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An industry homecoming

> "When it comes to the history of the fertilizer industry, many paths eventually wind their way back to Europe."

Berlin will play host to IFA's 86th Annual Conference in June. This will be an industry homecoming in many ways. After all, when it comes to the history of the fertilizer industry, many paths eventually wind their way back to Europe.

Ammonia was first manufactured on an industrial scale by the Haber-Bosch process at BASF's Oppau plant in Germany in 1913. This was a founding moment for the modern global fertilizer industry, one that has subsequently enabled the large-scale production of nitrogen fertilizers worldwide.

Germany is also the cradle of the global potash industry. Pioneering potash mining using simple cold leaching began in 1861 in the town of Stassfurt in the North Harz district of central Germany.

More sophisticated potash production by hot leaching began later in 1898 at Sondershausen in neighbouring South Harz. Between 1970 and 1992, some 560 million tonnes of ore were mined from this district – producing more than 130 million tonnes of potash fertilizers with a value of around $7.5 billion.

The potash deposit underlying Germany's Werra district is arguably the most valuable in the world. Having been continuously exploited since 1900, the district is thought to be responsible for around 10 percent of all potash extracted globally. The deposit is actively mined today and is still the mainstay of German potash production.

Germany's potash industry remains a centre of engineering and mining excellence. The country can boast world-class potash mining and processing equipment manufacturers such as Köppern, Ebner, and GHH Fahrzeuge, all featured in our potash technology article this issue (page 64).

While Germany's position as Europe's engineering and manufacturing powerhouse is built on long traditions, it is maintained by a constant commitment to innovation and excellence. Independent mineral company K+S exemplifies both the continuity and tenacity of German industry – and its adaptability and commercial acumen.

K+S can trace its origins to the founding of Aktiengesellschaft für Bergbau und Tiefbohrung in Goslar in 1889. Renamed Salzdetfurth AG a decade later, the company eventually became Kali und Salz when three potash producers merged in the early 1970s. The Kassel-headquartered company finally became K+S in 1999.

K+S recently achieved its highly ambitious goal of becoming a potash producer on two continents with the official opening of its Bethune mine in Saskatchewan 12 months ago. This state-of-the-art, two million tonne capacity solution mine extends the company's global presence, while also reducing its average production costs.

In another sign of its forward-thinking approach to business, K+S recently launched *Shaping 2030*, its new long-term growth strategy. In advance of IFA's Annual Conference in Berlin, the CEO of K+S, Dr Burkhard Lohr, briefed *Fertilizer International* about the company's ambitious future growth plans (page 63).

While Berlin's hosting of this year's IFA conference provides a chance to reflect on the fertilizer industry's European heritage, it also offers an opportunity to think about its future direction. One thing is clear: Europe's longevity as a major fertilizer-producing region has been achieved by looking forwards, not backwards. The ability to adapt to and exploit changing circumstances is the secret behind its continuing success. ■

S. Inglethorpe

Simon Inglethorpe, Editor

IFA CONVENES IN BERLIN

The 86th International Fertilizer Association (IFA) Annual Conference is being held in Berlin, Germany, 18-20 June. As in previous years, BCInsight will be attending and exhibiting at what is the industry's leading showcase event. If you're attending, please do visit our stand and say hello. We are very much look forwarding to being in Berlin this summer, and having the opportunity to meet with friends and colleagues, both old and new.

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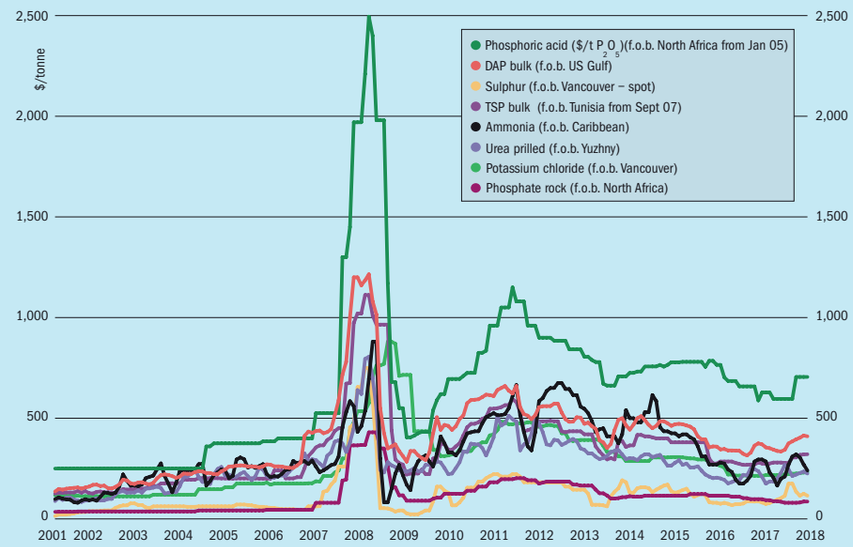
Market outlook

Historical price trends $/tonne



Source: BCInsight

Market insight courtesy of Integer Research

AMMONIA

The prolonged European and US winter has had a cooling effect on market sentiment. Prices, which began falling in January, have kept on a downwards trajectory over the last two months due to lower direct application demand in the US Midwest. However, East of Suez, Chinese merchant demand from industrial consumers remains strong. The environmental restrictions that closed much of China's gas-based ammonia supply have also dramatically tightened the domestic market.

UREA

Poor growing conditions have been the nitrogen market's defining theme so far in 2018, with little sign of improvement over the last two months. Long winters in Europe and the US Midwest saw freezing conditions and heavy rainfall extend into the Spring application season. This delayed fieldwork and squeezed import demand in March and April. This has more than offset improved sentiment generated by two earlier-than-expected Indian tenders – IPL and MMTC booked a total of 1.6 million tonnes of urea in March and April – and the ongoing collapse of China's export position. The Atlantic and Mediterranean basins also remain oversupplied. This has forced the Egyptians and Russians to ship through Suez and compete with Iran for low-netback Indian tender business.

PHOSPHATE

Market activity gradually increased during March after a subdued start to the year. Major finished phosphates benchmarks continued to rise in March as improved demand tightened the market. Prices averaged $400-420/t f.o.b. in March, compared with $380-405/t f.o.b. in January. Indian buying was limited due to awaited announcements on first quarter phosphoric acid contracts, maximum fertilizer retail prices and fertilizer subsidies. Finalisation of these matters prompted a slow improvement in Indian buying sentiment through March and April. China's exporters mostly stayed out of the international DAP market in March as Indian buyers were not prepared to meet China's $420/t f.o.b. offers. High domestic ammonia prices have given Chinese DAP exporters little room for manoeuvre on price. However, more Chinese product should be available for export in coming months as the country's domestic season winds down.

POTASH

Tight market supply and steady demand continued into the second quarter, maintaining upward pressure on prices. Canpotex, BPC, Uralkali, APC and SQM are all said to be committed on sales for the next few months. MOP demand has continued to be robust in Brazil, Southeast Asia and – less consistently – in Europe. European enquiries for cargoes picked-up in April, while demand dried-up elsewhere. Last year's MOP price rally has continued into 2018. Brazil spot prices reached $305/t cfr in mid-April while standard MOP in Southeast Asia climbed to $280/t cfr. MOP prices in Vancouver and Baltic stayed close to the $220-230/t f.o.b. range in the

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first quarter, despite the rises seen in other markets.

Price increases for the 2018 China and India supply contract agreements seem inevitable, based on prevailing market conditions. MOP producers are heard to be targeting a $30-50/t increase in China cfr prices. Buyers have yet to begin negotiations, though, as Chinese port stock levels remained high at 2.5 million tonnes in April.

SULPHUR

The global sulphur market came under pressure at the end of the first quarter, as loosening supply combined with falling demand from market players. This is likely to herald a softer second quarter with little to suggest improving sentiment. Middle East price expectations were initially optimistic in March, due to anticipated Chinese import demand. However, prices later fell to $110-120/t f.o.b. in April when this failed to materialise. Chinese buyers have remained largely out of the traded market, instead looking to port inventories and domestic production to balance demand.

The start-up of the Kashagan project in Kazakhstan has been the main supply-side change so far this year. The project finally began exporting but is not due to reach full export capacity until 2019. ■

Market price summary $/tonne – End-April 2018

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phosphoric Acid
f.o.b. Caribbean	220	n.m.	f.o.b. E. Europe 110-120	f.o.b. US Gulf	409-411	n.m.	n.m.
f.o.b. Yuzhny	210-220	220-225	-	f.o.b. N. Africa	404-430	315-320	655-860
f.o.b. Middle East	260-270	212-238**	-	cfr India	425-429	-	730*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	210-254	-	cfr US Gulf	90-100	f.o.b. Vancouver	110-120	
f.o.b. Middle East	207-244	-			f.o.b. Arab Gulf	110-120	
f.o.b. Western Europe	-	€420-450			cfr North Africa	110-132	
f.o.b. FSU	194-244				cfr India	130-140+	

Prices are on a bulk, spot basis, unless otherwise stated. (= contract ** = granular). Phosphoric acid is in terms of $/t P_2O_5 for merchant-grade (54% P_2O_5) product. Sulphur prices are for dry material. (+ Quotes for product ex-Arab Gulf)*

MARKET DRIVERS

- **Ammonia:** The market looks long and sentiment remains bearish. Consequently, buyers are likely to begin targeting sub-$200/t Black Sea cargoes in the next few months. Yara/BASF's new Freeport ammonia plant was completed in April and will add around 60,000 tonnes monthly to the market from May. Chinese ammonia prices are easing now that the winter supply crunch has ended. Chinese domestic operating rates rose from 45-50 percent in January to around 65 percent in April, after seasonal environmental restrictions were relaxed.
- **Urea:** The US supply situation is improving with Koch Enid and Nutrien Borger now operating stably. The commissioning of Dakota Gasification's new North Dakota plant in late March will add over 25,000 tonnes of new urea supply to the Northern Plains market each month. We expect this new supply, when combined with the delayed start to the US season, to weigh on prices. PIC in Kuwait, which had been expected to close in March, remains operational for the moment. The closure by Petrobras of its Fafen BA & SE plants now looks likely to be held back until the third quarter. GPIC is down for scheduled maintenance and Qafco V is scheduled for maintenance in May. These Middle East turnarounds are unlikely to provide support, however, with Black Sea prices expected to fall to around $210/t by June.
- **Phosphate:** Second quarter phosphoric acid contracts between OCP and its Indian JV partners were settled at $730/t cfr, an increase of $52/t on the first quarter. The settlement will be a key influence on global DAP trade and prices in coming months, as it translates to a DAP import parity of around $430/t cfr. However, keen competition for Indian market share should keep DAP prices below the parity price during the second quarter, in our view. At the same time, softening domestic ammonia costs in China should allow marginal exporters to accept lower DAP offers. Ma'aden's continuing production ramp-up at Wa'ad al Shamal will intensify competition in Asia and keep f.o.b. prices competitive. China's share of the Asian market already looks weakened thanks to Vietnam's recent decision to restrict phosphates imports for the next two years.
- **Potash:** India's MOP subsidy for the 2018 fiscal year is set to fall 10 percent year-on-year. Nevertheless, we expect Indian MOP demand to remain at elevated levels, supported by favourable monsoon rainfall and near-record grain output. The MOP market is projected to stay balanced or moderately undersupplied throughout 2018 and into next year, despite the arrival of new supply sources and increasing MOP volumes. The supportive weather and buoyant macro conditions that helped bolster demand in 2017 should remain in place for the time being.
- **Sulphur:** Supply-side growth is expected to continue throughout 2018 – moving the sulphur market into surplus and adding downward pressure to all price benchmarks. Export supply out of Saudi Arabia is expected to fall as sulphur is redirected towards growing domestic phosphate production. Morocco's sulphur demand will also grow as OCP ramps-up its phosphates production capacity, pushing Moroccan sulphur consumption to record levels. These market shifts will, however, be offset by reduced import demand from China. This will continue to weigh heavily on the supply/demand balance in 2018, adding to downward price pressures. Chinese import demand in 2017 was down six percent year-on-year, a trend that is expected to continue this year as new domestic supply continues to capture market share and displace imports. ■

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UNITED STATES

Yara and BASF open Freeport ammonia plant

Yara International and BASF officially opened their world-scale ammonia plant in Freeport, Texas, in April.

The new $600 million Yara Freeport plant, a joint venture between Yara (68 percent) and BASF (32 percent), is located within BASF's existing Freeport complex. The two partners will each share ammonia output from the new 750,000 t/a capacity plant in proportion to their respective ownership stakes.

Unusually, the plant runs on hydrogen off-gas from nearby petrochemical plants, rather than natural gas. This substantially reduced project capital costs by avoiding the need for an expensive reforming section.

The plant's long-term hydrogen and nitrogen supply requirements have been secured thorough an agreement with industrial gases company Praxair. The costs of this supply agreement are linked to advantageous US Gulf natural gas prices.

Yara will market its share of the plant's ammonia production to industrial customers and North America's agricultural sector.

"Together with our partners at BASF, we built a world-scale ammonia plant that not only raises the bar in terms of safety, efficiency and quality but also applies the principles of industrial symbiosis by using a by-product as feedstock for ammonia production," said Svein Tore Holsether, Yara's president and CEO. "Yara Freeport strengthens our leading position in the global ammonia market and expands our production footprint in North America."

PHOTO: BASF

Yara and BASF executives cut the ribbon at Freeport.

BASF will use its ammonia production share to produce polyamide 6, widely-used in the manufacture of carpet fibres and casings for the wire and cable market. Polyamide 6 is also injection-moulded to produce high-performance engineering plastics for vehicles.

"This joint venture with Yara… at the Freeport site… demonstrates BASF's commitment to investing in North America," said Wayne Smith, the chairman and CEO of BASF's US subsidiary. "The new plant allows us to take advantage of world-scale production economics and attractive raw material costs to strengthen the competitiveness of our customer value chain in the region."

New infrastructure has been put in place to support the new Freeport plant. Yara has built an ammonia storage facility at Port Freeport, while BASF has upgraded its existing terminal and pipelines.

Canpotex completes terminal expansion

Canpotex completed its five-year expansion project at Portland Bulk Terminals in Portland, Oregon, in March. This increases annual potash capacity at the terminal by around 3.5 million tonnes to 7.5 million tonnes.

Canpotex – the Canadian potash export consortium owned by Mosaic and Nutrien – invested nearly $150 million in the expansion project. The aim was to improve the efficiency of ship loading and rail operations at Portland Bulk Terminals and provide more potash storage capacity. Improving health and safety at the terminal and reducing its environmental impact were also priorities for Canpotex.

The large-scale expansion project involved more than 50 suppliers and subcontractors. A new shiploader and a 110,000 tonne capacity warehouse were installed as part of the expansion. Upgrades to the vessel loading system at the terminal will ensure the efficient transfer of potash from trains, through the warehouse system and onto vessels.

"The expansion of our Portland terminal is the culmination of five years of hard work, dedication and partnership between Canpotex, the Port of Portland, the local community and dozens of vendors and suppliers," said Ken Seitz, president and CEO of Canpotex. "The improvements we have made at Portland Bulk Terminals will enhance our ability to reliably ship our potash overseas and meet customers' needs."

Portland Bulk Terminals has been wholly owned by Canpotex since 1997.

"The completion of this expansion project enables Canpotex to be agile and responsive to our international customers' demands for high quality, Canadian potash," said Seitz.

INDIA

Toyo wins urea plant contract

Toyo Engineering has won a contract to build a large fertilizer complex at Gorakhpur in northern India.

The $753 million contract was awarded by Hindustan Urvarak and Rasayan Ltd (HURL) in March. It covers licensing, engineering, procurement, construction and commissioning services for a 2,200 t/d capacity ammonia plant and a 3,850 t/d capacity urea plant.

The urea plant will use Toyo's latest *ACES 21* urea synthesis technology. KBR will provide the licensing and basic engineering design for HURL's ammonia plant. The complex will consume imported liquefied natural gas feedstock delivered via a pipeline.

HURL is a joint venture between five public sector energy and fertilizer companies – namely Coal India Ltd, NTPC, Indian Oil Corporation Ltd, Fertilizer Corporation of India Ltd and Hindustan Fertilizer Corporation Ltd.

"We are pleased that KBR's ammonia technology has been selected for the first greenfield urea plant being set-up by HURL as part of this initiative by the government of India," said John Derbyshire, president, KBR Technology & Consulting. "This project will be an important milestone for India to meet its urea demand and KBR is honored and proud to be a part of this project."

India's prime minister Narendra Modi laid the project's foundation stone in July 2016. This symbolised the project's importance to the Indian government and its eventual goal of self-sufficiency in urea production.

"The HURL project at Gorakhpur shows the commitment and support of the government of India… towards the Indian Fertilizer sector," said Arun Kumar Gupta, HURL's managing director. "We believe that with best technologies and project management practices, this project will fulfil our vision of growth, efficiency and building national self-sufficiency."

