – and nobody could do a thing to prevent it.

We can't control most of the natural disasters that happen. But sometimes we can control their effects, both by preventive measures and remedial ones.

Humans are ultimately responsible for nearly all of the earth's pollution. We can't control what others do, but we can see that we don't contribute to the mess.

A good formaldehyde process is all about control. Careful loading of catalyst. Tight control of the HTF temperature and the methanol inlet. Safe handling, both of methanol and of spent catalyst. But none of us HCHO producers can control the price of methanol, nor of molybdenum.

Good control is basically synonymous with efficiency – and the opposite of wastefulness. It's about making the most of what we've got. In our case, making the most formaldehyde out of the methanol we've got.

The very "soul" of Perstorp Formox is to continually squeeze more formaldehyde out of less methanol, and to do our utmost to help each and every customer do likewise.

That's why we invest so much effort in our technical support. We're not content to supply a plant and then let you spend years figuring it out. It's not in our nature to sell you catalyst and then let you hope for the best. That's why we're behind you all the way, offering our support from start to finish of every load of catalyst, and constantly devising new process and plant improvements.

You could call us control freaks.

Mikael Ekblad
General Manager
Perstorp Formox

India is a country of huge contrasts. And with over a billion people, India is also a country with a huge population – currently the second most populous nation on earth, right on the heels of China. In the 58 years since its freedom from colonial rule, India has been undergoing monumental transformation towards becoming a modern society that also happens to be the world's largest democracy. With annual economic growth running at some 7-9% annually for the past few years, India is aiming for a slot among the world's top 10 economies by 2020 – making India a developing country in the most active sense of the word.

For the chemical industry in general, India is apt to be linked to the Bhopal disaster of 1984, in which leaking methyl isocyanate led to the loss of several thousand lives and serious health consequences for several thousand more. If good can be born of disaster, Bhopal certainly jump-started the adoption of increasingly stringent health and environmental safety measures, not only in India, but all over the world.

As a result, modern players in Indian chemical industry tend to see the internationally accredited and verified ISO programs (such as ISO 14001) as the hallmark of a professionally run chemical company. The lesson is that an accident in any chemical industry anywhere in the world will adversely affect the entire chemical industry in terms of public perception, media attention and, ultimately, legislation and regulation.

The major site of India's chemical industry is the state of Gujarat, one of the country's 26 states, located a bit north of the huge Mumbai (formerly Bombay) metropolis along India's west coast. The states and state governments play a very important role in Indian life and economy, since India's current tax structures involve heavy local taxes. For example, a chemical company selling its products to a customer within the same state might have to pay 15% in local tax, but if that customer is located just across the state boundary, the tax rate drops to around half of that. Tax reform legislation is in the making that would replace this restrictive system with a national VAT-like structure, but such reforms are often subject to pressures from from special-interest groups, according to one source, so it may take a couple of years before this reform is in place.

Another 2-sided problem facing the chemical industry is duty barriers, which have dropped from a whopping 85% in 1985 to the current level of around 15%. On one hand, this reduction has helped to open up India's economy, but faced

with high energy (and methanol) prices, Indian industry has had to struggle to internally generate the levels of efficiency that are needed to make it competitive.

On these problems, I found general agreement among those I spoke with, including the Perstorp Formox customers I interviewed. But opinions differed on the subject of population growth. Some felt that although India's economy is rapidly creating a larger "pie", the number of "slices" is growing even faster, thus quickly eating up the gains. But others saw the large population as a strength.

Everyone agreed, however, that India is seeing tremendous focus on building up the infrastructure (roads, trains, communication networks) and promoting education. Indeed, India has become a major outsourcing target for the global IT industry. India's schools of higher education are gaining high international esteem for their academic levels in science, technology and business. This of course bodes well for the future, and makes India a country to watch – and perhaps to read about in ***informally speaking***.

The Indian formaldehyde industry seems to differ from other parts of the world, especially Europe and North America, in a couple of ways. One is that due to the year-round heat (an Indian "winter" may be 25°C / 80°F, although cooler in the far north), HCHO can be transported somewhat longer distances, so less HCHO is produced exclusively for captive use. Another is that there are a lot of smaller producers who may be selling low-grade HCHO at cut-rate prices on a "gray" (if not black) market, thus competing with established (and scrupulous) producers. This situation is likely to improve in pace with India's continuing development.

The "Gate of India" arch in Mumbai harbor

Let's pay a visit to two well-established – and scrupulous! – producers!

Stan Erisman, Editor

Kanoria Chemicals & Industries Ltd

The small town of Ankleshwar (population around half a million), some 325 km due north of Mumbai, is India's largest (and the whole of Asia's second largest) industrial area, with an industrial park that stretches almost as far as the eye can see from the top of an absorber tower. It's also the principal site of India's largest formaldehyde producer, Kanoria Chemicals. Messrs. ***O.P. Patodia*** *(Director),* ***B.P. Agrawal*** *(President, Works) and* ***R.K. Dammani*** *(Vice President, Technology) have kindly provided the following information.*

What is the history of Kanoria Chemicals?

"The parent company was founded in 1960, with headquarters in Calcutta and production in Renukoot, near Varanasi, in central India, producing such products as NaOH, chlorine, pesticides etc," explains Mr Patodia. "The company culture at this site is entirely different than at Ankleshwar, since it consists of what amounts to a private township; the company has its own hospital, schools, markets etc for 10,000 people, many of whom work at the plant. They even have their own salt works for captive production of salt for use in the NaOH process!

"Then in 1983 we started up the site in Ankleshwar, mainly producing penta, for which we originally had to purchase formaldehyde externally. We also produce hexamine, alcohol and alcohol-based products."

When did you start making your own HCHO?

"In 1990," says Mr Dammani. "That's when we got our first plant from you. We got our second Perstorp Formox plant in '92, and have expanded the capacity of both plants in two stages. Now [in 2004] we've added a third plant using Perstorp Formox technology, making us the biggest formaldehyde producers in India."

From left: Mr Arun Agarwal (Sr. V.P.), Mr B.P. Agrawal, Mr O.P. Patodia, Mr R.K.Dammani, Mr Patel (HCHO plant manager)

Do you get adequate technical support from Perstorp Formox?

"Yes, we get really good support," adds Mr Dammani. "We faithfully send our operating data to your people every week and get important feedback. We've also had good support with our expansions, our loading plans and good information about other matters. And we have no problems with catalyst shipments.

"I can also mention that with methanol prices being what they are, it has become extra important to have efficient plants with high yield, and that's what we've got!"

How do you view the market situation in India today and for the future?

"There's been major economic growth in India – around 7% – for the past few years," notes Mr B.P. Agrawal. "This is the


The industrial park stretches to the horizon.

Safety has high priority at Kanoria's 3 HCHO plants.

biggest growth in India's history, and since inflation is under control, at around 5%, there's much higher optimism in India today. As a result, the standard of living is increasing day by day: better schools, better communications and transport, better quality of goods, and better housing. And of course that means more building construction, which will mean a growing market for formaldehyde.

"Much of this is fueled by India's new emphasis on education. We've got good business and technology schools here, so many multinationals are recruiting Indian graduates, and lots of IT jobs are landing in India, since the supply of local talent makes India advantageous for outsourcing. There's also a more open economy in India today – more privatization, more open to international trade and greater opportunities to develop."

How important are safety & environmental issues at Kanoria?

