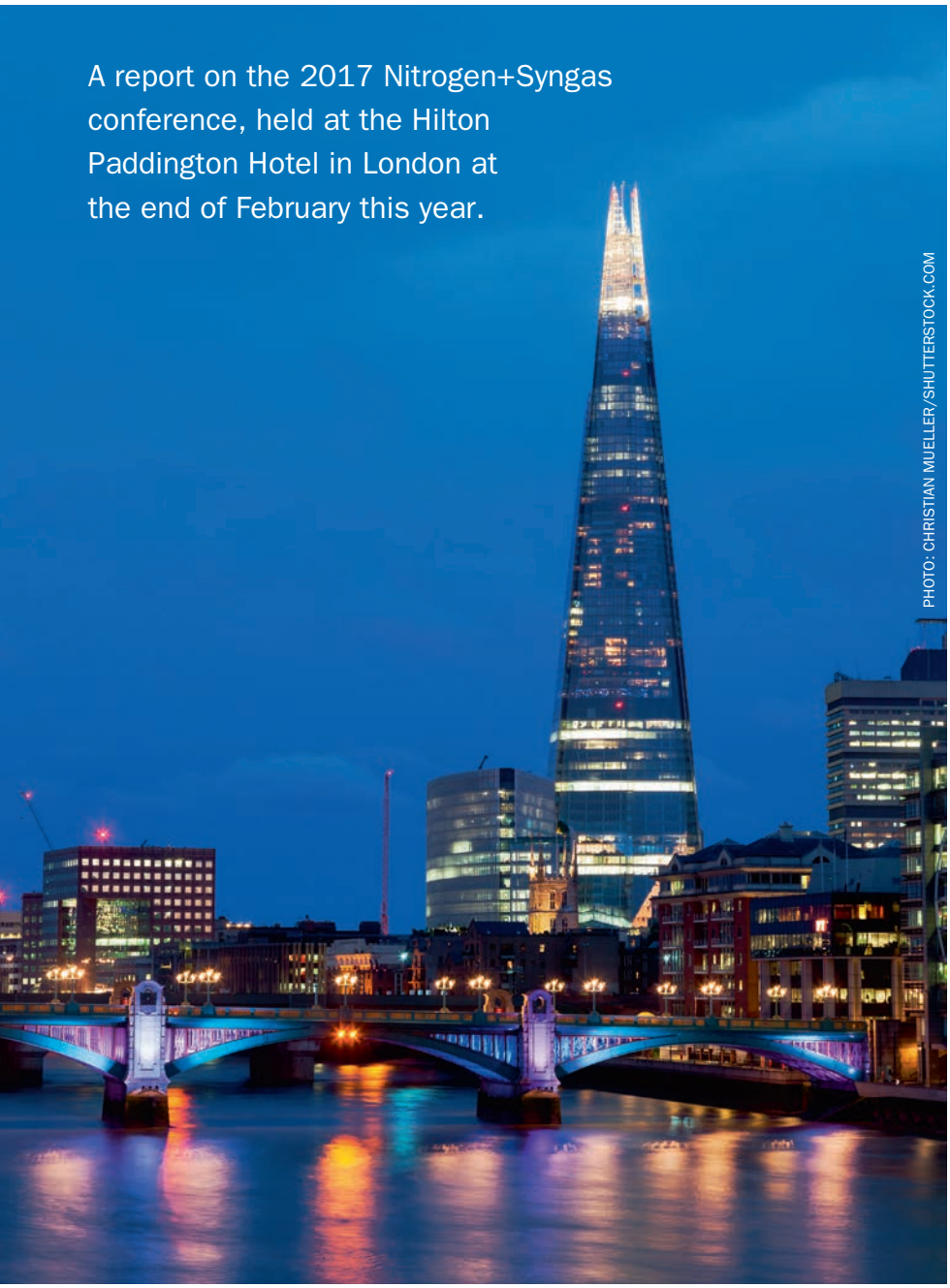
Nitrogen+Syngas 2017

A report on the 2017 Nitrogen+Syngas conference, held at the Hilton Paddington Hotel in London at the end of February this year.