The latest contract is Toyo's 16th urea project in India to date.

BRAZIL

Petrobras mothballs two fertilizer plants

Petrobras has decided to mothball two fertilizer plants, confirming its exit from fertilizer production.

The state-owned oil company said it would start mothballing both plants – the 657,000 t/a capacity Sergipe (Fafen-SE) urea plant and the 303,000 t/a capacity Bahia (Fafen-BA) ammonium sulphate plant – by the end of June. Combined, these two units lost Petrobras BRL 800 million in 2017.

"The decision to mothball these units is aligned with the company's strategic position to fully withdraw from fertilizer production. In 2017, Fafen-SE and Fafen-BA featured negative results close to BRL 600 million and BRL 200 million, respectively," Petrobras said in a statement in March.

But Petrobras subsequently announced a delay in the process to mothball and progressively shut down production at Fafen-SE and Fafen-BA. It agreed a temporary reprieve to keep the plants open by a further 120 days beyond the initial end-June cut-off. This followed an intervention by state-level government at the end of March.

The governments of Sergipe and Bahia will apparently use the 120-day respite period to find alternatives that would maintain production at both plants.

"We know that what matters most in Fafen is the price of gas, which is the responsibility of Petrobras, which charges an exorbitant price. Let's discuss the price of natural gas, the electric energy tariff, the water tariff," Sergipe's governor Jackson Barreto said, after meeting Pedro Parente, president of Petrobras, on 27 March.

Petrobras accepted this proposal while pointing out that the decision to end production at the Sergipe and Bahia was widely known, having originally been proposed in a 2016 cost cutting plan.

Yara opens first foliar plant

Yara International opened a $31 million foliar fertilizer plant at Sumaré in São Paulo state near the port of Santos in March

The new plant is Yara's first foliar fertilizer production unit in Brazil. It strengthens the company's manufacturing base in one of the world's largest and fastest-growing agricultural markets. Foliar fertilizers produced at the plant will be targeted at Brazil's soybean and corn farmers.

Yara is investing heavily in Brazil, both in fertilizer production and asset buying. Vale agreed to sell its Cubatão Fertilizantes complex to Yara in November, although the deal is currently being reviewed by Brazil's competition regulator Cade. Yara is also spending $275 million modernising its Rio Grande fertiliser plant in Rio Grande do Sul state. This is expected to double the plant's annual production capacity to 1.5 million tonnes by 2020. Yara is also making a major investment in Brazilian phosphates production through the Salitre project, a joint venture with Galvani located in Minas Gerais state.

RUSSIA

KBR wins another Acron contract

KBR has been awarded a further contract by JSC Dorogobuzh, a subsidiary of Acron, as part of an ammonia plant revamp at Dorogobuzh in Russia's Smolensk region.

KBR will now also supply proprietary equipment for the revamp. The company previously received a basic engineering design and licensing contract for the project.

Dorogobuzh wants to increase the ammonia plant's capacity to 2,100 t/d and improve its efficiency. KBR has selected a low-cost revamp option to achieve this – using the *KBR Reforming Exchanger System (KRES)* in combination with proprietary add-on ammonia converter technology.

"We take immense pride in working with Acron to revamp its ammonia production facility at Dorogobuzh," said

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John Derbyshire, president, KBR Technology & Consulting. "These recent contracts reinforce the trust of our clients in KBR's proprietary equipment and ammonia technology."

UNITED KINGDOM

CF to revamp Billingham

CF Fertilisers has announced a £40 million ($56 million), two-year revamp of its Billingham fertilizer production complex.

The move was partly in response to rising UK demand, according to CF's Billingham site manager Keith Brudenell.

"We are now the only company manufacturing high quality ammonium nitrate in the UK. Since CF Industries took a 100% holding in the site in 2015, demand has grown considerably and we are now developing the plant to keep pace with this and meet the challenges of the future," Brudenell said.

The first priority is a £15.75 million project to upgrade to Billingham's electricity distribution network. A new state-of-the-art high-voltage network should provide the plant with the power security it requires over the next 40 years and beyond.

The second major project will be a £15.5 million ammonia plant upgrade to extend its life by 20 years. "This will involve replacement of the steam reforming equipment and gas transmission piping on the high temperature part of the plant and our aim is to complete the upgrade by 2020," said Brudenell.

A further £8 million will be spent on replacing equipment at one of Billingham's nitric acid plants.

"All in all, this is a real vote of confidence in the Billingham site and its team and for industrial chemicals on Teesside in general," said Brudenell. "It will allow us to continue the long history of ammonia and fertilizer manufacture at Billingham and make sure we are in the best shape possible to look after the needs of all our employees and customers as we approach our 100 year anniversary in 2023."

POLAND

Grupa Azoty agrees supply deal with OCP

Grupa Azoty has reached a three-year phosphate rock supply agreement with Morocco's OCP Group.

OCP has agreed to supply the Polish fertilizer producer with an unspecified volume of phosphate rock between January 2018 and December 2020, in a deal thought to be worth around PLN 350 million ($103 million). OCP previously agreed to supply Grupa Azoty with one million tonnes of phosphate rock during 2017, in a similar but shorter-term PLN 135 million ($35 million) deal signed last May.

PHOTO: AZERNEWS

One of the artificial island platforms, Kashagan.

Polish phosphate rock imports from Morocco have been on the rise in recent years. Trade statistics show the country imported 1.2 million tonnes in 2017, some 56 percent of this supplied by Morocco. In total, Poland imported 674,835 tonnes of Moroccan phosphate rock last year, up from 541,279 tonnes in 2016.

NEW ZEALAND

New Ravensdown blending plant

Sackett-Waconia has commissioned a second precision fertilizer blending plant for Ravensdown in New Zealand.

The new blending plant, located at New Plymouth on New Zealand's North Island, went into production in March. It will offer customised fertilizer blends tailored to match customer soil test results. Combining precision blending with variable rate application technology will lead to much smarter farming, suggests Ravensdown.

Ravensdown's CEO Greg Campbell said: "We import over 100,000 tons of mineral fertilizers through the local port each year, supplying 150,000 tons to approximately 4,300 farms. We also have strong control of our supply chain, from the port through our 17 stores across the Western and Central North Island to the farm gate – thus ensuring quality, consistency and competitive pricing."

The new precision blending plant is one of only two in the whole of the Australasian region, the other being Ravensdown's Christchurch plant on South Island commissioned in 2016.

KAZAKHSTAN

Kashagan ramps up exports

Sour gas processing at the Kashagan project has now produced more than 1.5 million tonnes of sulphur – according to the latest update from the North Caspian Operating Company (NCOC), the consortium behind the project.

NCOC, the operator of the giant Kashagan offshore oil and gas field in Kazakhstan's sector of the Caspian Sea, released the update at the end of March.

Sulphur from Kashagan has been entering the international sulphur market in larger volumes since NCOC began exports by rail last October. Exports totalled 100,000 tonnes by the end of 2017 and went on to reach 250,000 tonnes at the end of March this year.

These export volumes are lower than Kashagan's full potential as a proportion of the sulphur extracted is still being stored as blocks, according to Bruno Jardin, NCOC's managing director. NCOC will eventually form and export Kashagan's entire sulphur output, however, once the plant reaches full capacity. The company also plans to re-melt stored sulphur blocks and process these into granules. ■

China News Round-up

Courtesy of Kcomber, owner of CCM and Tranalysis

Stamicarbon wins new Hubei urea plant license

Stamicarbon is licensing its urea production technology and supplying proprietary equipment to construct a new urea plant at Zhijiang in China's Hubei province.

The 2,330 t/d capacity prilled urea plant is being built by Hubei Sanning Chemical Industrial Co, Ltd. Stamicarbon's contract covers licensing, process design and the delivery of high-pressure equipment, including a *Safurex* pool reactor.

The plant will use Stamicarbon's *Ultra-Low Energy Design*. This delivers a 40 percent reduction in steam consumption compared to conventional urea plant technologies. The design will significantly reduce energy and operating costs and the plant's carbon footprint.

The plant is expected to start-up at the end of 2019. This is Stamicarbon's second license award in China in the past year.

Vietnam's phosphate import tariffs fall

Vietnam's new phosphate import tariffs should benefit Chinese exporters. The tariffs published by Vietnam's ministry of industry and trade in March are lower than the temporary tariffs previously imposed.

The tariffs cover both monoammonium phosphate (MAP) and diammonium phosphate (DAP) imports into Vietnam. They have now been set at a level of $49.55/t for the period from August 2017 to March 2019, and at $47.08/t from March 2019 to March 2020.

The new official tariffs are about $30/t lower than the earlier temporary ones. Previous excess charges will apparently be refunded retrospectively.

Vietnam is an important export destination for Chinese phosphate producers. Vietnam imported at total of 885,000 tonnes of DAP in 2017, some 87 percent of which came from China.

China continues to reduce fertilizer usage

China expects further reductions in fertilizer consumption and improved use efficiency throughout 2018. The country has achieved zero growth in fertilizer usage for the last three years, according to officials.

The government will promote further cuts in fertilizer consumption and greater use efficiency this year. Measures include encouraging large-scale fruit and vegetable-growers and major tea planting regions to switch from mineral fertilizers to organic types. New agricultural businesses, such as family farms, will also be expected to take the lead when it comes to cutting fertilizer use.

China's fertilizer demand is already on a downward path and actually fell last year. Demand is predicted to continue to fall in 2018, by as much as five percent year-on-year. The government's zero growth in fertilizer use policy, and its encouragement of soil testing, are partly behind this.

Yichang Xinfa buys Xinjiang Yihua from Hubei Yihua

Yichang Xinfa is to acquire an 80 percent stake in urea producer Xinjiang Yihua, a subsidiary of Hubei Yihua, and eventually plans to buy the company outright.

Xinjiang Yihua has a urea production capacity of more than two million t/a and was established in 2010. The company has proved to be one of Hubei Yihua's most profitable subsidiaries, making net profits of $12 million and $24 million in 2015 and 2016, respectively.

Profits at parent company Hubei Yihua have, however, been hit in recent years. A net profit of slightly below $6 million in 2015 deteriorated to a substantial net loss of $197 million in 2016.

China's fertilizer output falls to nine year low in 2017

China's overall fertilizer output fell to 61.84 million tonnes in 2017. This was down 9.43 million tonnes year-on-year and is the lowest level recorded in nine years.

The elimination of outdated fertilizer capacity from the market – as a result of environmental protection inspections and more exacting pollution standards – appears to be the main reason behind this significant drop. Supply-side structural reforms in China have also reduced domestic fertilizer capacity.

Added to that, average operating rates in the Chinese fertilizer industry remained low in 2017, mainly because of depressed fertilizer demand linked to falling grain prices.

Looking ahead, curbs to phosphate production are thought likely as environmental protection and safety inspections become more frequent in China. There is also scope for more closures of old and inefficient fertilizer plants this year, improving the market's supply/demand balance.

Domestic producers go international

A number of leading Chinese fertilizer producers are diversifying by investing in foreign countries. They are also increasingly turning to international markets to sell their products. Jiangsu Huachang, China's top exporter of compound fertilizers for the last three years, has set up a new joint venture for nitrogen-based fertilizers in Malaysia for example. Hubei Xinyangfeng has also made concerted efforts to increase worldwide sales and marketing of its products. The company has entered and established markets in more than 30 countries in Asia, America, Oceania and Africa in the past 12 years. Kingenta is another prime example of this new kind of outward-looking Chinese fertilizer business, and has set the pace in establishing an international presence. The company has bought or acquired shares in many well-known agricultural businesses in recent years, including Germany's COMPO EXPERT. Kingenta has also blazed a trail by opening branches in the US, Australia, India, Spain, Norway, Israel, Germany, the Netherlands, Vietnam and Singapore. ■

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People

Dmitry Strashnov will become EuroChem Group's new CEO in July. He succeeds the current CEO, **Dmitry Strezhnev**, who has decided to step aside after 15 years in the role. Strezhnev will, however, continue to serve as a director on the company's board.

Mr Strashnov joined EuroChem in November 2017 as chief operating officer, and brings a wealth of international management experience to the role. Before joining EuroChem, he was CEO of Russian Post from 2013 to 2017. Mr Strashnov was also a member of the management board of Tele2 AB previously and, prior to that, was CEO of Philips Consumer Electronics in Russia.

"The Board is delighted that Dmitry Strashnov will assume the leadership role of the Group," EuroChem Group's chairman Alexander Landia said. "He is a strong strategic thinker and operational leader who will ensure the Group remains focused on its global aspirations. I would like to thank Dmitry Strezhnev for his outstanding leadership of EuroChem Group from a small company to a top 10 industry leader worldwide".

Dmitry Strashnov replied by saying: "I am honoured to lead EuroChem as its potash plans come to fruition and it embarks on an exciting new stage of growth."

Yara International reshuffled its senior management team in March. **Petter Østbø** will take up the position of executive vice president (EVP) and chief financial officer (CFO). He previously served as EVP for Production. **Torgeir Kvidal** becomes Head of Mining operations, reporting to **Tove Andersen**, the new EVP for Production. Andersen was previously EVP for Supply Chain. Replacing him is **Pablo Barrera Lopez**, previously Country Manager Yara Chile. **Pierre Herben** will no longer be part of Yara's executive management team due to changes to its corporate structure. **Alvin Rosvoll** continues to be responsible for Yara's partner operations, reporting to **Lene Trollnes**, EVP for People & Global Functions.

"The changes we make today will strengthen our ability to deliver on our strategy – meeting global challenges with value-creating business opportunities. I would like to express my gratitude to the colleagues who now leave the management team for their considerable efforts and dedication to Yara," said Svein Tore Holsether, Yara's president and CEO.

George Burdette is the new chief financial officer (CFO) of Itafos. He replaces **Rafael Rangel** who departed the company in April to pursue outside opportunities. Mr Burdette joins Itafos with over 12 years of senior-level management experience. Notably, he has played a major role in acquisitions, divestitures, mergers and finance deals totalling $8 billion during his career, both in the US and emerging markets. Before joining Itafos, he was head of project finance for the Americas at First Solar. Mr. Burdette also held a number of private equity and corporate roles at both Zaff Capital and AEI prior to this. During this time, he worked with Brent de Jong, Itafos chairman, and Brian Zatarain, Itafos CEO. Mr Burdette holds an international MBA from the University of South Carolina.

Brian Zatarain, the CEO of Itafos thanked Rafael Rangel for his tenure and welcomed Mr Burdette to the company: "Itafos is well-positioned to continue the implementation of its strategy of building a pure-play phosphate fertilizer company. Mr Burdette is the right person to join our leadership team as we enter this new phase of growth."

Sven Ombudstvedt was re-elected as chairman of PhosAgro in March. **Andrey G Guryev**, vice president of the Russian Union of Chemists, was also re-elected as the company's deputy chairman.

A number of PhosAgro directors have also been re-appointed to board positions. The company's audit committee will be chaired once again by independent director **Marcus Rhodes**. PhosAgro's CEO **Andrey A Guryev** was re-appointed chairman of the strategy committee. Independent director **James Rogers** will lead the company's remuneration and human resources committee. The environmental, health and safety committee will be chaired by executive director and Apatit CEO **Mikhail Rybnikov**. Finally, **Ivan Rodionov** will chair PhosAgro's risk management committee.

Calendar 2018/2019

JUNE

8-9
42nd AIChE Annual Clearwater Conference 2017,
CLEARWATER,
Florida
Contact: Perry Alonso,
AIChE Central Florida Section
Email: vice-chair@aiche-cf.org

18-20
86th IFA Annual Conference,
BERLIN,
Germany
Contact: IFA Conference Service,
28 rue Marbeuf,
75008 Paris,
France.
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

SEPTEMBER

24-26
CRU Africa Fertilizer Agribusiness 2018,
CAPE TOWN, South Africa
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup

OCTOBER

1-3
TFI World Conference,
SAN FRANCISCO, California
Contact: Valerie Sutton
Fax: (202) 962 0577
Email: vsutton@tfi.org

23-25
2018 IFA Crossroads Asia-Pacific Conference, SINGAPORE
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

NOVEMBER

5-8
Sulphur 2018 Conference,
GOTHENBURG, Sweden
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup

MARCH 2019

4-7
Nitrogen+Syngas 2019 Conference,
BERLIN, Germany
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup

25-27
Phosphates 2019 Conference,
ORLANDO, Florida
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup

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PHOTO: YARA

The rise and rise of precision ag

Machine-mounted sensors can check the nitrogen status of crops.

Precision agriculture allows fertilizers to be applied more efficiently. Variable rate application places nutrients exactly where they are needed in the right amounts – instead of being applied uniformly across the whole field. This reduces both input costs and environmental impacts. Careful calibration of fertilizer applications also ensures a more uniform crop response, improving yield and quality and boosting farm profits.