"Safety and environment are a key part of our company culture," confirms Mr Patodia, "as well as our legal system. All our people get training in safety procedures, and we're constantly reminding our people of the importance of observing them. The government conducts strict annual boiler inspections, and of course our plants are connected to an emission control system, so we meet those demands as well. We started up our operations here in Ankleshwar around the time of the Bhopal accident, so safety and environmental thinking have been with us right from the start."

Facts about Kanoria Chemicals

- Founded in 1960, HQ in Calcutta, production in Renukoot and Ankleshwar
- Around 2,000 employees, of which 500 are in Ankleshwar
- Started own HCHO production in 1990
- Main downstream products from HCHO are penta, formic acid and hexamine
- 3 HCHO plants using Perstorp Formox technology

Atul Ltd.

About 200 km north of Mumbai (some 3 hours by train) lies the remarkable town – and company – of Atul. The company occupies a tremendous "campus" of well over 3000 hectares (1250 acres) that houses not only the plants and offices of Atul Ltd, but also schools, medical facilities, housing for nearly 800 of the company's employees, recreational facilities, its own power and water supplies, lots and lots of green nature and wildlife – in short, a microcosm. ***Dilip Anjikar****, General Manager for Manufacturing, tells the story.*

Can you tell us something about the company history?

"The oldest roots date back to the founding of the Lalbhai Group textile mills in 1908. Their need for dyes and treatments of textiles led to the formation of Atul – the chemical business – in 1947. Today Atul consists of six divisions, some of which still serve the textile industry, but others have branched out. These include our Polymers Division (where we produce and use formaldehyde), which was originally part of a joint venture with CIBA of Switzerland, under the name Cibatul. That business was merged into Atul in 1999."

When did you start producing HCHO?

"We started in 1973, using a silver plant. Then we got a plant using Perstorp Formox technology in 1988. I think this may have been the first of its kind in India. [Editor's note: It was!] In any case, we are very happy with your technology – and our customers are pleased with the quality of our formaldehyde. We shut our old silver plant down in 2001."

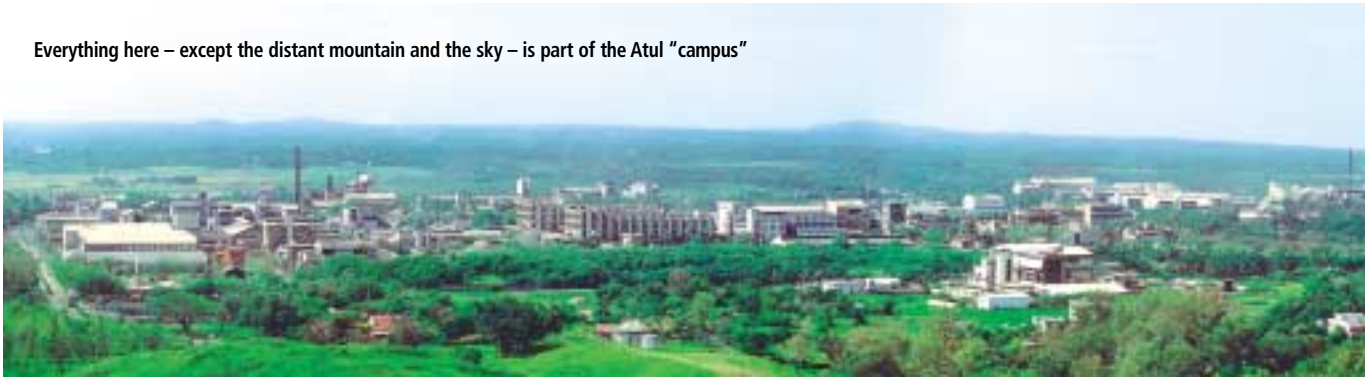
What do you use your HCHO for?

"We have captive consumption for UF resins and epoxy resins and hardeners, as well as external sales, mostly for use as UF coatings. Our climate makes it feasible to transport formaldehyde within a radius of up to 800 km, which means we can basically cover the various parts of India."

What threats and opportunities does Atul face?

"The high cost of methanol is definitely an inhibiting factor for growth, not only for us but for the entire Indian HCHO-based industry. And we have to deal with tough competition from a number of unscrupulous small producers who don't


India's first Perstorp Formox plant



Everything here – except the distant mountain and the sky – is part of the Atul "campus"

Photo courtesy of Atul Ltd

pay taxes and maybe don't care so much about quality. Atul doesn't circumvent the law. We pay our taxes. So instead we have to keep on innovating to bring down costs, because margins are shrinking. But we feel that once better tax controls are in place, and once quality becomes more of a competitive factor, we'll be well-positioned. In addition, we have the ability to handle complex chemistry and our company is very flexible."

How do you view safety and environmental issues?

"We take these things very seriously. It's more than the fact that we've got ISO 9001 and 14001 certification. I think since Bhopal, the whole of India has been alerted to the necessity of responsible chemical handling. We got lots of help in this from our former Swiss-based partners [CIBA], who provided the latest technology for establishing safe practices. There is also a deep-seated spiritual reverence for nature among Indian people. We have, in fact, a variety of birds and snakes right here on our industrial 'campus', which we see as a sign of living in harmony with nature. During the land development stage, our founder planted half a million trees out of concern for nature. We also make extensive use of environment-friendly technology, and have won numerous government safety awards."

You have a special relationship with your people?

"Definitely. Many of our employees live right here 'on campus', where we provide schooling through 12th grade. The academic standard is high, so there are good opportunities for going on to higher education. In India, education is a matter of survival that we don't take for granted. Education comes first, sports second! And the care we offer our employees certainly pays off. In fact, industrial relations have not caused a single day of work loss over the past 30 years!"

Facts about Atul Ltd.

- Formed in 1947 as the chemical business of the Lalbhai Group
- 3,500 employees in 6 divisions
- HQ in Atul, offices in the UK, USA, China and Germany
- 80 employees in the Polymer Division Manufacturing Wing, which produces HCHO
- Producers of epoxy & UF resins and curing agents
- India's first Perstorp Formox plant, 1988.

Atul at Atul in Atul*

Atul Shah, our man in India, is flanked by Mr Vivek Gadre, Vice President (left) and Mr Dilip Anjikar.

Opportunities for headlines like that don't come along every day!

Right at home in India

Atul Shah, the go-to guy for Perstorp Formox in North America, has now assumed a similar role in India – as well. As you might expect, ***informally speaking*** has the story.

Why are you filling this role too?

"For one thing, we had a vacancy in India that we urgently needed to fill. I have quite a lot of experience by now, so I guess you can say I was qualified. Then there's the fact that I travel to India regularly anyway. I grew up in Mumbai – or Bombay, as it was known back then – and my parents are still living there. So it made a perfect fit."

What advantages do you see?

"It's a big advantage knowing the culture, the customs and the language, even if I'm a bit rusty on some of the dialects. OK, the managers tend to know English very well, but being able to explain technical questions to the operators in their own language is a major plus. We have this setup elsewhere, with Edy [Edy Lie, based in Singapore], Dayang [Zhou Dayang in Beijing] and Anna [Anna Yevdokimova in Moscow]."

What about your North American customers – aren't you stretching yourself a bit thin?

"If I'd tried this to start out with 5 years ago, there might have been problems. But now I know all my North American customers and their plants, and they know me. And we have the dedicated technical support of Magnus Hernelind and the process engineering team in Sweden. So we can usually cut straight to a problem and solve it quickly. And, as I said, I travel to India every year anyway!"