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The Shard at night, Southwark Bridge in the foreground.

For the first time in many years, CRU's Nitrogen+Syngas conference returned to the company's home base of London. Opening the conference, Mike Gallagher, CRU's general manager of the Fertilizers division noted that a lot of water has passed under the bridge since the first British Sulphur Nitrogen conference – Nitrogen '86 in Amsterdam. Nevertheless, the record attendance of over 700 delegates testified to the conference's continuing popularity and relevance. The meeting happened at a time when coal prices had risen in China and the idling of Chinese urea capacity had led to a rebound in urea prices, lifting the market for a while, but fundamentals still looked poor for the year ahead.

Market papers

As always the conference began with a round-up of the major markets of interest to the nitrogen and syngas industries, first and foremost of which is natural gas. Jane Rangel of Energy Aspects presented the gas market outlook, telling delegates that there has been a convergence in global gas markets as prices have fallen, and although there are still some peaks and price spikes in Asia, the wave of new LNG capacity is finally hitting the market; around 50% of Australia's new capacity is now on-line, with a total of 60 million t/a being added from 2014-22, while much new US capacity is still to come, another 50 million t/a to 2022. The LNG market is seeing an additional 50% of new capacity from 2014-2020, and while there is much regasification capacity ramping up, with new demand potential in China, the Middle East and north Africa, Europe and Pakistan, it will not match the new supply availability. Australian LNG is mainly contracted to Asia, squeezing out Qatari spot cargoes to European markets instead, and possibly squeezing US cargoes out of Asia and even Europe. This will lead to the continuing convergence between Henry Hub and UK national balance point (NBP) prices – outside the US, NPB is increasingly becoming the price setter, and may end up being no more than Henry Hub +$1.00/MMBtu. Northeast Asian prices likewise may not rise higher than Henry Hub +$2.50/MMBtu. The overall market will only balance if Europe takes a lot more gas – possibly another 25 million t/a – but there is a lot of unused LNG import capacity, and as Europe continues to switch to gas-based power, away from coal, another 30-50 bcm per year of demand is likely and up to 70 bcm possible, especially with the carbon pricing increment on coal. However, LNG will probably not squeeze out Russian pipeline imports, she said, especially now the devalued rouble has made Russian gas more competitive. If spare gas goes unexported in the US, there could also be room for additional power switching from coal to gas there.

Anders Isberg of CRU considered nitrogen costs in a supply-driven market.

Overcapacity is now the nitrogen market's defining feature, he said; weak energy prices and currencies have created a deflationary price environment, and demand has struggled to keep up after a year of poor conditions in key markets – India has seen record grains production and weak demand, pushing stocks to record levels, while China is reforming its agricultural sector and has recently slashed its corn support price from $300/t to $160/t, and also aims to cap nitrogen fertilizer consumption from 2020. Meanwhile there is still more new urea capacity coming onstream from 2017-19, in China, Africa, Iran, the USA and CIS. The cost curve has flattened due to falling gas prices as well as weak non-dollar currencies. Russian producers have particularly benefited from the depreciated rouble, although it may rebound a little this year. Chinese anthracite coal prices also halved from 2011-16, although there is some movement back up now, which has also kept a lot of Chinese capacity more competitive, at least until 2016, when falling nitrogen prices made most Chinese capacity loss-making once again. Going forward, Chinese coal policy is likely to set an upper price bound based on the profitability of power producers, and a lower one based on the profitability of coal producers, leading to falling prices for thermal coal, but relatively higher prices for anthracite. On the supply side, China is expected to close about 12 million t/a of the most polluting urea capacity over the next few years and may institute seasonal production cuts in energy intensive industries around major cities to reduce smog, affecting another 36 million t/a of capacity around 45% of China's urea). This is likely to mean less urea available for export, dropping from 13 million t/a in 2015 to 7.4 million t/a this year and as low as 3-4 million t/a in 2021. This should help push global urea prices back up to $300/t by the end of the decade.