A four billion dollar market

Precision agriculture has been in the news lately. In March, consultancy Informa forecast that the global precision farming market would reach $4 billion this year, driven by an impressive 13 percent annual growth rate. The adoption of increasingly sophisticated crop nutrition technology is playing a major role in growing this market.

Precision ag delivers improvements in crop yields by measuring crop or soil conditions and matching these to variable rate fertiliser applications. Informa reports that farmers are increasingly making use of real time GPS data to decide precisely when to plant, fertilize and irrigate their crops. Some 80 percent of Australian farmers and 70 percent of US farmers, for example, use satellite positioning on tractors and machinery, making both countries leading adopters globally followed by Brazil and Argentina.

Sophisticated sensor technology is also driving change by allowing farmers to monitor crop nutrient levels, soil conductivity and soil moisture.

"In the next few years we will see increased use of sensor systems connected over the internet to increase the precision of seeding and fertiliser spreading and allow site-specific weed management in crop protection," Informa reports.

Widespread uptake of consumer technology, particularly smartphones and tablets, and improved rural broadband is also allowing farmers to take technology into the field and instantly access a range of valuable agronomic information.

Investment surge

In another sign of growing interest, venture capitalists have been flocking to invest in farming technology in ever larger numbers. Investment in fledgling farm tech businesses grew by almost one-third to reach $2.6 billion in 2017. Last year saw major investor interest in novel farming systems ($652 million), farm management software ($464 million) and robotics & automated farm equipment ($209 million).

Mergers and acquisition (M&A) activity also picked up in 2017 with two of the sector's giants assimilating promising start-ups. DowDuPont's buy-up of farm management software maker Granular for $300 million in August was followed by John Deere's $305 million purchase of ag robotics company Blue River Technology in September. Both deals were the largest farm tech acquisitions since Monsanto's purchase of The Climate Corporation for $1 billion in 2013. Fertilizer producer Yara also strengthened its precision ag portfolio by acquiring ATC last November. The purchase brought with it *Adapt-N*, the leading US nitrogen recommendation platform.

A world-changing idea?

Venture capitalists are not alone. Precision ag is being enthusiastically championed by a growing number of converts. *Financial Times* (*ft*), for example, featured precision agriculture in its '50 Ideas to Change the World' series at the end of last year.

Precision ag's economic and environmental merits derive from its ability to maximise crop yields by ensuring individual plants receive exactly the right amounts of water and nutrients, at exactly the right time. "What it can do is quite dramatic in terms of increasing productivity and reducing the environmental impacts of farming,"

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Precision Ag: The Basics

Precision agriculture helps farmers to select and apply the right inputs at the right time and at the right scale. Variable rate application of fertilizers, for example, enables nutrients to be targeted where they are most needed – instead of being applied uniformly across the whole field – reducing costs and overall use. Using inputs more efficiently contributes to 'sustainable intensification' of food production, a process in which crop yields are optimised while environmental impacts are reduced.

Main applications

Precision farming in crop production typically uses satellite positioning to locate and track vehicles and equipment within fields. Farmers have applied precision ag in three main areas:

- **Automatic tractor steering control:** this reduce overlaps when treating fields in parallel strips, saving inputs, fuel and time by some 6-10 percent.
- **Controlled traffic farming (CTF):** this reduces the area prone to soil compaction damage from 55-85 percent of the field's surface to 15-20 percent by driving machinery along fixed routes.
- **Site-specific crop management:** this measures variations in field conditions – by **aerial or satellite imaging** or by the use of **vehicle-mounted sensors** – and adjusts treatments and inputs accordingly using **variable rate technology (VRT)**, also known as **variable rate application (VRA)**.

Aerial and satellite imaging

Maps showing variations in soil conditions, crop growth or yield can be prepared by taking measurements across fields and linking these to individual satellite reference positions. Maps are created from the imaging (visible, near infrared and thermal) data collected by multispectral or hyperspectral cameras on satellites, aircraft or unmanned aerial vehicles (UAVs, drones). These can be used to assess crop canopy conditions, for example.

Vehicle-mounted sensors

Farmers can also use vehicle-mounted sensors to measure how conditions vary within a field. A range of devices exist for measuring soil status, such as apparent electrical conductivity (EC) sensors, gamma-radiometric soil sensors and soil moisture sensors. Physiological sensors have also been developed to measure the nitrogen status of crops.

Variable rate application (VRA)

VRA enables farmers to adjust the rate of delivery of fertilisers, seeds and herbicides in different parts of the field. Farmers sub-divide fields into distinct zones, using either aerial/satellite imaging or real-time data gathered by vehicle-mounted sensors, and then tailor their treatments and applications accordingly. Software is used to decide the optimum amount for each part of the field.

VRA usually allows total inputs to be reduced without affecting crop yields. Use of VRA in Germany for nitrogen fertilization has been shown to produce economic savings of €10-25/ha, and also improve nitrogen use efficiency by 10-15 percent, without impacting yields. Other EU studies in winter wheat and canola claim even larger benefits of €48-83/ha. ■

Vicki Hird, from food and environment consultancy Sustain, told *ft*.

Farmers are increasingly arming themselves with a plethora of precision farming equipment, including drones, satellites, robots and large-scale data collection devices. Indeed, these precision ag tools have already become widely-adopted by farmers in North America, Europe, Australia and parts of South America.

Key players

Agrichemical giants have moved fast to acquire their own precision ag platforms. Examples include Monsanto (Climate Corporation), Bayer (*xarvio*) and DowDuPont (Granular). Standalone precision ag platforms have also flourished, notably SMART and Trimble.

Digitally determining fertilizer applications is fast becoming the new normal, at least for certain crops in more agriculturally advanced countries. The story of fledgling ag tech company **SMART** illustrates how quickly the market is evolving. SMART's software can recommend application rates and timings for more than 250 crop types. Having only entered the market in 2014, the company has now sold its fertilizer management platform in more than 62 countries.

The **Climate Corporation**, a subsidiary of Monsanto, is another fast-expanding ag tech company. It is poised to launch its *Climate FieldView*™ digital platform in Europe this spring.

Using this platform, "Farmers can manage their inputs to optimise yield in every part of their field with manual variable rate seed and fertility… tools," the company says. The Corporation's technology gives farmers the ability to optimise their fertilizer use via a customised NPK management plan.

"In the past, farmers made field-by-field assessments," comments Mark Young, Climate Corporation's chief technology officer. "Today they are moving towards foot-by-foot data collection and analysis to make better decisions."

The Climate Corporation launched a free digital agriculture platform in India last May. This provide users with regular farming advice, updates on temperature, rainfall and humidity, and the latest crop price information. The Corporation is targeting the 70 percent of smallholder farmers in India with access to smartphones, and has set itself the long-term goal of reaching 150 million of the subcontinent's farmers.

The company also has ambitions to roll-out its platform to Africa and other parts of Asia. Mark Young is convinced of the benefits this will bring: "We will see a new level of sustainable crop productivity across the world, as farmers continue to see the value these tools can bring to their operations."

California-headquartered **Trimble**, originally best known for its GPS guidance and steering technology, has added greatly to its farm tech capabilities through a range of acquisitions over the last five years. The 10 companies acquired range from RainWave, a precipitation monitoring system to Irrigate-IQ, a precision irrigation company, to Fifth Element, a forestry and logistics technology platform.

Trimble's precision ag software features the *Field-IQ* crop input control system. This creates simple variable rate maps for fertilizer, seeds or crop protection. Trimble also acquired Agri-Trend's proprietary farm data management platform following its buy-out of the Canadian consultancy in 2015.

Agri-Trend's founder Robert Saik believes the move to precision agriculture and variable rate application is having a profound impact on the fertilizer business. "When a farmer moves to the precise application of nutrients by zone, the planter effectively becomes the blender and the blend is regulated by the programming in Trimble ag software tied to the GPS location in the field. Ultimately this will be great news for the environment because it further enhances our ability to feed a crop exactly what it needs according to the nutrient supplying power of the soil," Saik told *Fertilizer International*.

Bayer also has a strong digital farming presence through is *xarvio*™ *FIELD MANAGER* agronomy software platform and *xarvio*™ *SCOUTING* app. *xarvio*™ has even been described as 'Uber for ag'. The smartphone *SCOUTING* app can measure the nitrogen status of crops. It also determines weeds, classifies and counts insects, recognises plant diseases and analyses leaf damage. The app is widely-available in Europe with a North American roll-out also planned.

"We currently have 350,000 users. Our ambition is to have five million growers on the platform next year with an emphasis on sub-Saharan Africa and Southeast Asia," Tobias Menne, Bayer's head of digital farming, said last November. "In Brazil, we market our products on a per acre basis, and the *SCOUTING* app is free of charge. Sudan's deputy ag minister just visited and told me this is what we need for our farmers. They all have a smartphone but they are lacking credible knowledge around agronomy."

Fertilizer producers

Major fertilizer producers also offer their own precision ag platforms, including Yara (*YaraPlan*), Nutrien (Agrium's *Echelon*) and Simplot (*SmartFarm*). They have also been routinely providing online digital resources to farmers for many years – Nutrien (PotashCorp's eKonomics) and Mosaic (cropnutrion.com) being just two examples.

To take advantage of the growing availability of smartphones and tablets, these online resources are increasingly being supplemented by a growing range of free apps for farmers.

Yara offers a number of smartphone apps. Yara *CheckIt* uses a crop photographic library to help farmers quickly identify nutrient deficiencies. Yara *ImageIT* measures crop nitrogen uptake based on crop photographs and uses this to generate nitrogen recommendations. Yara also offers a nutrient removal app specific to Germany (*Entzugsrechner*) and a nutrient calculator app (Gjodsel) that works out the correct fertilizer recommendation for a given nitrogen application rate.

The *KALI-TOOLBOX* app from **K+S** helps diagnose deficiency symptoms in cereals, potatoes, maize, rape, sunflowers, grapevines and sugar beet. The app provides photographs to help identify deficiency symptoms and makes recommendations to correct these. A converter tool to calculate the nutrient content of fertilizers was added to the app in 2016.

Haifa Group offers the comprehensive *NutriNet* plant nutrition software package to help growers plan irrigation schemes and fertigation programmes. The Group's *Haifast* software also calculates nutrition requirements for crops grown in soilless hydroponic systems. Extra to this, Haifa also markets three precision plant nutrition apps:

- *FoliMatch*: a foliar feeding advisor
- *FertiMatch*: an assistant for fertigation calculations
- *FloraMatch*: used to predict controlled release nutrition

Nitrogen sensors

Machine-mounted sensors able to detect the nitrogen status of crops, and adjust fertilizer applications accordingly, are becoming increasingly popular with arable farmers. Probably the three most popular types are *N-sensor* from Yara, *Isaria* from Fritzmeier and *GreenSeeker* from Trimble.

The *Isaria* sensor was recently evaluated in UK trials on wheat, barley and rape crops, as part of a agronomic project led by nitrogen fertilizer manufacturer **CF Industries**. Using the *Isaria* crop sensor to measure crop nitrogen uptake and optimise application rates resulted in higher profitability, compared to flat rate applications. Yields increased by 3-12 percent, and fertilizer cost margins improved by seven percent on average. Nitrogen efficiency also benefitted with a 70 percent better nitrogen balance at harvest.

Yara's vehicle-mounted *N-Sensor* determines crop nitrogen requirements optically and controls the fertilizer spreader in real time. It automatically generates maps of crop density, nitrogen requirements and fertilizer spread when connected to a GPS receiver. The sensor was originally developed at Yara's research centre in Hanninghof, Germany. More than a thousand units are currently in use globally.

The sensor works by measuring light reflectance from the crop canopy at different spectral ranges. It operates using either ambient light (*N-Sensor*) or a built-in light source (*N-Sensor ALS*) for low light or night time operation. Yara's nitrogen sensor system is designed to work continuously at normal tractor speed, scanning two strips three metres wide on either side of the tractor.

The reflectance measurements obtained provide information on variations in crop chlorophyll content and biomass within the field. Software converts these measurements into nitrogen uptake and optimum nitrogen application rates and sends these to the spreader controller. This instantaneously adjusts the nitrogen fertilizer spreading rate in real time to exactly match actual crop needs.

Yara also markets the *N-Tester* handheld device. This measures crop nitrogen requirements from leaf chlorophyll levels, and is calibrated for different crops and growth stages.

A digital future?

All of these moves are part of a wider industry shift towards integrating the selling of fertilizers and other inputs as part of a comprehensive package of services to farmers.

This new farmer-focussed type of fertilizer company – and the increased integration of products and services – is exemplified by industry giant **Nutrien**. The company, created by the merger of Agrium and PotashCorp at the start of the year, is the world's largest provider of crop nutrients, inputs and services. Its retail arm – soon to be rebranded Nutrien Ag Solutions – operates out of 1,500 locations across North America, Australia and South America. It employs more than 3,300 crop advisors and generates annual sales of $12 billion.

Nutrien announced the launch of a new digital agronomic platform in April. This will allow farmers to optimise their yields by incorporating the *Echelon* precision ag platform, previously offered by Agrium. *Echelon* already has a leading market position in North America, providing precision agricultural services covering more than 15 million acres of land. These include precision soil sampling, variable rate applications and yield analysis.

Nutrien's new digital platform allows farmers to manage all their accounts, services, products and payments via a single customer portal. Farmers can also use the portal to interact with agronomists and field representatives. It will be initially available in North America from July onwards and then rolled-out in phases.

Nutrien is clearly embracing digital farming. And where Nutrien leads others are sure to follow. ■

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Nigeria's world-class nitrogen industry

Dangote's 2.6 million tonne capacity urea plant in Lagos State, Nigeria, is nearing completion. It will join two existing plants operated by Notore and Indorama and will more than double the country's urea production capacity. We report on Nigeria's emergence as a production and export hub for nitrogen fertilizers.

Despite its oil wealth, Nigeria's $55 billion agricultural industry remains the country's largest economic sector, contributing almost 25 percent to the nation's GDP and employing two-thirds of the entire labour force.

Diverse agriculture

A large variety of crops are cultivated by Nigeria's farmers. Roots and tubers – mainly cassava, yams, cocoyam and sweet potatoes – dominate in the south, while grains such as sorghum, millet, maize and rice predominate in the northern savannah. Other commonly grown crops include groundnut, melon, beans, soybean, sesame, okra and pepper. Cocoa, rubber, groundnut, oil palm are Nigeria's main export crops, although production has been in decline.

Smallholder farmers account for about 90 percent of Nigeria's total agricultural output, typically cultivating between 0.8-1.2 hectares in forest areas and 2-4 hectares on savannah. The use of farm inputs is low by international standards with Nigerian fertilizer applications averaging just 12-15 kg/ha.

A range of factors have combined to keep agricultural productivity low. These include the high cost of farm inputs, poor access to credit, inefficient fertilizer procurement and distribution, inadequate storage facilities and poor access to markets. Maize and rice yields in Nigeria are only about half those of South Africa or Thailand, for example, and about one-fifth of US levels. For certain crops, more than 40 percent of the harvest is lost due to spoilage and waste. More encouragingly, Nigeria has the potential to more than double its agricultural GDP by 2030, according to consultants McKinsey, with plenty of scope for improving the country's crop yields and crop mix.

Nigerian fertilizer consumption

Nigeria consumed just under one million tonnes of fertilizers in 2016, with urea – largely domestically produced – and imported NPKs accounting for around 80 percent of domestic usage (Figure 1).

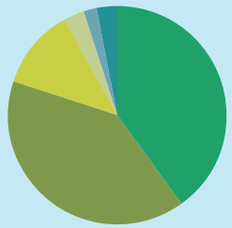
NPKs accounted for almost two-thirds of Nigeria's fertilizer imports in 2016. The country's NPK consumption, although highly variable, averaged around 290,000 tonnes between 2013 and 2016. A total of 380,455 tonnes of NPKs were imported and consumed in 2016, up by 130 percent on the previous year. More than two thirds of NPKs were supplied by Morocco (67%) in 2016, supplemented by imports from Russia (17%), Estonia (9%) and the UAE (7%). NPK importers include Wacot, Flour Mills, Elephant and Masco.

Nigeria's farmers apply a range of NPK formulations. The 15-15-15 grade is commonly applied on maize, cotton, sugar cane and ginger. Whereas NPK 20-10-10 is used on yam, millet, sorghum and beans. While NPK 27-13-13 is applied on maize, rice and sorghum.

Nigeria's urea imports have dwindled from 598,616 tonnes in 2013 to just 21,013 tonnes in 2016, being largely displaced by rising domestic output. Nigeria's urea production jumped from 281,750 tonnes in 2015 to 695,000 tonnes in 2016, after Indorama's plant entered production, supplementing production from the country's existing Notore-operated plant.

Conversely, urea exports have grown sharply from just 50,000 tonnes in 2013 to 329,630 tonnes in 2016. Brazil was the main destination (172,490 tonnes), followed by Uruguay (77,140 tonnes), the United States (31,580 tonnes), South Africa (30,020 tonnes) and Argentina (18,400 tonnes). A further large expansion in urea exports looks likely once Dangote's plant enter production.