CEFIC launches FormaCare

In January, CEFIC – the European organization representing the interests of the chemical industry (see the autumn/winter 2004 issue of ***informally speaking***) – launched FormaCare, a new group to represent the previous formaldehyde, polyol and amino glue sectors within CEFIC. The purpose, says **Dr Detlev Clajus**, Secretary General of FormaCare, is "to do formaldehyde justice!" He kindly agreed to an interview for this newsletter during a recent visit to Sweden (the Perstorp Group is one of the executive members of CEFIC).

Photos by Cecilia Håkansson

Can the formation of FormaCare be seen as a response to the recent reclassification of formaldehyde?

"It's definitely the major issue right now, but it's not the only reason. We also need to have an organization in place for dealing with possible new issues as well. And a channel for communicating factual information to the general public."

What are your thoughts on the reclassification?

"First, it's important to realize that the final word has not been said. The reclassification is a recommendation that has to be passed by the EU Commission, which at the moment is not even foreseeable.

"Second, the reclassification is based on a limited number of nasopharyngeal cancers found in workers exposed to high levels of formaldehyde several decades ago. Since then, formaldehyde levels in the workplace have been lowered significantly. So the reclassification is really based on outdated information.

"Third, it must be remembered that a hazard classification doesn't consider actual exposure levels. But we all know that many substances are potentially carcinogenic – it's the dose that counts!"

Why isn't this obvious to everyone?

"Because the debate tends to be about 10% scientific and 90% emotional. Some people would like to see a skull and crossbones on furniture. And there can be political aspects. What FormaCare wants to do is see that the facts get back on the table before any binding decisions are made. Since we're made up of producers and users, we can share the costs of having new research conducted by independent institutes and universities. This can be the best way to do formaldehyde justice!

"It is, after all, a safe, stable means of producing very many necessary products. In the board industry, for example, other alternatives [to formaldehyde-based glue] would be significantly more expensive. And bear in mind there's formaldehyde in natural wood too – just as there is in our own bodies, in fruits and vegetables. It's a natural substance!"

How will you be communicating this?

"To the general public, primarily via our website [www.formacare.org], possibly via flyers or ads. And then we have our contacts with the authorities."

Will you be cooperating with your North American counterpart, FCI?

"Yes, we'll be having close collaboration with FCI – and with Japan. Actually, formaldehyde is not such a hot topic except in the West and Japan. But of course it can become hot for other regions too – especially when they're looking to export to the West."

What about your own background?

"I've been with Degussa for about 20 years, where I've worked in different management positions, mergers & acquisitions, environmental department and production. My degree is in chemistry. I was called upon to head FormaCare from Day One, which was January 13th. This is an exciting opportunity, and a real challenge, to help enlighten people about the important role of formaldehyde."

Follow-up:

CO measurements in HCHO plants

by Magnus Hernelind

The biggest by-product in formaldehyde production is normally carbon monoxide. CO loss is defined as the percentage of the incoming molecules of methanol that are converted into carbon monoxide over the reactor. The typical trend for CO loss and measured concentrations during the catalyst lifetime can be found in the graph below. Formaldehyde plants with adiabatic beds will have similar trends, except that CO loss will have an offset of + 0.5-1.0 % – but at the same time the amount of dimethyl ether and unreacted methanol in these plants will be lower, so the total yield will be the same or better. During the first couple of weeks of the run, the CO loss is usually slightly higher and then it drops to a minimum point. After that, the CO begins increasing slowly and sometimes during the last month of operation it may increase quickly. When you see the CO loss beginning to accelerate, that's the best time to order the next catalyst load.

What to do when the CO loss is high?

The usual procedure is to raise the HTF (heat transfer fluid) temperature a couple of degrees, but you can do more:

- Decrease the methanol feed rate (this is actually the best way of lowering the CO loss).
- Increase the amount of water in the process gas into the reactor, e.g. by increasing the absorber-top temperature.
- Lower the oxygen concentration in the plant.
- Increase the airflow.

When several of these measures are applied, the amount of unreacted methanol from the reactor often increases, which means the HTF will have to be adjusted upwards again a couple of degrees Celsius to retain the conversion.

More about CO measurements

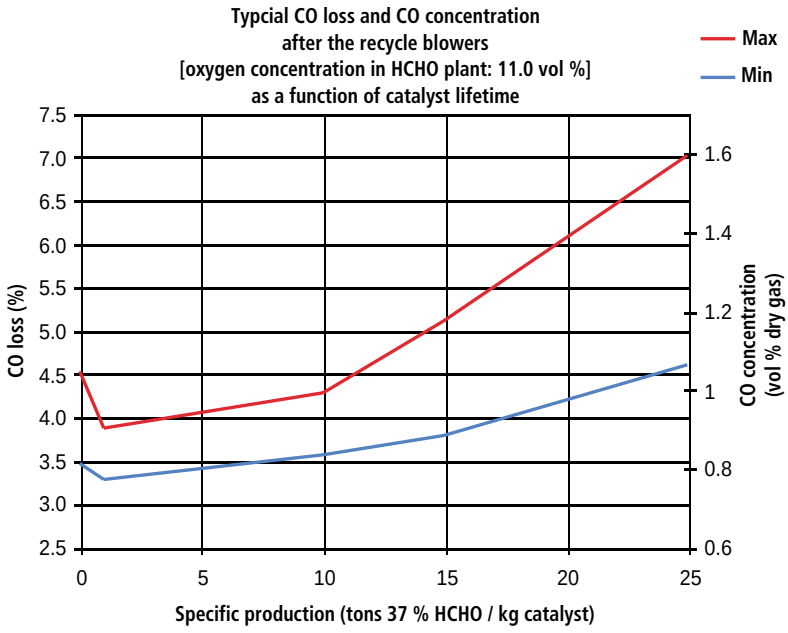
The most common methods for measuring the CO loss involve using an infrared (IR) gas analyzer or a gas chromatograph (GC). A GC is build to handle gas taken from most points in a formaldehyde plant, but the IR instrument only analyzes dry gas. When using the IR technique for a single-reactor system, a good sampling point in the plant is where the risk for para formation and condensation is the lowest, i.e. right after the recycle blowers. Remember that if you use an IR instrument, the gas analyzed is first dried in a gas cooler, which means the reading is about 3 % higher (depending on the current climate conditions and the absorber top temperature & pressure) than the actual concentration, since you have removed the moisture.

Same concentrations, different losses

The CO concentration measured after the recycle blowers with an IR gas analyzer is strongly dependent on the oxygen concentration in the plant. Two different plants can have the same CO loss even though they have measured different CO concentrations – because they have different oxygen concentrations. The table below shows the oxygen/carbon monoxide concentrations corresponding to a CO loss of 4.4 %.

OXYGEN / CARBON MONOXIDE concentrations corresponding to CO loss = 4.4 %

Oxygen (vol %) after recycle blower	CO (vol %) after recycle blower
11.5	0.95
11.0	1.01
10.5	1.06
10.0	1.11
9.5	1.16



Important safety notice! When you have an online IR measurement for CO, it is often placed in a confined space, so you should carry a portable CO sensor in case a gas leak in the system has occurred.