Europe's fertilizer industry has faced particular challenges from high feedstock prices and burdensome regulations, said Jacob Hansen of Fertilizers Europe, but it nevertheless remains a €13.2 billion industry employing 95,000 people directly and indirectly. Imports of urea into Europe are still growing, rising from 3 million t/a to 5.5 million t/a over the past decade, and while most nitrogen in Europe is consumed as ammonium nitrate this still has a knock-on effect on pricing. However, in the past couple of years European gas prices have fallen dramatically compared to its competitors, and made the European fertilizer industry much more competitive – previous runs of high gas prices had already made the European industry the most energy efficient, and plants are also older and generally depreciated in capital terms as well. The main challenges remain regulatory, with EU attempts to reduce CO_2 emissions by 40% having a disproportionate effect on the nitrogen industry. However, new markets in technical urea, premium prices for nitrates which better suit European growing conditions, and value added advantages in product specialisation can still help European producers compete, said Jacob. He remarked on the 18th century scientists who could not work out how the bumblebee was able to fly, and said that Europe's fertilizer industry, like the bumblebee, nevertheless continues to fly.

Ruud Schiers of Rabobank enlarged on the topic of speciality fertilizers and nitrogen use efficiency. The characteristics of the dominant farming model is an important predictor of fertilizer demand, he said – Asia and Europe have a scarce land model, whereas the US, Brazil and Russia have an abundant demand model.

Turning to the Chinese situation, Gavin Ju of CRU's Beijing office noted China's continuing market transition for many sectors – from 2015 rail freight has been the same for all commodities, and rail freight rates have quintupled in a decade; from 2016 power tariffs have been the same to all industries, with charges rising an average of 43% last year; and natural gas has become an open market. There are no VAT exemptions any more, and fertilizer export taxes were removed at the end of 2016. China's nitrogen industry has now become much more market-oriented,with gas prices now decided by negotiation and not the government, and coal prices also rising. The industry response to these increasing costs has been to move to new gasification technologies with larger capacities and more productivity, and which are more energy and labour efficient (up to 50-70% lower specific energy consumption). A switch to bituminous coal, direct agreements with power suppliers and rail freight companies, and a switch to bulk packaging (1 tonne 'big bags' rather than 50 kg sacks) have all helped to shave costs, but only large scale producers can achieve some of these measures. Inefficient capacity is now closing, around 12.6 million t/a from 2013-16 and probably another 14 million t/a from 2017-21. He still foresaw no serious import of urea into China, however, as tariff quotas and import taxes still mitigate against this.

Euronext are now offering a UAN futures contract, as described by Ulrich von Furstenburg. Europe is the second largest market for UAN after the US, consuming 4 million t/a, of which 2.2 million t/a is represented by France. Euronext's UAN-30 is a physically deliverable futures contract for 30-tonne lots, responding to the specific request of French farming cooperatives, allowing them to manage price risk by hedge tools, but he hoped it would find wider application in Europe.

Reforming

The heart of any syngas process is the reformer, and a sizeable section of the conference covered reforming technologies and issues. Mark Loring of KBR compared increasing the size of reformer tubes against increasing the number of reformer tubes as a way of increasing reformer throughput. Both can work, depending on the specific project situation – adding a tube row allows most of the structural work to be done pre-turnaround, allowing for a lower downtime penalty when done at the same time as the convection section modifications and is worth considering in any revamp study.

Peter Sandberg of Haldor Topsoe suggested the Haldor Topsoe heat exchange reformer (HTER) as a way of increasing capacity to an existing syngas front-end without major modifications to existing equipment. Capacity increases of up to 25% are possible and can be accommodated in most plot plans, and in a grassroots plant it can allow the use of petcoke or coal as a feedstock. The main challenge is integration into the steam balance to ensure steam requirements are met when ammonia steam generation is reduced.