Fig. 1: **Nigeria's fertilizer consumption, 2016**



Source: AfricaFertilizer.org

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Million tonne fertilizer market

Nigeria's annual fertilizer consumption currently stands at just under one million tonnes (see box). Low crop yields have been partly a consequence of bottlenecks in the fertilizer supply chain. Fortunately, the recent revitalisation of Nigeria's fertilizer blending capacity (see box), together with the emergence of large-scale domestic urea production, look set to provide a much needed boost to agricultural productivity and farm incomes. More effort has also gone into educating and training farmers on the benefits of crop inputs in recent years.

Nigeria currently has 1.9 million tonnes of operational urea production capacity. The country's two existing urea plants located near Port Harcourt, Rivers State, are operated by Indorama Eleme Fertilizer & Chemicals Limited (IEFCL) and Notore Chemicals Industries Limited. A new 2.6 million tonne urea plant being built by Dangote Group at Lekki, Lagos State, is expected to be come on-stream either later this year or in 2019. Looking further ahead, Brass Fertilizer & Petrochemical Company also has plans to develop a 1.3 million t/a urea plant at Brass Island, Bayelsa State (Figure 2).

Fig. 2: **Location map: Nigeria's urea plants and projects**

Indorama

Indorama's Port Harcourt nitrogen complex was commissioned in June 2016 and later inaugurated by Nigeria's acting president Yemi Osinbajo. The completion of the 1.4 million t/a capacity urea plant marked the successful culmination of an ambitious project to build the world's largest single-train urea plant in sub-Saharan Africa.

The complex, located on 38 hectares of land at Eleme in Rivers State, comprises a 2,300 t/d ammonia plant and 4,000 t/d granular urea plant. The site is supplied by natural gas via an 84 kilometre long pipeline and has access to the export market through a terminal at the nearby Onne Port. The $1.5 billion complex was financed by the International Finance Corporation (IFC) and a consortium of 15 European and African banks.

The world-class Eleme complex incorporates state-of-art ammonia and urea process technology licensed from KBR and Toyo Engineering, respectively. The ammonia plant uses KBR's *Purifier* process technology, while the urea plant employs Toyo's *ACES 21* urea synthesis technology and *Spout Fluid Bed Granulation Process*.

Production output is divided between domestic sales, international offtake agreements (Helm, Trammo and Transammonia) and export sales. The company supplies urea in bulk to major West African ports such as Abidjan, Cotonou, Dakar, Lome and Tema – and the wider international export market – through its own port terminal at Onne, 16 kilometres from the production plant. The port is capable of loading vessels with a capacity of up to 35,000 tonnes and provides Indorama with a logistical advantage in the region, relative to other international suppliers. The sailing time from Onne to Cotonou in Benin, for example, is just 1-1.5 days. However, it is still quicker and less costly for Indorama to supply some neighbouring countries such as Benin and Niger by road.

The company has sizeable urea storage capacity including an 80,000 tonnes warehouse at the production plant and another 45,000 tonne warehouse at its port terminal. A dedicated fleet of 35 trucks is used to transfer urea in bulk from the plant to the dedicated port terminal at Onne.

Indorama distributes granular urea domestically through a wide variety of different channels. These include four off-takers (NPK blenders such as TAK Agro, Springfield Agro, Sambooka Fertilizers, Golden Fertilizers), a network of 250 agro-dealerships across Nigeria, commercial farms and through some 2,500 retailers. The company supplied around 320,000 tonnes of granular urea to local farmers across Nigeria in 2017, while another 180,000 tonnes went to local blending plants under the government's presidential fertilizer initiative (see box).

Indorama says it regularly supports blending plants throughout West Africa by providing quality inputs. The granular urea manufactured by Indorama is superior to many urea products previously available in Nigeria, conforming to the following characteristics:

- Nitrogen content: 46 percent minimum
- Low moisture: 0.5 percent maximum
- Urea formaldehyde concentrate (UFC-85): 0.45-0.55 percent
- Low biuret: One percent maximum
- High crushing strength: 3 kgf maximum
- Free ammonia: 50 ppm maximum
- Iron content: 1 ppm maximum
- Granule size: 90 percent minimum between 2-4 mmm

These specifications ensure that Indorama's urea exports meet internationally-accepted standards. They also meet new domestic standards for urea being introduced by Nigeria's fertilizer quality control bill. In a market where products have been wrongly labelled

Nigeria's presidential fertilizer initiative

Nigeria's fertilizer supply is largely government controlled and regulated. Recently, as part of the country's new presidential fertilizer initiative (PFI), the government has been investing in the refurbishment of NPK blending plants to bring these back into full operation. It has also been directly procuring fertilizers for NPK blending at a discount from manufacturers and traders. The initiative is designed to increase Nigeria's NPK capacity and make fertilizers more affordable by:

- Revamping local blending plants to increase domestic NPK production
- Enforcing a retail price of ₦5,500 per 50 kg bag
- Making NPK fertilizers available to farmers throughout both the wet and dry season

The initiative is expected to deliver the following benefits:

- Deliver foreign reserve savings by increasing market share of locally blended NPKs from below 30 percent to more than 70 percent
- Save ₦60 billion in fertilizer subsidies
- Create significant direct and indirect jobs and increase agricultural productivity and food output

In April this year, the Nigerian government revealed that 11 blending plants with a combined capacity of over two million tonnes had been returned to full operation in 2017 under the initiative.

"In 2017, PFI delivered 10 million 50 kg bags (500,000 tonnes) of NPK 20:10:10 fertilizer at a price of ₦5,500 in time for the wet season", commented information minister Alhaji Lai Mohammed. "That's down from the price of ₦9,000 per bag in 2016 – a 40 percent reduction in price."

He continued: "The FOREX savings in 2017 was 150 million dollars, thanks to the substitution of imported inputs of NPK with locally sourced inputs. In 2018, PFI will targets the delivery of 20 million 50 kg bags (one million tonnes), double the figure for 2017."

The minister also confirmed that the PFI had saved the Nigerian government ₦60 billion in subsidies in 2017. He said that, before the PFI, every imported bag of fertilizer was subsidised by ₦6,000 each.

The Nigerian government is planning to expand the PFI to a total of 23 blending plants this year.

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and mis-sold previously, the quality of urea is a valuable, unique selling point and builds farmer loyalty, in Indorama's view. The company also thinks there is tremendous scope for introducing and marketing value-added products in West Africa, such as coated and complex fertilizers.

Indorama has embarked on an extensive farmer training and educational programme in Nigeria. The company trained around 200,000 of the country's farmers in crop management practices last year, using materials developed in English, French and the Hausa language. Agronomic services offered by the company include:

- **Farmer service centres:** free agronomic advice on best management practices and 4Rs nutrient stewardship at agro-dealer outlets and farm sites.
- **Crop management practice folders:** some 60,000 folders have been distributed to date on cassava, cotton, maize, paddy rice, sorghum, sugarcane, tomato, yam etc.
- **Free soil testing:** provided to more than 1,000 farms in 2017.
- **Daily weather advice:** by mobile phone SMS.
- **Field demonstrations on balanced fertilizer use:** 280 demo plots established across 20 states for maize, rice, sugarcane, tomato, yam, cassava, wheat and cotton.
- **Farmer training events:** typically organised during harvest time at demo plots
- **Agronomy app:** provides farmers with a range of information on weather, crop management practices, soils and a nutrient calculator via mobile phone.

Indorama is extending these services to other countries in the region such as Cote D'Ivoire, Ghana and Senegal.

Notore

Nigeria's Notore Chemical Industries Plc is a leading fertilizer, agricultural and electricity generating company. It currently operates Nigeria's other urea plant, the longstanding 550,000 tonne capacity plant at Onne.

Notore acquired the assets of the former National Fertilizer Company of Nigeria (NAFCON) for $152 million on its privatisation by the Nigerian government in 2005. The company has since expanded and diversified during the tenure of Group CEO and managing director Onajite Okoloko.

NAFCON, a joint venture between the Nigerian government and KBR, was once West Africa's largest nitrogen fertilizer producer, due to its ownership of a 1,500 t/d urea plant commissioned at Onne in 1987. However, NAFCON's fertilizer output declined during the 1990s and eventually ceased in 1999 after key equipment failed. Following privatisation, ammonia and urea production resumed at the Onne complex in 2009. This was after Notore entered into a 20-year gas supply agreement with the Nigerian Gas Company and secured the necessary investment, drawing on a $222 million loan facility from a syndicate of Nigerian banks.

Notore currently has 1,500 t/d of urea and 1,000 t/d of ammonia production capacity. It also has the ability to produce and sell NPK fertilizers. Fertilizer production is located on a 560 hectare site with its own jetty at Onne, Rivers State, in Nigeria's delta region – a well-placed location for product shipments and distribution along the Atlantic coast. The company currently exports to West Africa, North Africa, Latin America and North America.

Notore is also a major provider of agricultural services in Nigeria. The company develops, markets and sells Notore-branded seed varieties for maize and rice, Nigeria's staple crops, and uses its fertilizer supply chain to distribute these to farmers. It claims to operate the largest agricultural services team in Nigeria supported by over five thousand extensions workers.

Notore has increased its ability to provide Nigerian farmers with access to fertilizers, and driven down supply chain costs, by developing a comprehensive national distribution network. The company's supply infrastructure includes:

- **Haulage:** a transport network of more than 350 trucks
- **Distribution:** more than 60 distribution partners with over one million tonnes of warehousing capacity and 40 fully automated redistribution vehicles servicing more than 1,250 rural farming communities and over 3,000 agro dealerships across Nigeria
- **Agricultural services:** a fully equipped department of agricultural extension professionals supported by over 5,000 village promoters embedded in rural farming communities. These bring best practice and modern agricultural techniques to small-holder farmers and farmer cooperatives.

As well as providing access to seeds and fertilizers, Notore has been educating famers on the use of these inputs using an innovative approach that combines agricultural extension demonstrations, videos and radio communication. The company has also helped overcome the affordability barrier by selling smaller 10 kilogram and one kilogram bags of fertilizer to subsistence farmers in Nigeria.

Dangote Group

Saipem is currently constructing Africa's biggest fertilizer plant in Lagos State in southern Nigeria for Dangote Group. The company has invested $2 billion in the nitrogen production complex at a site in the Lekki free trade zone. The dual-train plant will have capacity to produce 2.6 million t/a of urea and 1.5 million t/a of ammonia.

The fertilizer plant is just one part of Dangote's massive Lekki integrated petrochemical complex. The company is investing $12 billion overall constructing a 650,000 barrel per day crude distillation unit, a 3.6 million t/a polypropylene plant, and installations able to process three billion cubic feet per day of natural gas.

The Lekki fertilizer plant is in the latter stages of construction and was originally targeting completion in the first quarter of 2018. The plant is being built to the following specification:

- Ammonia plants: 2 x 2,200 t/d based on Haldor Topsoe technology
- Urea melt plants: 2 x 3,850 t/d based on Saipem's Snamprogetti technology
- Urea granulation plants: 2 x 3,850 t/d based on Uhde Fertilizer Technology
- Dedicated power plant: 3 x 40 MW steam turbine generators
- Auxiliary boilers: 3 x 200 t/h steam generation
- EPC contractor: Saipem, Italy, and Saipem Construction Nigeria
- PMC contractor: Tata Consulting Engineers, India

Dangote Group is a diverse industrial conglomerate operating across 10 African countries, generating annual revenues of around $3 billion from its major interests in the cement, agriculture, food processing, oil & gas and power sectors. Dangote has invested $7 billion in Nigerian industry in the last five years, equivalent to around 10 percent of the country's total direct foreign investment. Its current investment pipeline, for various Nigerian projects at different stages, totals more than $23 billion.

Dangote has the following sales and marketing strategy for the output from its urea plant:

- **Global sales:** 55-65 percent of output. Sell to global traders and target deliveries to geographically-close markets in the Americas.
- **West Africa sales:** 15-20 percent of output. Focus on neighbouring countries and other African countries where Dangote already operates.
- **Domestic Nigerian sales:** 20-25 percent of output. Invest to stimulate demand. Partner with the government to improve the fertilizer subsidy programme. Pre-build stock levels in the hinterland to avoid late deliveries and satisfy the seasonal demand spike.

Although current domestic consumption represents a relatively small fraction of Nigeria's installed urea capacity, there is potential for this to grow significantly, in Dangote's view. The company suggests that Nigeria's total domestic fertilizer consumption could eventually grow to 1.7-2.9 million tonnes annually under some scenarios, up from around one million tonnes currently. Such an eventuality could see Nigeria's urea consumption rise from under 400,000 tonnes annually currently to 0.9-1.4 million tonnes.

Part of the output from Dangote's new urea plant will be dedicated to its growing farming business. The Group is planning to expand sugar cane and rice cultivation in Nigeria to around 300,000 hectares, raising its annual fertilizer requirement to 150,000 tonnes.

Dangote says it will ensure year-round domestic fertilizer availability by having strategic depots and a dedicated truck fleet. It will also exert leverage on distributors to keep its products competitively priced, and demonstrate the value of fertilizers to farmers via extension services. Dangote also intends to expand into NPK production by forming partnerships with blenders and local phosphate producers. The Group ultimately aims to move into speciality/customised fertilizer production, supported by more extensive soil testing services and farmer education work.

Future urea capacity

Nigeria's urea production capacity looks set to rise to 4.5 million tonnes, once Dangote's 2.6 million t/a Lekki urea plant enters operation (Table 1). The company had been targeting completion in the first quarter of 2018, and a recent Nigerian news report suggested production could commence as early as June. But start-up delays would not be surprising, given the plant's scale and the fact that it is just one component of a massive petrochemicals project. More conservatively, the International Fertilizer Association (IFA) expects the project to be commissioned during 2018 and 2019.

Looking further ahead, Indorama is planning to double urea production capacity at its Eleme, Port Harcourt complex to 2.8 million t/a. The 'Eleme II' project includes new 2,300 t/d ammonia and 4,000 t/d urea plants. Indorama has already engaged technology licensors and EPC contractors for the project's front end engineering design (FEED) phase. Similar to the original project, Indorama is seeking International Finance Corporation (IFC)

COUNTRY REPORT

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Table 1: **Nigeria's main urea producers and project developers**

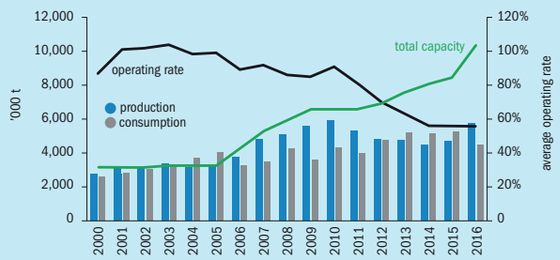
	Notore Chemical Industries	Indorama Eleme Fertilizer and Chemicals	Dangote Group	Brass Fertilizer & Petrochemical Company
Location	Onne, River State	Eleme, Port Harcourt, River State	Lekki, Lagos State	Brass Island, Bayelsa State
Ammonia capacity	330,000 t/a	820,000 t/a	1.5 million t/a	790,000 t/a
Urea capacity	500,000 t/a	1.4 million t/a	2.6 million t/a*	1.3 million t/a
Status	Operating	Operating	Under construction	Proposed
Start-up	2009/2010	2016	2018/2019	Post 2020
Comment	Expansion project planned	Eleme II expansion project planned		

**Dangote currently estimating three million t/a of urea capacity* *Source: company information*

backing for the $1.1 billion Eleme II project. The finance package includes:

- An IFC loan of up to $120 million
- Third party co-investment of $50 million
- Syndicated and parallel loans of up to $830 million
- $100 million of equity raised by shareholder subscription

Fig. 3: **Africa: urea capacity, production, consumption and operating rates, 2000-16**



Source: Nexant

Although this finance package is pending formal approval, IFC favourably describes Indorama as a "long time repeat client". Analysts Argus class the project as firm and expect it to be delivered between 2020-2023.

Notore is also eventually aiming to double its urea production capacity to one million tonnes. The company has long-standing plans to build a second fertilizer production plant at its existing Onne site under a 2012 joint venture (JV) agreement with Japan's Mitsubishi Heavy Industries. The resulting integrated complex would have the capacity to produce 3,000 t/d of urea, 1,700 t/d of ammonia, and 1,500 t/d of other petrochemical products.

At the end of last year, Notore also unveiled plans to create one of Africa's largest petrochemical hubs at Onne, after receiving special developer status from Nigerian authorities for this 'free zone' project. Notore has opened discussions with Mitsubishi about developing a methanol plant as part of the hub. The company is expecting significant direct foreign investment in the project.