Catalyst school

The importance of accurate loading

by Ronnie Ljungbäck

As we all know, the purpose of having catalyst in the reactor tubes is to convert methanol to formaldehyde with high selectivity. It is essential for the performance of a formaldehyde plant that the catalyst is loaded in accordance with our recommended loading plan.

The choice of loading plan is based on the plant design, where a number of factors must be considered, e.g. the methanol flow and the total gas flow in the tubes. Since the conversion of methanol to formaldehyde involves an exothermic reaction, it is important to be careful in the selection of the right catalyst combination.

Material stuck to the tube wall just below the mixed layer acts like a kind of "cholesterol" and should be removed.

Pre-loading precautions

Proper preparation is a prerequisite to accurate loading of the catalyst in the reactor tubes. Of course you should be sure that you have the right catalyst types and amounts required. If you have any doubt whatsoever, please contact your Perstorp Formox representative. Other pre-loading precautions – which should be regarded as standard procedure – include:

1. checking for HTF leaks in the reactor tubes
2. seeing that bottom net or clips are in place
3. cleaning the reactor tubes (if needed).

Nearly all formaldehyde producers seem to routinely perform points 1 and 2 above. Point 3 seems to be less than universal, so, I would like to offer some explanation on this.

The importance of cleaning

As the catalyst is being used, there is normally a certain amount of degradation, which involves migration of MoO_3 from the upper part of the reactor tubes and catalyst layer to lower parts, and also a subsequent disintegration of the catalyst. This is normally observed in the form of a back-pressure increase during the run of the catalyst load. After a completed run, you can expect to find a small "clot" or obstruction, at the point where the pure catalyst layer starts in the tubes (just below the mixed layer). This must be removed, as must any MoO_3 needles that may be found after the reactor.

We also recommend that you inspect the vaporizer (or aftercooler, depending on your design), and check/clean out any further catalyst dust or para found there.

Tubes control

It is also important to load the multi thermocouple tubes in accordance with our normal recommendations, i.e. the multi thermocouple tubes should be equalized with the surrounding reactor tubes in terms of pressure drop. This is necessary in order to get representative and comparable results from the beginning of the operation of the catalyst load, and thus to get the most reliable hotspot temperature readings.

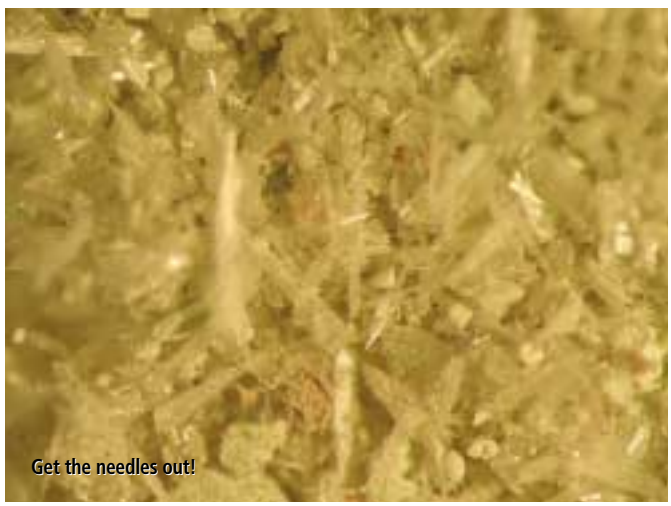
Another important thing to remember is to check the reactor tubes (e.g. with a wooden stick), both as the loading is proceeding and after completed filling of the reactor. Regardless of how the catalyst is being loaded (manually or by a 1-, 2-, 3- or 4-layer loading machine), checking the tubes is a simple and efficient way of assuring that the catalyst has been loaded properly.

Higher inlet, greater care

The CAP loading plan may be designed for operation with up to 10 vol% methanol inlet, which offers a great boost in productivity. But when operating at this level, it becomes more important than ever to ensure that the loading procedure is conducted in the best possible way, in terms of observing and respecting the loading heights recommended by Perstorp Formox. There are two main reasons for this extra caution:

1. More reaction heat needs to be handled.
2. There are higher potential methanol losses.

With a 10% methanol inlet, the methanol content will obviously be higher per volume unit of gas, which means greater heat – heat that must be distributed as evenly as possible over the reactor tubes. This is taken care of by the selected CAP loading plan, provided that the tubes are loaded accurately, of course. If the loading plan is changed, it will influence the heat transfer and the reaction temperatures, and can cause



Get the needles out!

overheating of the catalyst in the pure or mixed layer, and/or undesirable low activity or reaction temperatures.

A 10% inlet also means that there are higher potential losses in terms of kg per hour of methanol. Unloaded or improperly loaded tubes may have several consequences:

- lower yield due to higher total methanol slippage (mainly from unloaded tubes, but also from tubes containing only mixture or pure catalyst);
- over-heated catalyst in tubes where no mixture is present;
- shorter economical catalyst operating lifetime due to the higher methanol slippage from the empty tubes, which also increases with time, since the pressure drop in the tubes containing catalyst increases as the catalyst is being used;
- increased risk of methanol fires after the reactor and consequently unwanted shutdowns of the plant, due to the higher concentration of unconverted methanol in the gas exiting the reactor.

The bottom line thing

A single unloaded tube, when running at 10% inlet, means a loss of at least 7-9 kg of methanol per day from that tube, and that's just at the beginning. The loss will increase as the pressure drop over the reactor increases, so you'll lose about 2-3 tons of methanol during the course of a year (except for the energy you'd hopefully be able to recover in your ECS).

I'm sure you'd much rather have that extra 2-3 tons of methanol show up as formaldehyde on your bottom line! That means taking the time and effort to load carefully, strictly according to our recommended loading plan, and monitoring the procedure every step of the way.

CAP follow-up

The cover story of the latest issue of ***informally speaking*** (autumn/winter 2004) has generated a lot of interest – not surprising, considering the great potential it offers for boosting the productivity of formaldehyde plants. CAP (which stands for Catalyst Activity Profile) was launched in mid-2003 and represents a further development of Perstorp Formox's mixed layer concept, i.e. catalysts of different activities that are combined to match activity distribution – and therefore heat release – to the plant's capabilities. With a CAP loading profile, it is in fact possible to operate at an inlet of up to 10 vol% throughout the catalyst lifetime!

With the interest have come a lot of questions, several of which are answered below. Others will be taken up at Formaldehyde Americas 2005 in Vancouver in early October (see "Seminar News", page 16).

Why do we need CAP? Why not just increase the inlet with the old type of mixed layer concept?

It may be possible to increase inlet somewhat, at least for part of the catalyst lifetime, but if you intend to operate at high inlet for the entire catalyst load, an optimized high inlet loading plan must be used to ensure that excessive temperatures are avoided and to ensure that the conversion and yield are high enough.

Why hasn't it been possible to operate with this high inlet until now?

Perstorp Formox is continuously improving and developing the process design as well as the design of catalyst loading profiles. One step to increase productivity of a plant is, of course, to increase the inlet. But it's not that simple. You also need to achieve an acceptable catalyst lifetime, i.e. too high a pressure drop increase as well as too high temperatures must be avoided. You also have to achieve good conversion and yield, so you have to establish the correct contact time.

The higher the inlet, the more difficult it becomes to meet all necessary criteria, and during the development phase of the high inlet concept it was very important to ensure that catalyst with the correct activity was available, that the loading profile simulation tool was reliable enough and then, before launching the concept (since our philosophy is to sell proven concepts), to test it, first in pilot plants and then in full scale.