KBR have their own heat exchange steam reformer, the KBR Reforming Exchange System (KRES), and Mahesh Gandhi of KBR described scenarios where the KRES reformer can help achieve capacity increase, reduced energy consumption, and reduce steam export.

Was gas-heated reforming (GHR) ahead of its time? Anthony Fenwick of Johnson Matthey showed that the GHR plus autothermal reformer (ATR) flowsheet involved the greatest potential for saving process energy by importing electricity, and when

combined with renewable electrical generation could generate the lowest carbon impact of any methanol flowsheet.

BD Energy Systems have developed a new design method for reformer flue gas tunnels called Tunnel Optimal Performance (TOP), which avoids non-uniform gas flow, including vortex formation, and hence non-uniform catalyst heating, and showed computational fluid dynamics (CFD) modelling results which showed the performance improvements which can be achieved.

Haldor Topsoe also presented some of their recent developments for use of oxygen in secondary and autothermal reformers, which can extend plant reliability and availability even in today's more severe operating conditions, including a new generation of burners, shaped dense ceramic tiles, optimised catalyst loading techniques, improved refractory lining, and a new design of catalyst bed support.

Daniel Drabble of Quest Integrity explained how an inspection regime can provide a better understanding of and prediction of reformer tube lifetime and time to failure, allowing operators to avoid costly unplanned outages.

John Brightling of Johnson Matthey and Muhammad Majid Latif of Engro Pakistan presented a discussion of two serious incidents in a secondary reformer at Engro's old ammonia plant at Daharki; the first of which was an air compressor surge that caused a flameout and damage to the catalyst support from explosions. A second incident was a low air flow and consequent temperature increase caused by a booster compressor tripping due to a spurious alarm. In both instances the catalyst was examined and found to be in good condition.

Revamps

There is always pressure to achieve more from existing infrastructure, and so there was also a sizeable section covering revamping. VK Arora of Kinetics Process Improvements presented three case studies of revamping Benfield CO_2 removal systems in ammonia plants which mitigate CO_2 slip and allow for increased ammonia production.

Fatima Fertilizer Co Ltd detailed an ammonia plant revamp at their 1967-vintage plant in Pakistan which increased production from 1,500 to 1,700 t/d and decreased energy consumption from 8.3 to 8.04Gcal/t ammonia, as well as improving reliability and plant availability.

Casale were involved in revamping two 40-year old Kellogg ammonia plants for Azomures at Tigru Mures in Romania, as described by Marco Lonetti. Capacity was increased from 900 t/d to 1,050 t/d while reducing specific energy consumption by 10%, and bringing emissions and environmental parameters within current EU limits. There was also a significant increase in reliability and operability gained by adding a new state of the art distribute control system and emergency shutdown system, replacing the previous pneumatic control system.

Other strategies for increasing capacity were examined by Joerg Weidenfeller of ARVOS GmbH, by a new design of steam superheater which allows operation at higher temperatures and pressures – up to 540°C and 130 bar, reducing the duty on the process gas cooler and so providing the potential for improving overall process efficiency by either reducing gas consumption in fired heaters or increasing electricity production.

The KazAzot ammonia plant in Aktau, Kazakhstan, had an issue with high ammonia content in the flash and purge gases, up to 20-40% by volume, which went to flare. In order to recover this useful product, JSC GIAP instituted an ammonia recovery section, using nitric acid to neutralise the ammonia and generate ammonium nitrate solution, which was fed to the AN granulator on-site.

Operating experience

KBR shared their experiences of starting-up several world-scale Purifier-based ammonia plants over the past two years, including the 2,300 t/d Dyno Nobel plant at Waggaman, Louisiana, the Kaltim V 2,700 t/d ammonia plant in Bontang, Indonesia, the 1,000 t/d BCIC plant in Bangladesh and the 2,300 t/d Indorama Eleme plant in Nigeria, including pre-commissioning steps, problems encountered during start-up and ways around them.