Another Nigerian nitrogen project on the horizon is the $4 billion Brass Fertilizer project being developed by Brass Fertilizer and Petrochemical Company Limited (BFPCL) at Brass Island in Bayelsa State. The proposed project originally included a 1.3 million t/a urea plant. However, IFA and analysts Nexant do not expect this project to be delivered until after 2020. It is also unclear whether urea production is still planned, at least initially. Production units listed on the company's website currently only include a 770,000 t/a ammonia plant and 1.75 million t/a methanol plant.

African nitrogen outlook

The fertilizer sector consumes under ten percent of Africa's natural gas currently. The continent's urea capacity has more than doubled over the last decade, and is now above 8.5 million tonnes, while average operating rates have fallen below 60 percent in recent years (Figure 3). Egypt remains the region's nitrogen project hotspot, hosting more than 50 percent of African urea capacity.

Urea demand in Africa is close to 4.6 million tonnes at present, and is expected to grow at a modest 2.5 percent per annum over the next 10 years. Africa, although already self-sufficient, is likely to add new urea capacity in countries in North and West Africa, such as Egypt and Nigeria, with plentiful supplies of natural gas. There is also a growing interest in monetising new gas finds in East Africa, an emerging hydrocarbon province.

Nexant is cautiously forecasting that Africa will add just 1-2 million tonnes of urea capacity over the next decade, with the majority of this located in Egypt where new gas supply is expected from the 30 trillion cubic feet Zohr gas field. "New projects in Africa develop slowly due to political and security uncertainties, an onerous bureaucracy, limited access to finance and, in some cases, concerns about access to competitively-priced feedstock," comments Nexant.

The completion of Dangote Group's Lekki plant could reverse some of these assumptions and make the above forecast look conservative. IFC approval of the finance package for the Indorama's Eleme II project would also cement Nigeria's status as a leading global urea producing and exporting country. ■

Tessenderlo Kerley Int'l

We profile Tessenderlo Kerley International. This newly-formed business unit brings together all of Tessenderlo Group's international crop nutrition products under the umbrella of its *Crop Vitality* brand.

Last November, Tessenderlo Group announced the merger of its two separate crop nutrition businesses – SOP Plant Nutrition and Kerley International – creating a single new business unit, Tessenderlo Kerley International.

Two become one

The merger is a major reorganisation for Tessenderlo Group. For more than a decade, the strongly-growing Kerley International business has been marketing liquid fertilizers (notably *Thio-Sul*®, *KTS*® and *CaTs*®) outside the US and Canada, while the well-established SOP Plant Nutrition business produced and sold market-leading granular (*GranuPotasse*®), soluble (*SoluPotasse*®) and foliar (*K-Leaf*®) sulphate of potash (SOP) products to more than 100 countries globally.

Fertilizer International went to Brussels in March to meet with Tessenderlo Kerley International's senior team. We spoke to Geert Gyselinck, business unit director & commercial director, and Nicolas White, portfolio & knowledge director, about the merger and their ambitions for the new business.

Merits of the merger

The merger of the two business units into one makes commercial sense for Tessenderlo Group on a number of levels. Joining forces avoids duplication on frontline marketing and sales, for example. It also bring together a wider product portfolio under a single brand, *Crop Vitality*. Geert Gyselinck explains more:

"We were connecting to the same customers more and more – so we thought it was time to rationalise. Tessenderlo Kerley International combines 400 people from our long-standing SOP Plant Nutrition business with 100 from Kerley International, the liquid fertilizer business we started in 2013 – a sizeable business we've built-up globally in just a few years. I am leading the new business unit, taking the global commercial role, outside of the US and Canada."

"We have a much bigger team now with more information and knowledge – and we will be making full use of that."
Nicolas White

Nicolas White adds: "My role has changed slightly. Having all these products sitting together in the same basket in the market means we can now offer the best solutions to growers. We have a much bigger team now with more information and knowledge – and we will be making full use of that."

Knowledge tailored to local markets

Geert says Tessenderlo Kerley International, although a globally connected business, still works and acts locally:

"Knowledge is very important for us. We are the market leader globally on water-soluble sulphate of potash and have strong position on other SOP lines. Our liquid fertilizer business, mostly based on thiosulphates, has built a sizeable position in a number of markets in recent years.

"What makes us stand out from the crowd is that we have agronomic and commercial people around the globe working very closely with local distributors and farmers to build-up tailored knowledge, market-by-market. Our other key advantage, versus our competitors, is being able to drive that knowledge locally – on customers, products, climate and soil conditions.

"We have 20 agronomists worldwide. Their sole focus is building knowledge and trialling products – that's their vocation. Our strength is connecting that knowledge with local growers, whether it's in Mexico, Chile or Australia or Europe."

Different products, different nutrients

The newly merged business will not be adopting a 'one size fits all' approach though, says Geert:

"The products are different, the nutrients are different. SOP Plant Nutrition is focussed on potassium as a key nutrient whereas for liquid fertilizers such as *Thio-Sul*® –also our number one product line in the US – the majority of the business is nitrogen focussed.

"We are not going to create a mish-mash of everything. We have different product lines that need a tailored approach. We cannot use the same approach to put thiosulphate products on the market as we do in placing granular, soluble or foliar SOP."

Nicolas agrees: "Many products within our portfolio are at different stages of the life cycle. The approach you adopt depends on where they are in that cycle, SOP being a much older and more familiar product than some of the liquid fertilizers."

Combining the best of both

The larger product portfolio, and the ability to combine frontline expertise, offers real opportunities in Geert's view:

"Our new business unit and *Crop Vitality*, our new umbrella brand identity, allows us to use the brand promise we've developed in the US and roll that out across the world.

"Combining all our solid and soluble potassium products with our liquid nitrogen, potassium, calcium and magnesium lines creates a much bigger portfolio. But probably the biggest advantage of all is bringing together the frontline to combine the best of both heritage businesses. We

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can leverage the global coverage of SOP Plant Nutrition, for example, while taking advantage of the strengths of our locally-embedded liquid fertilizer Kerley International business – which has been building knowledge on a country basis.

"SOP Plant Nutrition had a global span, selling in 100 countries. Whereas the successful liquid business is focussed on a few, selected countries. We staffed these with local agronomists and local commercial people, working very deep in the market. This is the only model that works when developing a new product line where growers don't know what it is and what it does."

New production assets

The recent addition of a new liquid fertilizer plant in Rouen, France, has strengthened the company's manufacturing base. Geert lists Tessenderlo's fertilizer production assets outside of North America:

"We have our sulphate of potash facility in Ham, Belgium, supplying countries globally, and we also have three liquid fertilizer facilities outside of the US. We have a unit that makes potassium thiosulphate (KTS®) and calcium thiosulphate (*CaTs*®) next to the SOP plant in Ham. Our new facility in Rouen is making ammonium thiosulphate (*Thio-Sul*®), and we have a smaller Turkish operation serving the Middle East with tailored liquid fertilizers."

The Rouen plant is well-positioned to supply the large French urea ammonium nitrate (UAN) market, says Geert:

"For many years we served the big French liquid UAN market with *Thio-Sul*® from the US. But to maintain our long-term competitive position in Europe, in markets like France and Germany, we needed to have a facility based in Europe.

"We selected Rouen for many reasons. Most importantly, Rouen is the UAN hub in France. So it was the right location from a demand point of view. We also needed a good supply of raw materials and skilled labour – and we found all of that in Rouen.

Thio-Sul®: liquid bestseller

Geert makes a distinction between *Thio-Sul*® and the company's other liquid fertilizers:

"*Thio-Sul*® is blended with UAN in most cases. A high dosage is needed for rapeseed, a sulphur-hungry crop, with more of an average dosage for corn and wheat. Blending with UAN takes place close to the point of use. The products are delivered independently to local distribution points where the blend is made and shipped to nearby farms where it's applied.

"*Thio-Sul*® has some nitrogen but a lot of sulphur. The advantage of *Thio-Sul*® over the likes of ammonium sulphate is that it has other valuable properties, particularly nitrogen stabilisation. It's not 100 percent inhibiting but it is stabilising so there's less nitrogen loss."

There is plenty of scope to grow the European market for *Thio-Sul*®, says Geert:

"Our growth is not dependent on UAN market growth overall. There's still a lot of potential to penetrate our products into existing markets first. What we want to do in established UAN markets – France, Germany – is to increase the use of *Thio-Sul*® in blends. In West Europe, which is a stable-to-slightly-growing market, we plan to increase the penetration of *Thio-Sul*® – as there's still a long way to go to replicate the success of the US."

> **"The successful liquid business is focussed on a few, selected countries. We staffed these with local agronomists and local commercial people, working very deep in the market.**
> **Geert Gyselinck**

Market-leading *SoluPotasse*®

SoluPotasse® has become a highly successful SOP market product since its introduction. Nicolas explains more about its success:

"The driver for the SOP portfolio remains our fertigration grade *SoluPotasse*®. It was introduced in the 1990s and has grown from strength-to-strength. It's now marketed in more than 100 countries. Everybody knows the name *SoluPotasse*®, everybody knows the pink bag. It's the reference product in the market.

"In some cases, *SoluPotasse*® has become a victim of its own success, because it's attracting competitors and people infringing our intellectual property. That's clearly something we have to keep an eye on, and we do not hesitate to take legal action when necessary."

For *K-Leaf*®, Tessenderlo has needed to build the market and educate people about the benefits of applying potassium in foliar form, says Nicolas:

"Our foliar *K-Leaf*® product is an interesting one. You need something better for foliar sprayers – a high-quality, water-soluble grade – which was why we developed the product. We've had some great results using *K-Leaf*®, mainly as a cost-effective, complementary foliar spray, extra to a conventional soil application or fertigation programme.

"Our work with *K-Leaf*® has focused on field and broad acre crops. It acts like a booster. Not only do you get uptake of potassium through leaves but it also stimulates the plant to take-up other nutrients from the soil as well.

"In many field crops, such as potatoes, we've seen consistent yield increases of around 10 percent with *K-Leaf*®. Sometimes there's a huge benefit. We did a three-year *K-Leaf*® trial on walnuts. The benefits of these foliar sprays for the walnut grower is thousands of euros per hectare."

Quality holds the key

Summing up, Nicolas White says quality will remain a strong focus for Tessenderlo Kerley International across the whole of its *Crop Vitality* portfolio:

"We are able to demonstrate very effective fertigation results with our highly water soluble SOP grade *SoluPotasse*®. Because of that, product quality is something we've focussed on very strongly in the last couple of years. We try to educate the market about the importance of the quality of soluble SOP. That's important not only from an agronomic perspective but also from the perspective of ease-of-use and not damaging equipment."

Geert Gyselinck concludes with one final example of why collectively marketing all of Tessenderlo Group's crop nutrient products internationally under the *Crop Vitality* banner makes sense:

"We have a strong liquid products presence in around 20 countries. The good news is that these are also places where there is great untapped potential for our water-soluble products – because these countries have irrigation systems and arid climates. Our liquid fertilizer products mostly need irrigation systems to deliver them to the plants, as does our *SoluPotasse*® line." ■

Stamicarbon goes smart

Stamicarbon is a leading global provider of urea technology. The company has strengthened its commitment to sustainability by aligning its technology development strategy with the long-term goals of the United Nations. A new partnership on smart fertilizers is one outcome of this new strategy, as **Harold van der Zande**, Stamicarbon's business development manager, explains.

Strategic commitment to sustainablility

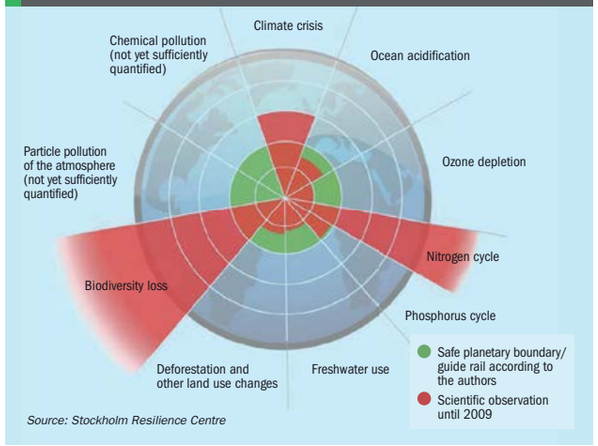
Stamicarbon, the innovation and license company of Italian Maire Tecnimont Group, has always taken corporate social responsibility seriously. Recently, the company renewed its commitment to sustainability and innovation by closely aligning its technology development strategy with the long-term goals of the United Nations.

It is widely agreed that food security and a good quality of life are fundamental, basic human needs. In response to this, the United Nations has made zero hunger and industry innovation priorities in its Sustainable Development Goals (SDGs). These are common objectives which Stamicarbon also supports and, indeed, is starting to put into practice. The addition of controlled-release fertilizers to Stamicarbon's technology portfolio exemplifies the company's new strategic commitment to sustainability.

Fig. 1: **UN sustainable development goals**

IMAGE: UNITED NATIONS

Fig. 2: **The Planetary Boundaries model**



Source: Stockholm Resilience Centre

The global challenge

Global food production will undoubtedly need to expand in future to meet the rising demands of a growing population. Equally, affordable food will need to become available to all, if humanity is ever going to eradicate hunger. To deliver these goals sustainably, a careful watch on the environmental impact of farming will also be necessary.

The United Nations has incorporated these aims in Sustainable Development Goal #2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture (Figure 1). The FAO has estimated that an increase in crop production of more than 45 percent will be required by 2050, to meet the additional demand from a planet of over 9 billion inhabitants, a 35 percent rise in global population from current levels. As well as keeping hunger in check, food output will need to rise to meet higher meat and dairy consumption, a consequence of growing economic wealth. Demand for grain for animal feed is forecast to rise even more sharply, due to the relatively low conversion rate when turning crops into meat and dairy products.

Fertilizers are set to play an increasing role in the growth of food production. In particular, the usage of urea, as the dominant nitrogen fertilizer (accounting for 60 percent of overall nitrogen demand), will need to be critically monitored. Although

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Fig. 3: **Fertilizer challenges**

Source: Stamicarbon

the application of urea remains essential if crop yields are to increase, its nutrient use efficiency is less than 50 percent. This means that more than half of urea's nitrogen content is lost – either volatilized into air as ammonia and N_2O, or lost to surface and ground water as nitrates. These losses have adverse environmental effects, ranging from air pollution and fine dust to elevated levels of nitrates in drinking water and the eutrophication of surface waters.

The 'Planetary Boundaries' model captures all of these environmental pressures in one simple-to-understand diagram (Figure 2). Environmental indicators such as the nitrogen cycle and biodiversity loss are displayed as segments on a spider diagram. The model shows, at a glance, whether present day values exceed the planetary boundary, defined as the maximum permissible level. It is immediately clear from the model that the planetary boundary for the nitrogen cycle is greatly exceeded, even if there is continuing academic debate about what the correct planetary limit is.

There has been an enormous rise in nitrogen fertilizer use in recent decades relative to historical levels. Nitrogen demand has increased greatly over time, driven upwards by expansions in the land area devoted to crop production and higher crop yields. The severe adverse effects associated with oversupply of nitrogen suggest action needs to be taken in many areas on the globe where boundary levels are exceeded (Figure 3).

To sum up, it can be confidently stated that global crop productivity needs to increase while, at the same time, global environmental pressures needs to be reduced. The aim should be to increase nitrogen use efficiency, while respecting planetary boundaries.

The fertilizer paradox

The fertilizer market, with a global turnover of around $300 billion, is by far the biggest agri-business segment, being responsible for about 60 percent of total agri-business turnover. Yet is it also one of the smallest investors in terms of R&D. Substantially more R&D money is spent in areas such as crop protection, seed development, farm machinery and food animal health, as a percentage of their turnover (Figure 4).

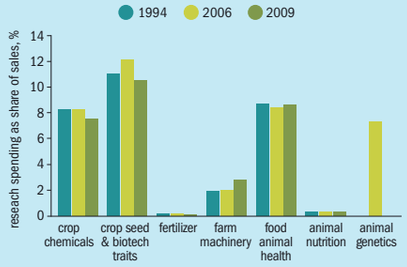
The last major fertilizer product innovations date from the 1960s, when products like DAP and MAP were developed. Since that time, a similar mix of fertilizer products has remained in use, because of a general lack of R&D spending and the absence of major breakthroughs in fertilizer product development. More attention has instead been given to matching fertilizer applications to the nutrient needs of specific crops and soil nutrient levels. This approach can be summed up as the 'smart use of fertilizers' rather than the 'use of smart fertilizers'.

Use of smart fertilizers

Fertilizers are traditionally applied a few times during the season, to try to ensure that plant nutrient needs are continuously met throughout the growing cycle. It is common practice in Europe nowadays to apply fertilizers in three split applications: the first application fulfils between 40-50 percent of total crop demand, the second applied several weeks later meets 20-30 percent of demand, while a third and final application, several weeks before harvest, boosts the nutritional value of the crop (Figure 5). However, the need to make sufficient levels available throughout the growing cycle can mean nutrients are quickly lost to the environment, as farmers tend to oversupply these to maximise their yields. The loss of oversupplied nutrients between applications often results in an overall nutrient use efficiency of below 50 percent.