Since the introduction last year, almost half of all the loads sold by Perstorp Formox are now of the High Inlet type. What's the general perception of performance when operating with the High Inlet loading profile?

The vast majority are very satisfied with the High Inlet type of loading profile, according to a survey we conducted. The survey confirmed that it is indeed possible to operate with higher inlet and that production capacity is high right from the start, making the start-up period very short. Further, the survey confirmed that the yield with the CAP-type loading profile is higher or at least as high as before. This and much more relating to maximizing the output of your plant will be discussed in more detail at the Formaldehyde Americas 2005 in Vancouver this October – and reported in the next issue of ***informally speaking*** in December.

Keeping on top of it

by Marie Grönborg

Were you one of those who were surprised to read about the impact of water content in the recycle gas in the summary from Formaldehyde Asia 2004 in the spring/summer issue of informally speaking a year ago? We've had lots or reactions and will therefore try to clarify – or actually to answer the question: What should the absorber-top pressure and temperature be?

The water content in the gas to the reactor is mainly determined by the partial pressure of the water at the absorber top, i.e. it's determined by the absorber-top temperature and pressure. This is because the recycle gas is saturated with water, unlike the fresh air that normally has lower relative humidity. Furthermore, the gas to the reactor contains approximately 2/3 recycle gas and 1/3 fresh air.

Some articles in the literature mention water as playing the major role in catalyst deactivation, but our studies have verified that water does not have the strong influence on catalyst deactivation that we had previously thought.

Why keep a low temperature?

There are two reasons to keep the absorber-top temperature reasonably low:

1. deactivation of catalyst
2. corrosion problems

Where deactivation of the catalyst is concerned, experience from a number of plants – including our own in Sweden – confirms this and suggests that a slightly higher water content has a very marginal effect, if any at all, on our catalyst's lifetime.

Therefore we say that for most plants operating at atmospheric pressure, the absorber top temperature can continuously be up to 35°C and up to 40°C for part of the run, without affecting the catalyst lifetime. For plants operating at 0.3 bar g pressurization pressure, this corresponds to 40°C and up to 45°C during part of the run. It may even be feasible to operate at even higher absorber top temperatures, but that should then be discussed with your Perstorp Formox representative.

Prematurely deactivated catalyst – who needs it?!

The corrosion problems are more a question of absorption efficiency – a lower absorber-top temperature gives better efficiency. If the formaldehyde content in the top of the absorber gets too high, there will be a high formaldehyde content in the recycle gas and you will risk corroding the blowers and/or you will have para build-up on the blower internals. The maintenance and operation cost will be high, and you will lose production due to standstills. To prevent such problems, the formaldehyde content in the recycle gas should always be below 1000 ppm.

Chilled water or not?!

The question for formaldehyde producers operating in regions with high ambient temperatures then is: Do you need chilled water to control the absorber top temperature in your plant?

It depends. Basically, if you need chilled water to be able to keep the formaldehyde content in the recycle gas below 1000 ppm, the answer is yes. If not, the answer is most probably no.

Unfortunately there is no simple answer whether there is a risk of exceeding 1000 ppm of formaldehyde in the recycle gas with no chilled water; it depends on your plant conditions and the absorber. There are two ways to scrub out any formaldehyde remaining in the gas: one is by lowering the formalin concentration gradually; the other is by reducing the liquid temperature. Generally speaking, in hot climates conventional absorbers with no packed sections (but with trays only) normally fail to provide enough cooling to enable operation without chilled water.

Para in the recycle line – who wants it?!

Keep it steady

It is also important to be aware that the water content in the gas has an impact on the reaction. Water will be occupying active sites on the catalyst, but an increase in HTF temperature can compensate for this. This means that at a higher water content, the HTF temperature should be increased to achieve the same activity and conversion of the catalyst. To avoid having to adjust the HTF temperature very frequently, it is thus better – and easier – to operate at a constant absorber-top temperature, and therefore to prevent big differences between night and day.

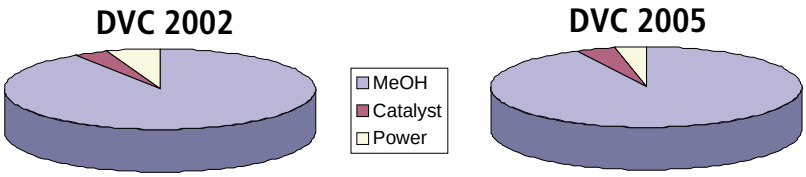
So – as long as the formaldehyde content in the recycle gas can be kept below 1000 ppm, you can operate your plants with an absorber-top temperature up to 35°C (if you operate at ambient pressure) or up to 40°C (if your plant is pressurized to 0.3 bar g) during the entire run, without worrying about the water affecting the catalyst lifetime.

But remember to adjust the HTF temperature when you change the absorber-top temperature, so that you maintain the same conversion and yield. Further, even with a higher absorber-top temperature, the effect on catalyst lifetime may only be marginal. This is why it is not economical for most of you to operate with chilled water.

Talk to your Perstorp Formox representative about what will work best at your site!

All things considered…

We live in a changing world. That simple fact is brought to mind as soon as you open your morning newspaper. Or when a new construction site obliges you to take a new route to work. Or when you examine the cost of producing formaldehyde. Methanol prices are high. Energy prices are high. Catalyst prices are high. But hold on – the value of your formaldehyde is also higher than ever!



The formula for economical formaldehyde production is and always has been very simple: get the most possible molecules of HCHO out of the fewest possible molecules of MeOH for the least possible money. This has not changed.

Getting priorities straight

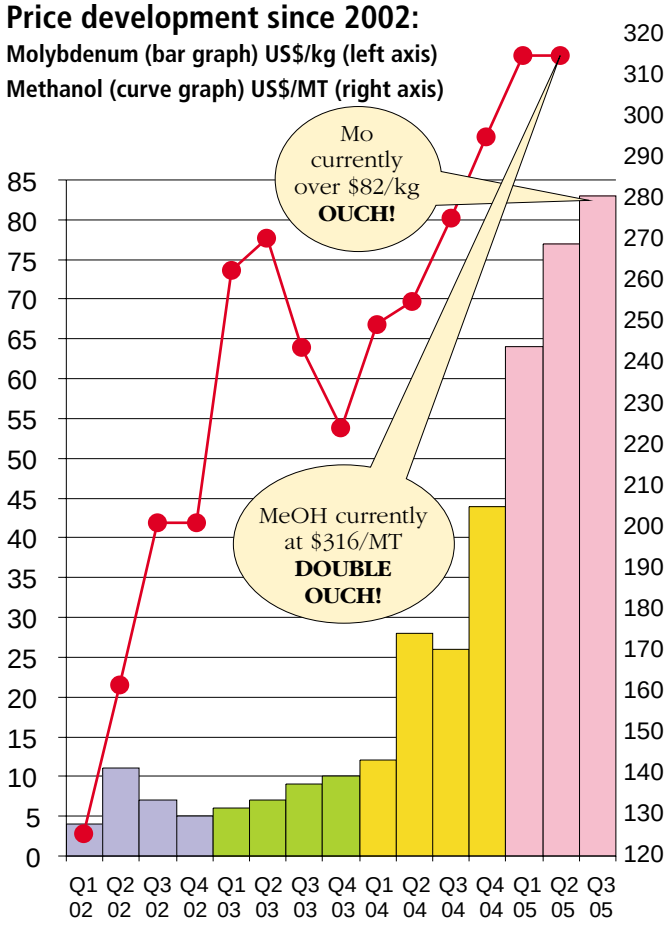
Another thing that has not changed is the fact that methanol accounts for and always has accounted for the lion's share – more than 90% – of your DVC (direct variable costs, i.e. production costs). Since few of us have any influence whatsoever on the price of methanol, our top priority should clearly be on getting the most out of it. And the higher the price of methanol, the more important that becomes.