Haldor Topsoe and Mitsubishi Heavy Industries likewise reported on the start-up and handover of a new integrated methanol and ammonia plant for JSC Ammoni at Mendeleevsk in Tatarstan, Russia, as well as the downstream urea formaldehyde unit. The plant can produce 2,050 t/d of ammonia in single mode, or 1,380 t/d ammonia, 67 t/d of methanol and 17 t/d of UFC-85 solution in co-production mode. Then in the next paper, and an interesting companion piece to the preceding one, Russian nitrogen technology firm JSC NIIK looked at the same project from an outside battery limits (OSBL) point of view, including provision of demineralised water, ammonia storage etc.

Engro Pakistan started up their new 2,200 t/d ammonia plant in 2010, and presented lessons learned during the first five years of the plant's operation, including recovery from a water ingress incident in the high temperature shift catalyst, steam drum issues due to an exchanger leak, low flow in the synloop exchanger, and primary reformer burner choke issues. The company also gave a separate paper describing improvements to the associated urea plant which have overcome start-up issues at the plant.

Waqas Shehryar of Fatima Fertilizers in Pakistan listed all catastrophic incidents at urea plants over the last 50 years, and the lessons that his own company had taken from these and implemented at their own site.

Efficiency improvements

Abu Qir Fertilizers in Egypt shared the results of modelling work they have been conducting to represent the behaviour of their radial flow ammonia synthesis reactor, which has been verified against plant data. The model can predict the first bed outlet temperature, something not normally capable of being measured, and allows calculation of catalyst activity coefficient. It can also assist adjustment of synloop operating conditions to identify bottlenecks and improve performance.

Casale and Clariant presented a joint paper highlighting several case studies of ammonia converter upgrades which illustrate how teamwork between catalyst supplier and technology licensor can have a synergistic effect in performance improvements across the board within an ammonia plant.

Mitsubishi Heavy Industries compressor division looked at the requirement for modernising and upgrading of syngas turbines to cope with the higher duties required of them as a result of revamping operations, and the advantages that can be obtained by getting the original equipment manufacturer (OEM) to participate in the project, highlighting improvements to turbines which can now be offered by Mitsubishi.

Jovica Zorjanovic of Clariant showed how the combination of Clariant's Shiftguard 200 and ShiftMax 217 can effec-

tively absorb and retain chlorides and sulphides, allowing the superior performance of the ShiftMax 217 to provide ammonia and hydrogen plants with energy savings and higher production rates.

Klaus Noelker of thyssenkrupp Industrial Solutions presented an analysis of energy consumption for ammonia and urea production, and areas where there is still room for optimisation of energy use. While in general there is only minor scope for such optimisation, where steam export is possible there are fewer restrictions for the designer and improvement can come from the steam system efficiency.

Taking lessons from the airline industry, Arunkumar Murugan of consultancy Fitiri looked at whether the human factor in plant operations management can be similarly 'optimised' to the plant's engineering, via what he called a 'context aware plant operations management system' (CAPOMS), equipping plant operators with the context-sensitive information needed to make good, timely decisions.

Anshuman Pandey of OPRA Turbines took a different approach, using hydrogen-rich by-product tail/purge gases to cogenerate electricity and heat. Such a system can have a payback time of only 2 years, he said, and high ongoing operational savings.

Urea technologies

Leon Postma of Stamicarbon presented an improvement to Stamicarbon's existing *LAUNCH MELT* urea process, which can achieve up to 5,000 t/d capacity in a single train. The *LAUNCH MELT* Flash is based on reducing the steam consumption of the high pressure stripper by reducing the stripping efficiency of the HP stripper. An in-line flash step between the stripper and the LP recirculation system with heat integration can even substitute for the HP scrubber, lowering investment and operating costs.

Saipem's offering also involved optimisation of the steam system but also the power generation system of a fertilizer complex, tailored to specific sites, and via close cooperation with technology and major equipment suppliers.

Martina Schmitz of thyssenkrupp IS described a new granulation exhaust scrubbing system – this paper is given in more detail on pages 45-49.