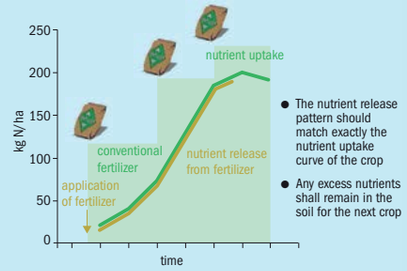
A smart fertilizer, in contrast, behaves very differently. It should be able to unlock and release nutrients to match the nutrient demands of the crop. In this way, nutrient

Fig. 4: **Research spending as share of sales**



Source: USDA, Economic Research Service

Fig. 5: **Nutrient release pattern**



Source: Stamicarbon

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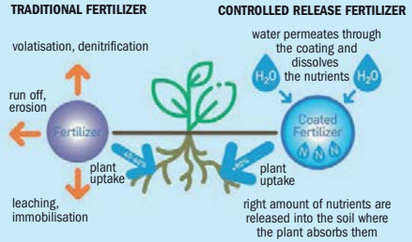
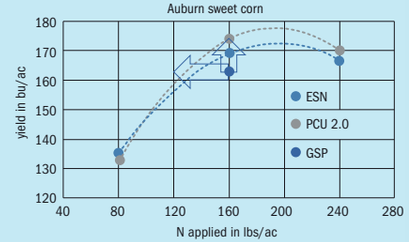
Fig. 6: **Nitrogen uptake**



Source: Stamicarbon

Fig. 7: **Field trials sweet corn**



Source: Stamicarbon

release is attuned to the needs of the crop, creating a perfect balance between nutrient supply and plant uptake, so preventing losses of nutrients to the environment. Ideally, optimal nutrient use efficiency can be achieved by adjusting the release curve of the fertilizer so it corresponds exactly with the nutrient demand curve of the crop (Figure 5).

Polymer coated controlled-release urea

Controlled-release urea can be regarded as a true 'smart fertilizer'. It is produced by encasing the urea granule within a polymer coating. This acts like a membrane, sealing the urea from the surrounding soil environment. Over time, urea's hygroscopic nature naturally attracts and draws in water (rain, moisture) through the membrane, where it dissolves part of the urea. A driving force then develops due to the high nitrogen concentration inside the membrane relative to the low concentration outside. As a consequence, nitrogen dissolved in water permeates outwards through the membrane into the soil, ready to be absorbed through the root system of the plant in an efficient and controlled manner (Figure 6). As the rate of permeation through the membrane is temperature dependent, and nutrient release also depends on water availability, an almost perfect balance is created between crop needs and fertilizer supply. As a result, losses to the environment, whether to air or water, are prevented and maximum nutrient use efficiency is achieved.

Field trials

During the summer of 2017, field trials were conducted with polymer coated controlled-release urea (PCU 2.0). The trials were designed to prove the concept against two benchmarks: another controlled-release urea product (ESN), and a split application of conventional fertilizers in accordance with Growers Standard Practice (GSP). Trials in different cropping systems, such as field corn, sweet corn and potatoes, have shown that significant increases in nutrient use efficiency are achievable (Figure 7). A single application of controlled-release urea provided 5-10 percent higher yields, against a split application of conventional fertilizers, when applied at the same overall application rate. Alternatively, controlled-release urea provided similar crop yields when applied at 75-85 percent of the total application rate of conventional fertilizers.

A business case analysis showed that the higher yield target allowed for a $150-800/t premium (depending on crop) for controlled-release urea, over regular urea, whereas the lower application target allowed for a $60-110/t premium for controlled-release urea over regular urea. This excludes the additional benefits of single application such as less labour and fuel.

Using controlled-release fertilizers to optimise cropping provides a number of important benefits:

- Negligible ammonia volatilization losses
- Negligible nitrate leaching losses
- Steady controlled-release of nutrients over the 3-4 month growing season
- Nearly all nutrients are available for the crop
- A single application in spring, with no need for a summer side dress, reduces application costs

There is also the option to choose between two optimal fertilization strategies:

- Higher yield from a similar application rate (allowing for higher fertilizer cost) or
- Similar yield from a lower application rate (less application of higher cost product)

Partnership development

A novel technology for the production of polymer coated controlled-release fertilizers, registered as *PurActive™ Technology*, has been developed by US-based Pursell Agri-Tech. This new approach, which combines a novel polymer composition with innovative coating technology, provides an economic solution to smart fertilizer production.

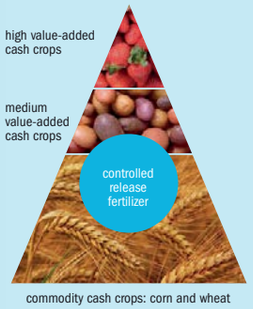
Stamicarbon, the leading urea technology licensor, has acquired a 20 percent stake in Pursell Agri-Tech. This strategic investment marks the company's entry into a promising new market – and is a major milestone in Stamicarbon's strategy of developing innovative technologies. The mutually beneficial collaboration has major synergies. Joining up Stamicarbon's global network and technological capability with Pursell Agri-Tech's leading expertise in coated fertilizers will enable promising initiatives in the controlled-release fertilizer market to be pursued and developed worldwide.

Market approach

The ability to provide a global supply position for this technology is one key reason why both companies have entered into partnership.

In North America the technology is being rolled-out through joint ventures with local distributors/wholesalers to maximise presence in local areas. The approach outside North America is different, with Stamicarbon providing licenses to interested parties,

Fig. 8: **Agricultural segments**



Source: Stamicarbon

such as large fertilizer producers or distributors. This is being offered to the market as a complete Stamicarbon technology package called *Controlled-Release Fertilizer Design™* with *PurActive™ Technology*. This approach ensures the technology will be available worldwide, as the polymer composition and equipment package is being delivered under exclusive arrangements with renowned global suppliers. The technical support secured through Pursell Agri-Tech will also provide assistance to potential customers during the full project cycle. Stamicarbon's *Controlled-Release Fertilizer Design™* will be available as a full 'Lump Sum Turn Key' project option.

Controlled-release fertilizer markets

At the heart of the *Controlled-Release Fertilizer Design™* package is a modular coating plant. It has a relatively low investment cost and a compact design, making it possible to erect such plants close to existing logistics facilities near end-user markets. This will prevent wear and tear of the polymer coating during long haulage, providing a regional supply position for controlled-release fertilizers. Developed to an optimised recipe, the polymer coating delivers a robust product able to meet the highest product and environmental requirements. Customers also have full flexibility to market the products made with *Controlled-Release Fertilizer Design™* using their own brand name, or colouring the products according to their own colour schemes, for example.

The technology is not only applicable to urea. It can also coat nearly all fertilizer compositions at different coating conditions. This provides customers with the capability to produce a broad range of controlled-release fertilizer grades with a wide range of different release periods. In the past, controlled-release fertilizers have generally been targeted at high value-added cash crops such as fruits and vegetables. In contrast, the low Capex/low Opex of new *Controlled-Release Fertilizer Design™* technology now allows controlled-release products to be targeted at all agricultural segments (Figure 8). This includes medium value-added cash crops such as sugar beets and potatoes, as well at the major commodity cash crops like wheat and corn. Advantageously, the controlled-release product can be applied using all traditional cropping methods, such as broad acre spreading, in the row, till or no till farming.

Modular plant design

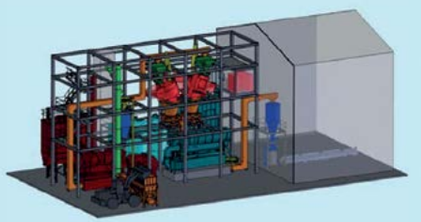
Stamicarbon's *Controlled-Release Fertilizer Design™* consists of a modular plant, designed and erected by the equipment supplier (Figure 9). It can be tailored to the customer's building premises and specific set of circumstances, matching their fertilizer feeding, bagging and emissions control requirements, for example. The coating plants are supplied as a complete package, including all proprietary equipment and controls, requiring only floor space within a building of adequate size. The specifics of the package will depend on factors such as location, climate and vicinity to other fertilizer operations.

The first commercial *Controlled-Release Fertilizer Design™* reference plant, operating on a 24 hours, 5 days a week regime, is running in Sylacauga, Alabama, in the US (Figure 10). It has a capacity to produce up to 100,000 t/a of controlled-release fertilizer and is being operated by our partner Pursell Agri-Tech.

Feeding the future

Previously, a technology capable of economically producing smart fertilizers for broad acre agriculture has simply not been available. This has now changed with the introduction of Stamicarbon's *Controlled-Release Fertilizer Design™* with *PurActive™ Technology*. This provides fertilizer producers and distributors with the ability to supply a range of new products to the market that allow for optimised fertilization. There is also the flexibility to achieve this in one of two ways: by increasing yields, or by reducing fertilizers inputs. At the same time, the wider application of controlled-release fertilizers reduces the negative pressure on the environment associated with the loss of nutrients to air and water. This latest innovation from Stamicarbon demonstrates how the fertilizer industry can take positive action to support United Nations Sustainable Development Goal #2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture. ■

Fig. 9: **3-D design of the controlled-release fertilizer plant**



Source: Stamicarbon

Fig. 10: **The first commercial reference plant**

PHOTO: PURSELL AGRI-TECH

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Inspired by
The School of Athens, Raffaello Sanzio 1509-1511
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AMMONIA
NITRATES & PHOSPHATES
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Conserving nitrogen

The Nitrogen Conservation Input System (NCIS) is the latest product innovation from pioneering Florida-based company Eco Agro. The System allows enhanced efficiency fertilizer (EEF) technology to be directly incorporated into urea production. This has a number of merits, as our US correspondent **Mark Evans** explains.

Eco Agro has made rapid advances since it was founded in 2013. By providing new and highly-innovative plant nutrient technologies, the company has already made great strides towards its goal of helping farmers become more productive, while at the same time protecting the environment. The latest product from Eco Agro, the Nitrogen Conservation Input System (NCIS), allows urea manufacturers to prevent nitrogen losses at the production stage, a potentially ground-breaking development.

A responsible approach

Eco Agro has brought a growing portfolio of enhanced efficiency fertilizer (EEF) products to market (*Fertilizer International* 480, p40). When it comes to sales and marketing, Eco Agro's business ethos combines an economic, agronomic and environmentally-responsible approach.

The list of innovative Eco Agro products is already impressive, including:

- The *PENXCEL* technology platform that improves the efficiency of nitrogen and phosphate fertilizers
- *N YIELD* nitrogen stabilisers
- *N-BOUND* nitrogen stabilisers
- *PHOS GAIN* enhancers
- The *NEON* family of products which combine two proven stabilisers in a simple and easy-to-use formulation

Protecting urea

In its latest move, Eco Agro has turned its attention to the metrics of urea manufacture, formulating a new approach that promises to drastically lower the manufacturing costs of enhanced efficiency fertilizers – thereby improving their affordability and availability too.

Eco Agro's Nitrogen Conservation Input System (NCIS) is specifically designed for urea manufacturers. It incorporates a number of proven, patented technologies and tackles head-on some of issues that have to date limited the mass adoption of nitrogen-efficient fertilizers. NCIS is a system for directly protecting urea with several nitrogen-conserving polymers during the manufacturing process, delivering unprecedented economic savings to producers.

Eco Agro recognised there was a need for NCIS because – in addition to nitrogen losses in soil – valuable nitrogen is also being lost during urea production, particularly when solvents are introduced in high-volume, high-heat applications. Such process losses were deemed unacceptable, given the surcharge that growers already pay for enhanced efficiency nitrogen fertilizers – typically around $40/gallon for a two quarts per ton treatment.

The new NCIS technology incorporates a number of key elements:

- **Eco Agro's *PENXCEL Advanced.*** This delivers superior heat stability and conserves ammonia during the high temperatures involved in urea production, leading to lower biuret values. It also contains proven active ingredients in a highly concentrated form. This allows urea producers to use *PENXCEL Advanced* to protect and conserve nitrogen at low input rates, thereby lowering the overall input cost.
- **The urease inhibitor NBPT** [N-(n-butyl) thiophosphoric triamide]. This provides nitrogen stabilisation protection against above-ground volatilisation, while highly reactive nitrile DCD (dicyandiamide) provides protection against below-ground nitrogen loss.
- **New advanced M-PAP** (modified poly acid polymer). This conserves ammonia in plant-available form, as well as further limiting nitrogen leaching and volatilisation.

Overall, NCIS combines proven chemical and polymer technologies in an ammonia- and temperature-friendly solvent delivery system, and does this at low input costs.

Reducing costs and losses

In tests, the water-free solvents in NCIS resulted in a three percent lower nitrogen loss in production, in comparison to standard industry solvents of similar chemistry. By modifying the polymer that produces ammonia, NCIS promises to make NBPT technology much more effective. Importantly, the technology significantly reduces the costs of producing enhanced-efficiency urea from around $40/t to just $10/t.

As well as its own research efforts, Eco Agro developed NCIS in liaison with several independent laboratories. Ray Perkins, Eco Agro's president, believes that wholesale adoption of NCIS technology could prompt a massive $1 billion change in global urea industry metrics.

"Until now, the cost had been too daunting for the industry to address the nitrogen loss issue at the production level. Coming up with the right science was a particular challenge. Finding the polymers able to absorb ammonium (NH_4) nitrogen was our 'Eureka Moment'. To be fully effective, the polymers also needed to be neutralised so as not to destroy the NBPT," says Perkins.

NBPT is the most expensive component in NCIS technology. The other polymers are cheaper and can bring down the overall costs of treatment, according to Eco Agro.

NCIS is an innovation that promises to bring about a massive step change in nitrogen efficiency. That is because reducing nitrogen loss at the manufacturing stage should ultimately lead to lower overall levels of urea production, while delivering the same agricultural efficiency. Lower absolute levels of urea manufacture should, in turn, reduce production emissions and cut leaching in soil. Worldwide production of urea is around 160 million t/a currently.

The adoption of NCIS at scale by urea producers could become a reality in the not-too-distant future. Ray Perkins has confirmed that a leading urea technology company is already interested in adopting NCIS. ■

IFA Global Technical Symposium

More than 170 delegates gathered at the Intercontinental Madrid, Spain, 9-12 April, for the 2018 IFA Global Technical Symposium.

PHOTO: IFA

The IFA 2030 roundtable.

Javier Goni Del Cacho, the CEO of Fertiberia and Fertilizers Europe's President, launched the event by giving delegates a very warm welcome to Spain. This was followed by some opening remarks by **Rakesh Kapur**, president of the International Fertilizer Association (IFA) and CEO of the Indian Farmers Fertilizer Cooperative (IFFCO).

Tuesday morning's opening session had a strong sustainability theme. The concerted action taken by the cement sector on sustainability in recent years could provide some valuable lessons for the fertilizer industry, suggested **Philippe Fonta** of the World Business Council for Sustainable Development (WBCSD). Cement manufacture is an energy intensive process responsible for 5-7 percent of man-made CO_2 emissions. Climate change was identified as a challenge by the cement sector as long ago as the late 1990s, and the industry created the Cement Sustainability Initiative (CSI) in response to this. This long-standing, member-led, voluntary initiative is one of the WBCSD's flagship projects. Its 24 member companies, operating in more than 100 countries globally, account for a third of world cement production, or two-thirds of production outside of China. CSI members are required to commit to a charter of individual and collective commitments. Compliance takes three years and firms are audited every four years thereafter. CSI members report on their CO_2 and energy management under the 2002 'Agenda for Action'. This covers the use of fuels and raw materials, air emissions, safety and land use. The CSI's work programme was later expanded to include more upstream activities, such as water and supply chain management, as part of a 'Future Review' in 2010.

Fertilizer production in Morocco has become increasingly sustainable, according to **Bouchra Nakara** of OCP Group. The company has taken steps to ensure that sustainability is integral to its multibillion dollar, long-term investment programme – including specific actions on energy, water and waste. OCP is implementing a strategy to reuse and recycle phosphogypsum as part of a mitigation and adaptation plan. The company is also targeting 95 percent energy self-sufficiency in three years, and electricity at two of its mine sites is already totally wind generated. Switching to a slurry pipeline has also delivered a water saving of three million cubic metres, for example, as well as saving 930,000 tonnes of carbon annually. Some 80 percent of the water used by OCP in

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beneficiation is recycled. The company has also rehabilitated more than 1,200 hectares of mining land since 2014.