Take an example. In the second quarter of 2002, the price of molybdenum was relatively low (see graph). So was the price of MeOH (then accounting for "only" 90% of the DVC). Today, the prices of both are way up, and the higher molybdenum prices are obliging us to raise our catalyst prices. Does this mean that the Perstorp Formox process has become more expensive than a silver process? Absolutely not!

The effects of rising MeOH prices are far greater on a silver process than on the more efficient Perstorp Formox process – even when a higher catalyst price is taken into account – simply because we give you better yield (see also page 14).

For someone running a silver process, the methanol situation has added about 5% more to the total DVC than for someone running a plant with Perstorp Formox catalyst, thus making the oxide process more competitive than ever!

Price development since 2002:
Molybdenum (bar graph) US$/kg (left axis)
Methanol (curve graph) US$/MT (right axis)



Control what you can

Unfortunately, none of us can control methanol prices. We just have to live with them. Neither can we control the price of molybdenum (Mo). Or can we? If you purchase Perstorp Formox catalyst, you can – to a large extent. If we were to fully compensate for the higher cost of Mo, we would have to raise our prices by US$ 38 per kg. But those who return their spent catalyst to Perstorp Formox are only marginally affected, thanks to efficient reprocessing to recover and re-use the Mo – and we credit you for it. In other words, this is a factor you CAN control.

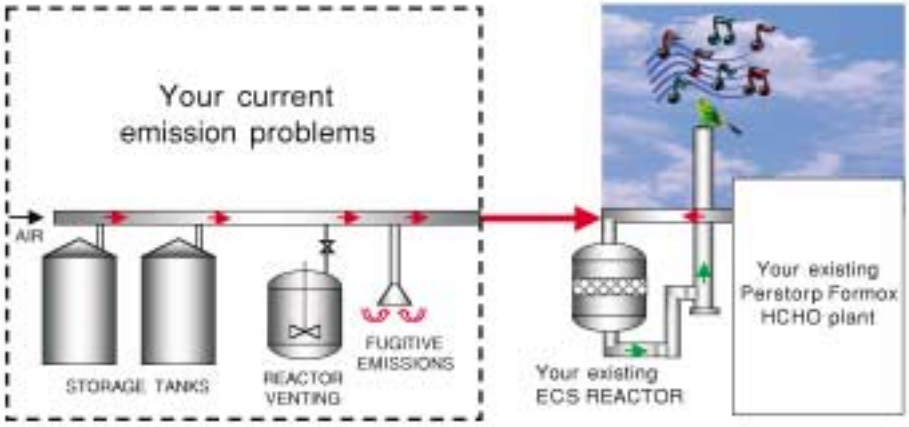
There are other factors you can control. See that your spent catalyst is kept dry and free from scrap and debris. Then, when you return it to Perstorp Formox, you'll get the maximum credit against your next catalyst purchase.

See that your loading procedures (see page 8) are carefully controlled. The same goes for your operating procedures. This is where good technical support from Perstorp Formox can save you a bundle. A good yield, resulting from good control of a good plant, will still give you the most cost-effective formaldehyde production on the planet. Yes, you can find cheaper plants. And cheaper catalyst. But you won't find any that give you the same yield. So you'll end up paying more for your HCHO, because it's ultimately mostly about the price of methanol.

Perstorp Formox doesn't just focus on making formaldehyde production more effective and efficient. It's who we are. We have managed to develop our process technology, plant design and catalysts – coordinating them all together – in ways that have drastically reduced the cost of producing formaldehyde, while at the same time making plants safer for people and the environment.

Finally, it's that old formula that determines your bottom line. When all things are considered, if you use a cheaper catalyst or process, but don't get the best possible yield, and if you don't have the technical support that can help you achieve it, you could end up losing money even if you got your catalyst for free!

Extra work for your ECS?



Do you have to deal with emissions of hydrocarbons from one or more sources (e.g. storage tanks, process equipment and fugitive emissions) on your site? If so – and if you have a Perstorp Formox formaldehyde plant incorporating an ECS (catalytic emission control system) – then it might be possible for you to take care of all of your emissions effectively and economically in the ECS you already have.

To be able to do so, it must be possible to categorize the emissions in question as:

- being of low hydrocarbon concentration
- adding in total no more than 10 - 20% to the design gas flow through the ECS
- containing no catalyst poisons.

If your emissions meet these three criteria, there your existing ECS and converted there.

The equipment required can be quite straightforward, comprising a fan to provide the necessary pressure, local pipework, a header to collect the emissions and deliver them to the ECS, and the necessary safety provisions, including an interlock for occasions when the formaldehyde plant is not in operation, and protection of tanks from potential vacuum conditions.

If you think that you could benefit from handling emissions in this way, get in touch with Perstorp Formox. For a modest fee, we'll arrange to study your particular circumstances and make appropriate recommendations.

Methanol market update

This update was kindly supplied by **Ben Iosefa**, Director of Strategic Marketing Planning, Methanex

Over the past few years, strong global methanol demand led by robust growth in Asia has combined with limited net new methanol supply capacity, resulting in balanced to tight market conditions and the draw-down of industry inventories to uncomfortably low levels.

Methanol fundamentals currently remain essentially unchanged, with supply not being able to sufficiently meet demand and replenish inventories. A number of planned and unplanned outages have maintained tight market conditions with no evidence of inventory rebuilding taking place. Our own inventories are well below a level that we regard as optimal.

In this environment, methanol prices have remained high and stable. In all global markets the Methanex non-discounted reference price has been at around $300/MT since the beginning of 2005, and several industry consultants are forecasting a continued firm market throughout 2005.

Apart from China, the first new addition to global supply in 2005 is our own 0.84 million MTPA Chile IV plant, from which we commence deliveries in Q2, 2005. However, in late 2004 we shut down two of our plants in New Zealand, effectively reducing our production capacity by approximately 0.6 million tones, thus substantially offsetting our new Chile IV production. We plan on producing approximately 0.4 million tonnes at our remaining plant in New Zealand this year, and our future focus will be entirely on our ability to produce positive cash flow.

Kitimat is the only plant in our system that buys natural gas at North American prices, and with increasing natural gas prices, this plant is currently cash-negative. The decision on whether to operate Kitimat beyond 2005 will be a function of methanol prices and natural gas prices and our decision will again be driven by our ability to generate positive cash flow.

In summary, therefore, between New Zealand and Kitimat we have up to 1.0 million tonnes of supply flexibility.

The only other increment to global supply we know of this year (outside of China) will be from a new 1.8 million MTPA plant in Trinidad. This plant has reportedly been somewhat delayed and won't begin shipping to customers until late Q3. It is important to note that the owners of this plant have announced an arrangement with Celanese that is expected to result in the shutdown of two Celanese-owned methanol plants in the USA, which would substantially offset supply from the new Trinidad plant.