Nitric acid

A short session on nitric acid plants and technology began with a report by thyssenkrupp IS on the new 1,500 t/d nitric acid plant they designed and built for Nitrogenmuvek in Hungary, using the company's tried and tested dual pressure process, and highlighting the environmental compliance features.

Willi Boll of Heraeus showed that the campaign length of a primary catalyst in a nitric acid plant can be significantly extended by optimisation of Heraeus' precious metal secondary catalyst for N_2O abatement, preventing the plant breaching emission limits for longer – from around a currently typical 40 days between primary catalyst changeouts to more than 80 days, and increasing secondary catalyst lifetime from 3 to 4 primary catalyst campaigns.

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Walter Bachleitner of Messer Group showcased his company's Oxyboost technology, which improves the absorption efficiency of nitric acid plants by using pure oxygen to oxidise nitrous acid (HNO_2) and nitrous gases in the liquid phase. As well as reducing NOx emissions, it can produce up to a 10% capacity increase at low investment cost. A case study of the system in action at Azomures in Romania was also presented.

Product finishing

The final session looked at product granulation and finishing. Keiji Sano of Toyo Engineering Co presented TEC's recent experiences of start-ups of large-scale granulation plants; a 3,500 t/d plant at PT Pupuk Kalimantan Timur (Kaltim) in Indonesia, and a 4,000 t/d plant for Indorama Eleme Fertilizer & Chemicals Ltd in Nigeria. Toyo has now completed a technical evaluation of a 6,000 t/d single train urea plant, and believes that the same approach as these two plants can be successfully scaled up to this throughput.

Uhde Fertilizer Technology has been looking at ways of removing the need for formaldehyde addition in urea granulation, which as well as having possible health effects, can also prevent the urea's use in various technical applications, including diesel exhaust fluid (DEF). UFT has now developed a new proprietary additive which works in the same way as urea formaldehyde, but without any of the drawbacks.

Ken Monstrey of Green Granulation Technology highlighted the use of a 'deep vacuum' in a variant on cold recycle urea granulation. The vacuum leads to more efficient water evaporation, removing or reducing the need for cooling and fluidisation air, and allowing a single exhaust fan for a lower overall pressure drop, as well as leading to more efficient dust removal. The system has been trialled at two fertilizer plants in China, including one producing 2,700 t/d.

Stamicarbon showed the results of an investigation into service life of a liquid divider in the high pressure stripper of the Pardis Petrochemical Company urea plant in Iran. Made from Safurex stainless steel, the observed rate of corrosion after 5.5 years – even in this most demanding of applications – means that the liquid divider should have a 10 year service life before requiring replacement.

And Sandvik – the manufacturers of Safurex – followed this presentation with a report on their newest grade of duplex stainless steel, Safurex Star, which combines all of the expected properties of Safurex with even better corrosion resistance (an improvement of around 10-20%), allowing it to be used in the most demanding applications such as HP stripper heat exchanger tubes, allowing increased lifetimes overall for HP strippers.

Careful handling of fertilizer granules is required to avoid breakage during production and conveying. Nikolai Velten of AUMUND Fordertechnik detailed some work conducted in conjunction with the Otto von Guericke University of Magdeburg and Institute fur Baumaschinen on the stresses experienced by fertilizer prills during transport in a bucket elevator. While it is not possible to completely avoid prill breakage during transfer operations, the results show that it can be greatly reduced by the choice of type of conveyor.

With sulphur as a fertilizer nutrient becoming increasingly important, Nenad Zecevic of Petrokemija in Croatia reported on experiments conducted by his firm on synthesising ammonium nitrate sulphate as a double salt using sulphuric acid and ammonia to add to the ammonium nitrate reaction mix and successfully granulate it into a 26%N 15%S compound fertilizer. A similar thought was behind the development by thyssenkrupp IS of a new fluidised granulation process for ammonium sulphate, which is detailed in the Industry News section of this issue, page 10.