Anil Chandramani explained the International Finance Corporation's strategic objectives when investing in the fertilizer sector. The corporation offers finance for new fertilizer production plants as part of its policy to promote private sector investment in developing countries. To date, it has invested $1.4 billion in a total of 68 chemical and fertilizer projects. IFC is also encouraging climate change mitigation through best practices such as precision farming and fertigation. The complexities of the World Bank's Nitric Acid Climate Actions Program (NACAP) were deftly unpicked by **Tanguy De Bienassis**. These auctions provide a price guarantee on future nitrous oxide emissions from nitric acid production through the buying and selling of credits. The auctions are being piloted in a collaboration between the World Bank and the Nitric Acid Climate Action Group, with the support of the German government. They potentially offer an effective and relatively cheap way for industry to meet its regulatory requirements.

In an energetic and entertaining presentation, **Trevor Brown** ran through emerging technologies for ammonia production. There is potential to improve the global ammonia industry's energy efficiency by 25 percent by 2050, suggested Brown, as old plants retire to be replaced by new ones, and by switching over from coal to gas feedstocks. Going beyond this will require a move away from steam methane reforming (SMR) to more carbon-efficient technologies. Low-carbon options for ammonia production include synthesis by electrochemical, plastic gasification and electrolytic technologies, or combining SMR with carbon capture and storage.

IFA 2030 roundtable

In Tuesday afternoon's first session, **Simon Inglethorpe** of *Fertilizer International* chaired a lively roundtable debate on IFA's 2030 initiative. Participating were **Ramon Lazo De La Vega** of the International Fertilizer Development Center (IFDC), **Antoine Hoxha**, of Fertilizers Europe, **Brent Heimann** of the Arab Potash Company (APC) and International Fertiliser Society (IFS) president **Luc Maene**. The session ended with the presentation of the 2018 Pierre Becker Memorial Award to **Mohamed Takhim** the CEO of EcoPhos (see page 62).

Best available technology

Best available technology (BAT) for nitrogen, phosphate and potash production was the theme of the Tuesday afternoon's second session. The European nitrogen industry has successfully shown how BAT can cut greenhouse gas (GHG) emissions, said Fertiberia's **David Herrero**. The take up of BAT in Europe has in part been driven by landmark EU policies such as Integrated Pollution Prevention and Control (IPPC, 1996) and the Industrial Emissions Directive (IED, 2010). Wider adoption of BATs elsewhere would undoubtedly help improve air quality and preserve water bodies, suggested Herrero, as well as deliver significant – if limited – reductions in GHG emissions. Looking ahead, Herrero suggested that ammonia may have a major role to play as an energy carrier in a future carbon-free economy.

Russia has rapidly introduced BATs in phosphates production, explained PhosAgro's **Eugene Shibanov**. BATs began to be adopted by the Russian fertilizer industry in 2014, following new federal laws and government resolutions and decrees. BAT principles have been specified for two phosphates granulation technologies: firstly, drum granulator and drier (DGD) technology and, secondly, ammoniator-granulator (AG) and drying drum (DD) technology.

Ulrich Kleine-Kleffmann of K+S explored some of the major challenges facing potash producers. Tailings heaps and the saline wastewater generated by potash production are two major environmental issues for K+S in Germany. The company has invested heavily in reducing its wastewater volumes. The recently-commissioned Kainite Crystallization Facility at its Werra Plant in Germany has cut wastewater generation by a further 1.5 million cubic metres annually. The company is also rehabilitating it tailings heaps by establishing thin vegetated cover.

Sustainable plant management

Wednesday morning's session began with a thorough and informative presentation by **Theodora Kouloura** of New Karvali Fertilizers (NKF). She described how an intervention plan for energy and water management at NKF's fertilizer production plant in Greece was devised and put into practice using a systemic approach. Successful adoption of the plan has enabled NKF to cut its water use by 20 percent, reduce electricity imports and provide all of the plant's thermal needs from waste heat.

Nutrient recovery

Two innovative examples of nutrient recovery for fertilizer production were provided in a joint presentation by **Cinta Cazador Ruiz** of Fertiberia and **Antonio Sancho** of Incro. Cinta described several technologies currently being evaluated as part of the EU-funded Newfert project. These included: DMPHOS, a new process for extracting phosphorus from ash and turning this into mono- or di-calcium phosphate, and a microbial electrolysis cell (MEC) for nutrient recovery from pig slurry. The eventual aim is integrate these technologies into a single industrial process for sustainable fertilizer production. Antonio explained the new nutrient recovery process being developed by Incro for the Oleofat project. This takes wastewater from an olive oil refinery and separates it into a concentrate for fertilizer production and a distillate for use in hydroponic farming. The project is planning to move to the start-up phase in May.

Christian Kabbe of Isle Utilities gave a comprehensive overview of the latest developments in nutrient recovery technology, particularly in Europe. Only technologies capable of delivering homogeneous quality products, and that integrate resource efficiency with energy efficiency, have a chance of becoming widely-adopted, in Kabbe's view. He also emphasised the need for strong commercial markets for recovered phosphorus products, and to keep costs low by minimising energy and chemicals consumption during nutrient recovery.

Phosphogypsum update

Aleff Group's **Julian Hilton** updated delegates on the latest progress in turning phosphogypsum (PG) waste into a resource, an objective long-championed by IFA. A second report from IFA on phosphogypsum (PG2) is currently under development. This will highlight good practice on sustainable management and use. It also anticipates potential breakthrough applications for PG such as climate-resilient agriculture and combatting desertification. IFA's Working Group on PG is moving towards a comprehensive, sustainable and integrated solution to PG based on circular economy principles. The ultimate goal is to achieve 'zero harm/zero waste', an ambition which the industry needs to embrace if it is to maintain its social licence to operate, in Hilton's view.

Parallel sessions

Wednesday afternoon was devoted to two parallel sessions. **Jeff Ivan** of Yargus Manufacturing and **Robert Saik** of Agri-Trend jointly presented on the automation of fertilizer blending and advances in precision agriculture. Yargus manufactures *LAYCO-PRO Automation*, an industry-leading automated blending system. This has the capability to blend granular fertilizers to the required grade and analysis with at least 99.5 percent accuracy. The system can control a wide range of functions such as liquid and powder coatings, product conditioners and bagging. Robert Saik explained how the Trimble precision agriculture app determines fertilizer recommendations based on soil test reports. The app can communicate with the latest *LAYCO-PRO Automation* software from Yargus to generate custom fertilizer blends for farmers.

Raw material choices have a fundamental influence on NPK plant design, argued **Cédric Habran** of SNC-Lavalin. Ensuring that the required raw materials are available during initial project planning is therefore important. Checking that a market exists for the final NPK product is also necessary at an early stage before the plant design become fixed.

Peter Albert of Geoalcali gave an update on the company's flagship Muga potash project in Northern Spain. The project is aiming to produce 540,000 tonnes per annum of muriate of potash (MOP) initially. Access to international markets is provided through the Port of Pasajes, San Sebastian, 150 km to the west. Production costs of $150/t (cost to port) are anticipated. The project is currently awaiting an environmental permit.

In what proved to be one of the symposium's most popular presentations, Stamicarbon's **Harold Van Der Zande** explained how the industry could undergo a timely shift from the "smart use of fertilizers" to the "use of smart fertilizers" instead. Stamicarbon, in a technology partnership with Pursell Agri-Tech, has developed a new design concept for a modular coating plant. This is capable of producing up to 200,000 tonnes of controlled-release fertilizers (CRFs) annually. The inaugural plant is due to open in Alabama in June. The latest CRF technology allows nutrients to be safely applied at a high dosage in a single application per season, with no need for side dressing. The aim is to target controlled-release urea (CRU) at broad acre cash crops such as wheat and corn. The innovative polymer coating developed by Pursell Agri-Tech releases nitrogen over a 3-4 months with hardly any nitrogen losses to the environment.

The symposium ended with a joint presentation on sulphur enhanced urea fertilizers by **Cyrille Allais** of Shell and **Harald Franzrahe** of thyssenkrupp Fertilizer Technology. Shell has developed a technology that incorporates micron-sized particles of elemental sulphur in urea. The resulting granular product, known as *Urea-ES*, has a high nutrient density with little or no leaching or run off. Granules breakdown fast in soil and plant-available sulphate is available within weeks due to the oxidation of elemental sulphur. *Urea-ES* combines some of the best attributes of long-standing sulphur fertilizer products, such as ammonium sulphate and sulphur-bentonite, with fewer drawbacks. thyssenkrupp have worked with Shell to develop fluid bed granulation technology for incorporating elemental sulphur into urea. *Urea-ES* production can be successfully integrated within an existing urea granulation plant using relatively simple and straightforward modifications.

IFA plans to hold next year's Global Technical Symposium in New Orleans, 8-11 April 2019.

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Next generation sulphuric acid catalyst technology

New catalysts from suppliers such as Topsoe and BASF offer distinct environmental and performance advantages. We look at how catalyst innovations are helping sulphuric acid manufacturers expand their production rates, and reduce emission levels to meet increasingly stringent legislative limits.

Sulphuric acid producers are searching for ways to improve their operational efficiency while reducing emissions levels, driven by the demands of downstream customers and environmental regulators. Upgrading to new catalysts can help sulphuric acid plant operators meet both these goals – as they offer improved production performance and the ability to meet exacting emissions standards. We report on recent catalyst innovations from market-leading suppliers Topsoe and BASF.

Topsoe's new *VK-711 LEAP5*™ catalyst offers a superior carrier system with improved intrinsic activity and optimal chemical composition. BASF's new shape *Quattro* catalyst, meanwhile, provides a step-change in catalyst activity with only limited increases in pressure drop.

New *VK-711 LEAP5*™ catalyst from Topsoe

Topsoe's new *VK-711 LEAP5*™, the second catalyst in the *LEAP5*™ series, builds on the knowledge and the industrial experienced gained from its immediate predecessor, *VK-701 LEAP5*™. The extra catalytic activity offered by new *LEAP5*™ technology can help sulphuric plant operators meet a number of objectives – challenges which would usually require a full-scale plant revamp. These include:

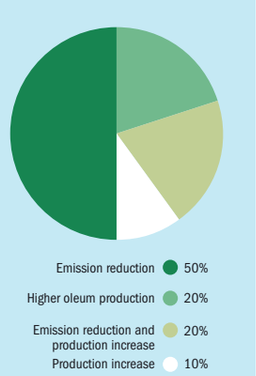
- Decreasing SO_2 emission
- Reducing scrubber chemical consumption
- Increasing acid production or gas treatment capacity
- Increasing oleum production;
- Reducing plant pressure drop through higher gas strength

Emissions reductions and production increases, separately or combined, have been the main motivations for adopting *LEAP5*™ to date (Figure 1).

The new *VK-711 LEAP5*™ offers a step change in activity compared to other Topsoe products, such as caesium-promoted VK59 (Figure 2). This is true at both lower and higher temperature.

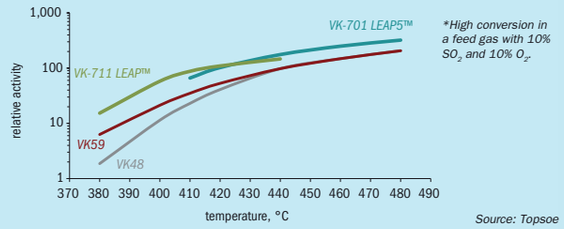
The extra activity offered by *LEAP5*™ series catalysts has enabled some acid plant operators to meet new emissions legislation, while other operators have used it to deliver higher production capacity, or a combination of the two. Where a plant also produces oleum – and economics favour oleum sales over sulphuric acid sales – *LEAP5*™ catalysts have boosted conversion before the oleum tower, and increased oleum production as a consequence of this.

Fig. 1: **Motivation for using *LEAP5*™**



Source: Topsoe

Fig. 2: **Activity of the new *VK-711 LEAP*™ catalyst in comparison with *VK48* and *VK59**



Source: Topsoe

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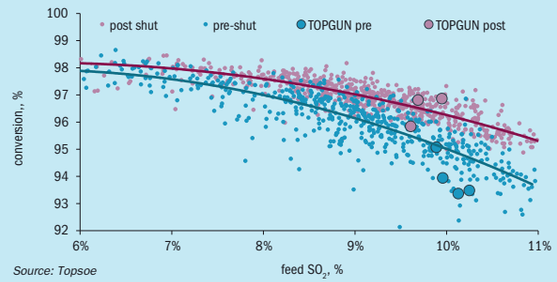
Fig. 3: **Conversion as a function of SO_2 strength, before and after installation of half a bed of *VK-711 LEAP5™***



Source: Topsoe

Case study: *LEAP5*™ for increased production

- SO_2 sources: S burning and Cu smelting
- Configuration: 3 bed single absorption
- Design production: 4,200 t/d
- Feed gas strength: 6-11% SO_2
- Average conversion: 96%
- Loading size of acid: 114 L/t (design), 150 L/t (average load)

Acid plant operators are already benefitting from the advantages of Topsoe's new *VK-711 LEAP5*™. One challenge faced by the operator of a three bed single absorption plant was the cost of delivering sulphur to the plant's remote site. It was also difficult to achieve high conversion, due to the three bed single absorption layout. This resulted in a significant part of the combusted sulphur being lost through the stack.

In this case study, it was decided to replace the top half of bed 3 with the new *VK-711 LEAP5*™ catalyst. The plant subsequently experienced an average improvement in conversion of just over one percentage point, after the installation *VK-711 LEAP5*™ in half of one bed (Figure 3).

The conversion improvements obtained will generally depend on feed gas strength. The higher activity of *VK-711 LEAP5*™ has a greater effect at higher SO_2 strength, with a degree of improvement as high as 1.5 percentage points. This conversion improvement corresponds to a production increase of around 11,000 t/a, with unchanged sulphur consumption. With sulphur saving of this magnitude, a payback time for the catalyst of less than two years is expected. As well as delivering sulphur cost savings, the conversion improvement also decreased the plant's environmental impact.

Case study: *LEAP5*™ for lower emissions

Another acid plant operator wanted to reduce SO_2 emissions from their single absorption plant. The potential conversion improvement convinced the operator to go with a catalyst solution, and replace the full last bed with *VK-711 LEAP5*™. The plant was re-started and performance pre- and post-*LEAP5*™ installation compared (Table 1).

The installation of *VK-711 LEAP5*™ was found to significantly improve conversion from 98.77 percent to 99.22 percent. This corresponds to a SO_2 emissions decrease of almost 50 percent, down to 573 ppm from 1,004 ppm. The very high conversion of *VK-711 LEAP5*™ was also obtained with an unchanged loading size of 257 L/t of acid, despite a 17°C temperature difference across the final bed.

Table 1: **Performance before and after *VK-711 LEAP5*™**

	Prior to LEAP5™	Post LEAP5™
Production rate, % of prior	100	104
Feed gas strength, % SO_2	9.25	8.8
Inlet temperature, °C	419	393-410
Conversion, %	98.77	99.22
Emission, ppm	1004	573

Source: Topsoe

BASF Quattro catalyst

BASF has been making sulphuric acid catalysts for more than 150 years. The company has been continuously developing new catalysts with superior performance since the first sulphuric acid plants began operating in the 1860s. Access to performance findings from BASF's own sulphuric acid plants also provides the company with a decisive advantage when it comes to developing new catalysts.

BASF introduced its new sulphuric acid catalyst *O4-115 Quattro* to the market in 2016. Due to its unique four-tube geometric shape (Figure 4), this caesium-based catalyst has a 30 percent higher catalytic surface in comparison to conventional star-ring shaped catalysts.

Consequently, sulphuric acid plants adopting this new catalyst can increase catalyst bed reactions by 30 percent, leading to higher production output while simultaneously lowering SO_2 emissions. The new catalyst is therefore especially attractive for sulphuric acid plants with limited catalyst volume – as performance can be improved despite this restriction. In addition, *BASF Quattro* shows improved physical and mechanic properties. Sieving losses, for example, can be reduced considerably because of its greater hardness.

The *Quattro* catalyst can be used meet a range of operational objectives at sulphuric acid plants:

- **Reducing emission levels:** higher active surface area results in better SO_2 conversion
- **Production debottlenecking:** higher active surface area allows for increased production rates at historical conversion levels (5-8 percent improvement typical)

Fig. 4: New shape of BASF sulphuric acid catalyst.

- **Improving performance:** for a limited bed height, a higher active surface area improves performance in the same amount of space
- **Reducing catalyst costs:** about 30 percent less catalyst is required for the same conversion rates

BASF Quattro: commercial trial

The first reference plant for *O4-115 Quattro* was the DOMO Caproleuna sulphuric acid plant in Leuna, Germany. The new catalyst was installed in August 2016. The plant manager was very satisfied with the performance, as the catalyst immediately showed an increase in SO_2 conversion and higher capacities simultaneously.

DOMO Caproleuna is a sulphur burning 3/2 double absorption unit with a design capacity of 50 t/d. The feed gas has an O_2/SO_2 ratio of 0.9.

The *O4-115Q* catalyst was installed in the fourth bed immediately downstream of the intermediate absorption tower. The activity of the new *O4-115Q* catalyst was firstly tested by increasing the SO_2 feed percentage while maintaining a constant O_2/SO_2 ratio. The O_2/SO_2 ratio was adjusted in a later trial to test the flexibility of the catalyst.