China remains as a significant influence on the methanol industry. Continuing strong growth there bodes well for strong methanol demand growth and on the supply side new plants are under construction. At today's pricing levels, we expect that all methanol plants in China are cash-positive and profitable, so they have every incentive to run their plants as hard as possible.

We are certainly observing increases in domestically produced methanol in China and this may lead to some price volatility in that country this year. However, the key issue in China is that most domestic producers are small scale and high cost, and that coal-based methanol does not meet many customers' specifications. We would expect to see supply curtailments from domestic Chinese producers at prices that are lower than levels prevailing today, but still much higher than historic average prices.

In summary, we believe that new supply additions in 2005 will be substantially offset by industry restructuring and demand growth. When combined with a number of scheduled plant turnarounds, this will result in a relatively balanced market. We thus feel that this is an environment with conditions that continue to be conducive to above-average methanol pricing.

Ben Iosefa

Projects & start-ups

New projects

- **Xinjiang Markor Chemical Industry Co, Ltd** has signed up for a new formaldehyde plant to be built at the company's site in the city of Korla, in northwestern China, located on the ancient "Silk Road" from Europe to China (see photo report below). This plant is the first supplied by Perstorp Formox that is designed with the new dual-reactor system from the beginning, i.e. not an upgrade of an existing plant.

Ongoing projects

- The project for **Casco Industrie SAS** in France is advancing and the plant is scheduled to go on stream this autumn.
- The **SAFCO** project in Saudi Arabia is running on schedule.
- The second of the three UFC plants being installed in Gubakah, Russia, for **Metafrax** went into production just before Christmas, 2004. The third was started in May!
- A new plant for another client in Russia is expected to start up this summer.
- In China, **Yantai Wanhua Polyurethanes** will be ready this summer with their plant capable of producing more than 400 MTPD of 37% formaldehyde.
- The project for a similar plant for **Yuntianhua** in China is proceeding on schedule.
- A twin-stream plant for **Polyplastics** in Nantong, China was successfully taken into operation just before Christmas (2 months ahead of the original schedule).

Upgrades

- A plant that was upgraded for dual-reactor operation went on stream smoothly in the beginning of December at a client's site in Europe. The operation has achieved its productivity goals. Expect more info in the next issue!
- Three pressurization projects are underway to boost the capacities for **BAC, Petanak** and another Malaysian client. All three projects are scheduled for completion this autumn.
- The pressurization revamp at **Oxiquim** in Chile went very well and the plant was back in action in the beginning of January.

Groundbreaking in China

The huge new **Markor** project in Korla (see above) was officially launched in a big way with a groundbreaking ceremony on May 10th. The project not only includes a Perstorp Formox formaldehyde plant, but also a BDO plant, being supplied by US-based International Specialty Products (ISP). The entire project is scheduled for completion in 2007. Here we see ISP Senior Vice President **Melvin Martin** and Perstorp Formox General Manager **Mikael Ekblad** at the shovels, as well as Markor Board Chairman **Mr Richard Feng** (inset).

Know

what you're comparing

by Bob Crichton

As you may have noticed, the molybdenum price has risen over the past year, putting pressure on catalyst costs. But remember: the catalyst price is a question of cents, while methanol consumption is about dollars – lots of them.

The fact is, a hike of $1/kg in the catalyst price adds only about 5¢ to the cost of producing a metric ton of 37% formaldehyde! This is insignificant compared with the increased costs we have seen as a result of methanol price pressure (see also page 12).

More than ever, it is important to ensure that you get the maximum amount of formaldehyde out of the minimum amount of methanol. This means seeing that your reactor is loaded with the correct catalyst, that it is properly optimized and that the catalyst is changed before the yield falls too far. Perstorp Formox can help you here, e.g. with the "Time to Reload" calculation – an Excel file available on request – contact your Perstorp Formox representative.

What about yield?

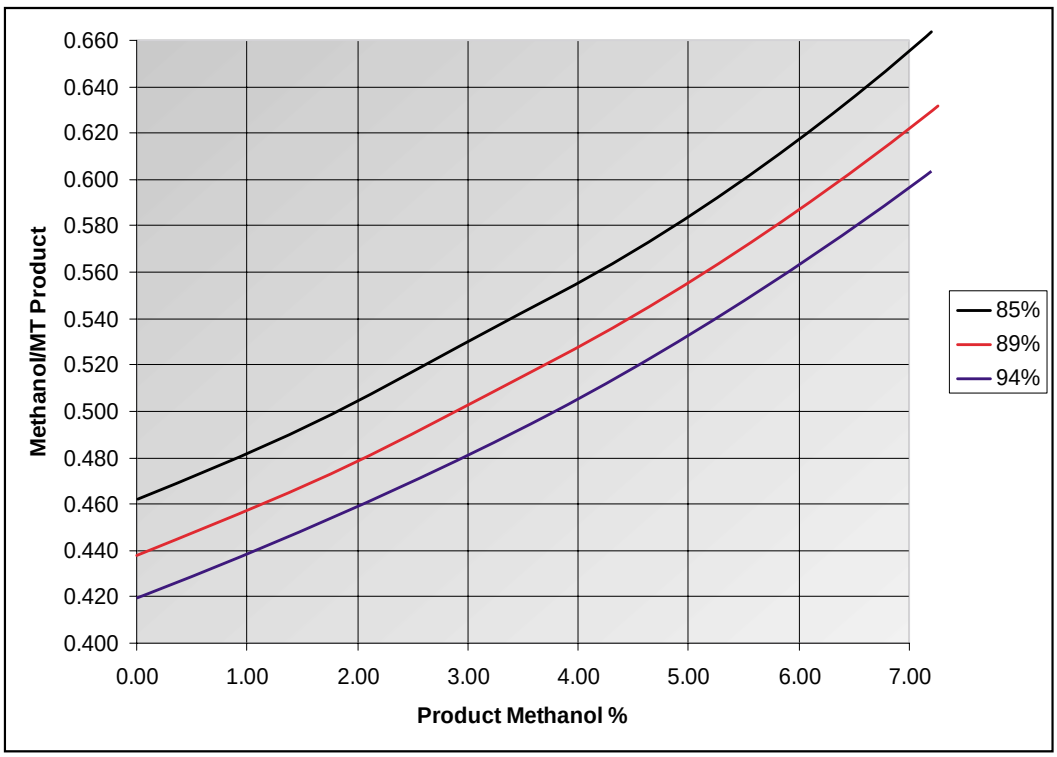
When comparing different processes and different catalysts, the key issue is yield, or rather methanol consumption. Though the terms "yield" and "methanol consumption" are often used synonymously, this is not strictly correct; you need to be clear about the basis for the calculation – in particular whether it is based on formaldehyde in the product or on the total product.

The differences can be considerable because the product we're talking about is not pure formaldehyde but an aqueous solution containing variable amounts of methanol. The consumption of methanol per unit of product depends on the methanol content of the product – and consumption rises as the methanol content rises.

Yield in the chemical sense is a measure of reaction efficiency; the amount of product actually produced expressed as a percentage of what is theoretically possible. For example, in the case of formaldehyde, the overall reaction can be expressed as:

$$CH_3OH + \tfrac{1}{2}\, O_2 \rightarrow HCHO + H_2O$$

From this we see that 1 molecule (mole) of methanol (CH_3OH) can produce 1 mole of formaldehyde (HCHO). As the molecular weight of methanol is 32 and that of formaldehyde is 30, then 1 weight unit of 100% formaldehyde requires 32/30 = 1.067 weight units of methanol. This is the stoichiometric amount, and a process achieving this consumption would be operating with a 100% yield. If, in practice, we achieve 93% of theory then only 0.93 units of formaldehyde would be obtained from the same 1.067 weight units of methanol. In this case, the methanol consumption would be 1.067/0.93 or 1.148 weight units of methanol per weight unit of 100% formaldehyde. Expressed in terms of 37% formaldehyde, this is 0.425 weight units of methanol per MT of methanol.



However, what the calculation gives you is the reactor yield – the amount of formaldehyde produced from the methanol converted. This is sometimes referred to as selectivity. To obtain the methanol required per unit of product, you have to allow for the methanol in the product, i.e. the unconverted methanol.

Count your moles

For example, let's assume the process we're investigating achieves a selectivity of 93% at a conversion of 95%. Instead of converting 1 mole of methanol, we have only converted 0.95 and hence we have produced 0.93 x 0.95 = 0.884 moles of 100%

formaldehyde from every mole of methanol fed to the system. The overall yield is thus 88.4% and we have consumed 32/(0.884 x 30) = 1.207 weight units of methanol for each weight units of methanol for each weight unit of 100% formaldehyde (0.447 weight units on a 37% formaldehyde basis). You don't always know conversion, but the box ("Calculating approximate conversion") shows you how to make an approximation.

The relationship between methanol consumption and methanol content is shown in the diagram for three selectivity levels: 85%, 89% and 94%.

There is a difference

For the Perstorp Formox process, it does not matter so much how methanol consumption is reported; conversion is high, there is very little methanol in the product (typically <0.5% on a 37% basis) and the expected methanol consumption is 424 kg/MT (37% basis). However, for other types of processes, particularly the silver process (where conversion and hence methanol levels can vary widely), it can and does make a very big difference.

One would expect a modern silver process to achieve a selectivity of 89%. At 0.5% methanol (37% basis) this corresponds to a methanol consumption of 450 kg/MT (37% basis). However, if the methanol content rises to 1%, consumption rises to 460 kg/MT (37% basis). The cost difference (in $US/MT 37%) between these two consumption levels and Perstorp Formox is considerable. For a process achieving 450 kg/MT 37% at a methanol cost of $250/MT, Perstorp Formox shows an advantage of $6.5/MT 37%. On a scale of 100,000 MTPA 37% this is $650,000 per year – and the figure rises to $900,000 when there is poor conversion and the methanol consumption rises to 460 kg/MT.

So, as we said at the start, yield is more important than ever; it pays to have the highest-yielding process and the highest-yielding catalyst and loading plan. Needless to say, your Perstorp Formox representative will help you make the right choice!

Calculating approximate conversion

Unfortunately, you don't always know the conversion basis, but you'll normally know the methanol content of the product and this can be used to approximate conversion, as it represents around 60% of the unconverted methanol. Thus:

Methanol loss (mole %)

$$= \frac{m \cdot 100 \cdot 30}{c \cdot 0.6 \cdot 32}$$

where
m = methanol in formaldehyde solution, % by weight
c = concentration of the formaldehyde, % by weight

For example, assuming
m = 0.4%
c = 37%

then the loss due to unreacted methanol would be

$$= \frac{0.4 \cdot 100 \cdot 30}{37 \cdot 0.6 \cdot 32} = 1{,}7 \text{ mole \%}$$

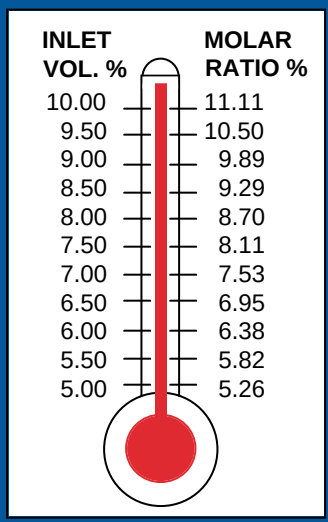
Hence the conversion is 100-1.7 = 98.3%.

Blame it on oil

Methanol is produced from gas, and gas prices are determined by the energy market. If the gas is far from the market (so-called "stranded gas"), the price is lower, as the alternative (liquefaction and transport by refrigerated tankers) is expensive. However, as oil prices (and hence the cost of energy) increase, the liquefaction option starts to look more attractive; the value of stranded gas rises and the cost of methanol increases.

Converting
MeOH vol% to molar ratio %

A number of our customers have expressed a desire to see an easy reference tool for translating methanol inlet volume % into molar ratio % and vice versa. Here it is!



Faces & Places

A couple of new faces, a returnee and another notch of responsibility for a few of our people. Here's what – and who – is new:

- **Jonny Hult** has joined our team as a process and technical support engineer. Jonny has a Masters in mechanical engineering, specializing in energy conversion, and comes to us after a number of years at ABB in Switzerland.
- **Anders Malmborg** joins us fresh out of Lund Institute of Technology with a degree in Chemical Technology and an MBA, and will be working as a process engineer.
- **Lucia Bengtsson** has rejoined us as the new center of gravity – i.e. secretary and assistant – replacing Maria Persson, who is now working elsewhere in the Perstorp organization.
- **Atul Shah** has expanded his duties to include sales and technical service for India (see page 5).
- We have a new team of **key account managers**, who will be coordinating plant technology, catalyst sales and technical service, serving as the interface between our customers and our technical department. These are (left to right in the picture below):
  - _ **Ronnie Ljungbäck**
  - _ **Lars Andersson**
  - _ **Fredrik Rietz**
  - _ **Paul Walter**


Jonny


Anders


Lucia


Atul

TRAINEES FROM NINGBO **A small group of trainees from the Advanced Training Course for the Ningbo project for Yantai Wanhua Polyurethane Co. Ltd. in China spent some intensive days in Sweden in late January. They also visited our plant in Holland.**

Do you know…?

…what materials are suitable for formaldehyde storage tanks? [Storage of formaldehyde]

…at what temperature formaldehyde should be stored? [Storage temperatures for formaldehyde]

…how plant yield is normally calculated? [Calculation of plant yield]

…why spent catalyst may look blackish? [Formaldehyde catalyst photo gallery]

…when, how and why you should clean your reactor tubes? [Brushing of reactor tubes]

You'll find the answers to these and many other questions you may have among the technical documents [titles shown above] in the Perstorp Formox Customer Center at

www.formaldehyde.com

You have signed up by now, haven't you?1!

Next seminars

The next seminar cycle is about to begin – and then some! Here's the current schedule:

- **Formaldehyde Americas 2005**
  The next seminar in the Western Hemisphere will be held in Vancouver, B.C., Canada, on **October 4-5**. Note! The dates given in the last issue of ***informally speaking*** were incorrect! **The deadline for registration is September 1st!**
- **A special seminar** will be held in **Istanbul** on **November 14.**
  This seminar will deal with how the new advances in Perstorp Formox technology can also be applied in plants using molten salt as the cooling medium.
- **Formaldehyde Europe 2006**
  To be held in Helsingborg and Perstorp (Sweden) in **May 2006.**
- **Formaldehyde Asia 2007**
  February-March is the likely timeframe, but the exact time and venue have not yet been decided. Stay tuned!

For further details about these seminars, you're always welcome to check our website (www.formaldehyde.com)!

informally speaking

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