After the first three months of operation between August and October 2016, BASF compared the success of the *O4-115Q* catalysts (trial results) versus the standard *O4-115* star ring shape catalyst previously used by the plant (reference results). The results obtained (Tables 2 and 3) revealed two important findings:

- The plant saw no increase in pressure drop in the fourth bed of the reactor where the *Quattro* catalyst was installed
- The *Quattro* catalyst allowed for increased production rates, over a flexible range of temperatures and O_2/SO_2 ratios, with improved conversion

Table 2: **DOMO reference vs trial feed gas**

	SO_2 (%)	O_2 (%)	O_2/SO_2 ratio	Capacity (t/d)	Conversion (%)
Reference	12.1	11.1	0.91	869	99.81
Trial	12.6	11.3	0.90	883	99.86

Source: BASF

Table 3: **DOMO reference vs trial temperatures**

	Bed 1	Bed 2	Bed 3	Bed 4	Bed 5
T inlet reference, °C	426	432	432	415	417
T inlet trial, °C	425	440	437	423	422
Delta T reference, °C	193	94	33	28	10
Delta T trial, °C	197	92	35	30	10

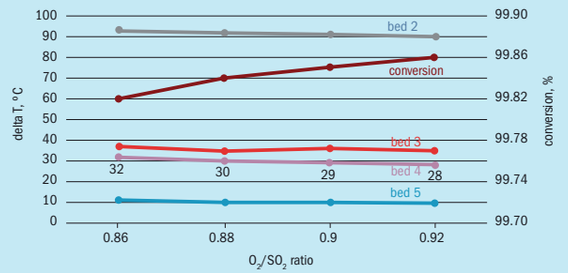
Source: BASF

Table 4: **Comparison of performance testing October 2016 vs May 2017**

	Conversion, %			
	Bed 3	Bed 4	Bed 5	Capacity (t/d)
October 2016	90.64	99.54	99.86	883
May 2017	89.69	99.52	99.86	883

Source: BASF

Fig. 5: **Converter performance adjusting O_2/SO_2 ratio**



Source: BASF

Inlet temperatures into beds 2 to 5 rose during the trial. Heat exchangers were not able to keep up with energy gains from the reaction, even though they were running at maximum capacity. With properly-sized heat exchangers for these operating conditions, BASF believes this plant could see a production capacity increase of 6-8 percent.

BASF re-tested the performance of the *Quattro* catalyst again when it returned to the site in May 2017. Due to its superior performance, the cumulative conversion of the *Quattro* catalyst in bed 4 was the same as it was in October 2016 (Table 4), maintaining overall conversion at 99.86 percent. This was despite a performance drop-off of almost one percent of the catalyst in beds 1 to 3. Based on these results, BASF is confident that the capacity of this plant could be increased further.

To provide clients with improved flexibility, BASF also wanted to understand how the *O4-115Q* catalyst performed over varying O_2/SO_2 ratios. Converter performance results at various O_2/SO_2 ratios for the DOMO case study are shown in Figure 5. These were obtained at a constant total gas flow rate of 70,000 Nm^3/h and constant bed inlet temperatures. ■

Acknowledgement

This article is partly based on the articles 'Meeting sulphuric acid catalyst challenges' (*Sulphur* 374, p47) and 'Acid catalysts upgrades' (*Sulphur* 371, p48) in our sister magazine *Sulphur*.

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SUPPORTING YIELD GROWTH AND QUALITY

Yield growth is required to support the demand for increasing global crop production. Overview of the Agricultural Outlook 2017-2026 by the Organisation for Economic Co-operation and Development (OECD) of Food and Agriculture Organisation (FAO) reports that the bulk of the additional cereal production over the outlook period is projected to be generated through crop yield improvements leading to a total increase by 2026 of 11% for wheat, 14% for maize, 10% for other coarse grains, and 13% for rice.

Growing healthy plants and sustaining crop yield and quality begins with nutrient-rich soil. With four of the six macro nutrients (potassium, sulphur, magnesium, and calcium), fertilizer plans that include POLY4 deliver a better outcome – farmers see increased crop yield, improved quality and also improved soil structure from this one simple product.

POLY4 is a naturally occurring, low chloride, multi-nutrient fertilizer certified for organic use. It is the trademark name for polyhalite products from the Sirius Minerals Plc's polyhalite project in North Yorkshire, UK.

Our global R&D programme, conducted in partnership with 105 leading agricultural universities, research institutions and commercial associates, operates across five continents. To date we have established 305 POLY4 crop trials on 33 crops in 19 countries.

Sirius Minerals' global research and development data shows that POLY4's nutrients become available over time, which more closely meets the nutrient uptake requirements of the plant. POLY4 is suitable for use and increases quality of both broad-acre and high-value crops.

Our product supports and improves early canopy and crop establishments. A soybean trial showed that plant population improved by 7% at emergence and by 4% at harvest. A barley trial showed that early crop establishment leads to better crop canopy cover and reduced weed population, including wild oats. Results have indicated that wild oat weed incidence can be reduced by 25%.

Using POLY4 as a source of nutrients helps to improve crop quality, is more efficient and effective for farmers whilst offering additional value with the potential for increased economic margins.

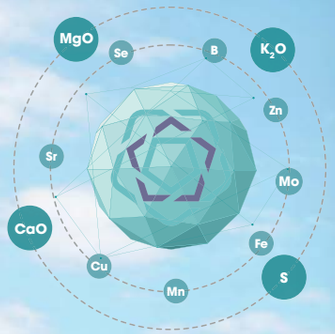
POLY4

A **SIRIUS MINERALS** PRODUCT

www.poly4.com

$K_2SO_4MgSO_4 2CaSO_4 2H_2O$

K_2O	S	MgO	CaO
14	19	6	17



EFFECTIVE, EFFICIENT, FLEXIBLE AND SUSTAINABLE

IMPROVING CROP QUALITY

BROAD-ACRE CROPS

SOYBEAN

- Protein source is vital for animal and human nutrition: soybean value can be improved by +7% from a POLY4 blend compared to an MOP blend.
- Higher plant emergence of potentially +8% could deliver savings in seed costs.
- Enhanced macro and micro nutrient uptake increased compared to a standard blend: 7% N, 10% P, 7% K, 11% Ca, 13% Mg, 11% S are achievable and is the key driver of plant health.

RICE

- Improved quality characteristics include 5% grain number per panicle.
- Reduced toxic elements: 26% reduction in aluminium uptake compared to MOP.
- 38% increase in K uptake.

CEREALS

- Grain nutrients: improvement in grain N in barley compared to MOP (grain N <1.8) to help deliver to premium malting markets.
- Lower N:S ratio indicating no S deficiency.
- 21% improvement in NDVI rating compared to MOP.
- 3% increase in tiller numbers compared to MOP+S.
- Improvement in wheat protein: important for premium grain suitable for bread making.

HIGH-VALUE CROPS

POTATO

- Specific gravity at 1.07 indicates dry matter content of 20%, which is important for frying quality.
- Tuber brightness score 6.5 indicating tuber health and surface disease resilience.

TOMATO

- Brix (sweetness) +1.6%.
- Higher levels of Ca concentration in fruit: important for fruit quality and shelf life.
- 1.3% firmness improvement leading to a longer shelf life.
- Titratable acidity indicates a reduction in sharp taste by 3.8%.
- Tomato bacterial spot: 38% reduction in severity, compared to MOP, 72 days after planting.

TEA

- Polyphenol/amino acid ratio (taste) 0.34.
- Water extractable solids (amino acids, flavour index) 440 g kg^{-1}.
- Leaf protein release amino acids and caffeine during processing (caffeine) 433 g kg^{-1}.

Sources: Sirius Minerals trials: University of São Paulo (2016) 4000-USP-4022-16; Warwick University (2016) 8000-WCC-8014-15; Nanjing Institute of Soil Science, Chinese Academy (20000-CAS-20010-14); University of Florida (2015) 1000-UOF-1021-15; Virginia Tech (2015) 23000-VIR-23011-15; Sichuan Academy of Agricultural Science (2015) 19000-SAAS-19011-14; Yunnan Agricultural University (2014) 21000-YAU-21010-14.

SIRIUS MINERALS PLC

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Profitable sulphuric acid production

Improving sulphuric acid plant profitability remains the Holy Grail for operators. **Jason Hartman** of DuPont Clean Technologies explains how *MAX3*™, a holistic solution for plant design and operation from *MECS*®, can optimise emissions, energy recovery and operating costs.

Sulphuric acid plant operators have consistently sought to minimise capital costs and maximise profitability. Prior to the 1980s, many plants operated without advanced heat recovery systems. Since then, improvements in plant technology and design have delivered improved operational efficiency – typically by including advanced waste heat recovery systems such as *MECS*® *HRS*™.

Cuttings costs and emissions

In the past, attempts to cut capital and operating expenditure – while simultaneously reducing emissions – have failed because technology at the time was unable to do both. Producers were instead forced to make choices that delivered tangible benefits in one area and unfortunate downsides in another, whether financial or environmental.

The twin goals of curbing production costs and emissions have been one of the driving forces for R&D at DuPont Clean Technologies for the past decade. These efforts have culminated in *MAX3*™ technology, a highly-efficient integration of a conventional single absorption sulphuric acid plant process with a Heat Recovery System (*HRS*™) and *MECS*® *SolvR*® regenerative SO_2 scrubbing technology. This newly-developed technology is built on a holistic understanding of plant design, equipment and operations – an approach that has yielded multiple benefits. Not only does *MECS*® *MAX3*™ eliminate equipment and reduce operating costs, it also maximises energy recovery and delivers best-in-class SO_2 emissions.

How does *MAX3*™ work?

In developing a plant design that achieves maximum profitability and emissions control, the focus needs to be on cutting operating costs, recovering more energy, and achieving best-in-class SO_2 emissions. To deliver this, DuPont Clean Technologies designed a fully-integrated single absorption *MAX3*™ flow scheme that combines a *HRS*™ plant with *MECS*® *SolvR*® technology (Figure 1).

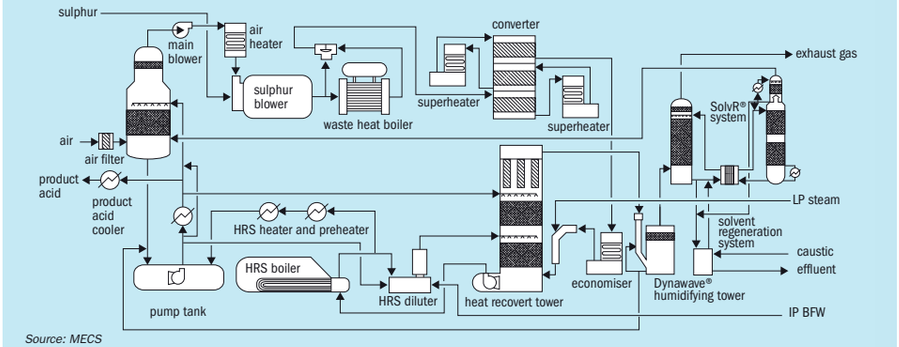
Operating and capital costs

The *MAX3*™ process offers substantial operating cost benefits when compared to a traditional double absorption sulphuric acid plant with *HRS*™. Overall energy recovery is slightly higher due to the choice of single absorption. The proportion of heat recovered as high-value, high-pressure steam is also up to 20 percent higher than in a conventional plant, while intermediate-pressure steam is reduced by 40 percent.

At the same time, utility costs for a *MAX3*™ plant are low compared to those of a double absorption *HRS*™ plant, yet it can meet the requirement for SO_2 emissions to be almost undetectable. A *MAX3*™ plant also delivers lower electricity and caustic consumption with equivalent or lower cooling water use.

The capital cost of a *MAX3*™ plant is roughly the same as for a conventional plant.

Fig. 1: ***MECS*® *MAX3*™ flow scheme**



Source: MECS

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The reduction in capital cost achieved by the elimination of double absorption equipment is offset by additional heat recovery equipment and the use of the *SolvR*® system.

Energy recovery with *MAX3*™

Incorporating a number of *MECS*® technologies enables *MAX3*™ to increase production of high-value, high-pressure steam while reducing cooling water consumption. The plant design achieves these results in a number of ways:

Energy recovery through *MECS*® *HRS*™: This technology recovers intermediate-pressure steam from sulphuric acid plants. This is then used to generate electricity or replace steam produced by a fuel-fired boiler. The traditional *MECS*® *HRS*™ system recovers low temperature energy as intermediate pressure steam of up to 10 barg (bar gauge pressure). Improved alloy materials allow high concentration (>99 wt%) strong acid to circulate in the *HRS*™ at elevated temperatures. This results in the production of up to half a ton of steam per ton of sulphuric acid. Including steam injection in the system boosts heat recovery further, by converting excess low-pressure steam into more intermediate-pressure steam.

Energy recovery via *SolvR*®: The efficient removal and recycling of SO_2 by *SolvR*® makes it possible to switch sulphuric acid plants from double to single absorption. This eliminates an acid tower and cuts equipment costs. It also increases high-pressure steam production and keeps the plant's capital costs at roughly the same level as a typical double absorption plant with *HRS*™. Optimisation and reconfiguration of the *HRS*™ and high-pressure steam systems delivers drastic improvements in high-pressure steam production. It achieves this while also reducing intermediate-pressure steam and maintaining cooling water use at or below that of a conventional *HRS*™ plant.

Single absorption energy recovery improvement: Switching to a single absorption plant also makes it possible to operate without a low temperature economiser, eliminating the need to reheat gas from an interpass absorption step.

Shifting energy from intermediate- to high-pressure steam: Reconfiguring the *HRS*™ to heat high-pressure boiler-feed water results in an energy shift from intermediate-pressure to high-pressure steam. Alongside this, higher deaerator operating pressure also improves both intermediate- and high-pressure steam production. The transfer of additional energy to high-pressure steam is achieved by using an air heater for combustion air in the sulphur furnace. This has the net effect of increasing high-pressure steam production, regardless of the heat source used.

Low temperature energy recovery with *SolvR*®: Integrating low-temperature energy recovery from the *SolvR*® overhead condenser reduces both cooling water and low-pressure steam use. The supply temperature of the treated water does, however, limit the amount of energy recovered.

Additional heat recovery options with *MAX3*™: *MAX3*™ offers two additional energy recovery options. One option involves meeting the low-pressure steam requirements of the *SolvR*® system (as low as 0.2 barg) by installing a back-pressure turbine drive using high-pressure steam. Alternatively, excess low-pressure steam generated by this turbine, or from other sources on-site, can be upgraded to intermediate-pressure steam through the addition of *SteamMax*™ to the *HRS*™. This raises the steam injection rate from approximately 40 percent to as much as 90 percent.

***MAX3*™ steam production:** Incorporating each of these energy enhancements with *MAX3*™ results in high-pressure steam production of up to 1.55 tons of steam per ton of sulphuric acid, at approximately 45 barg and 400°C. The resulting increase in high-pressure steam production cuts intermediate-pressure steam production from the *HRS*™ to 0.29 tons steam per ton of sulphuric acid, at approximately 10 barg saturated.

SO_2 emissions with *MAX3*™

In a *MAX3*™ plant, the use of the proprietary *SolvR*® solvent improves absorption and the selective removal of SO_2 from exhaust gases, making it possible to reduce SO_2 emissions to almost zero. The removed SO_2 is concentrated and subsequently returned to the upstream process or condensed as a standalone high-value product. Valuably, *SolvR*® is non-toxic, non-corrosive, very stable, robust and offers lower operating costs than competitor technologies.

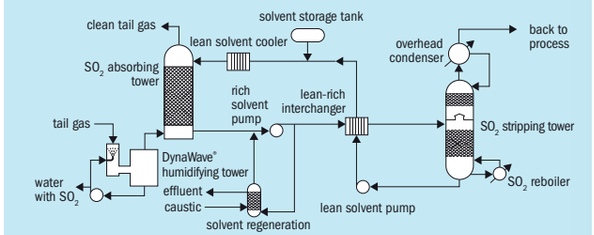
The solvent forms a stable complex at relatively low temperatures (25-40°C) and efficiently removes sulphur dioxide from exhaust gases. This is then released when the solvent is heated to around 100-110°C. *SolvR*® solvent also has a high absorption capacity. This enables a small flow of solvent to efficiently remove sulphur dioxide from the flue gas in the SO_2 absorbing tower.

SolvR® is capable of removing sulphur dioxide over a very wide range of concentrations in the inlet gas (300 ppmv to 50 vol%). Typically, the system will reduce emissions to below 20 ppmv. If lower emissions are required, stripping steam can be raised incrementally to reduce these to below 10 ppmv. Operating data for the first commercial unit has shown that *SolvR*® is capable of reducing emissions to about 1 ppmv with higher solvent flows to the SO_2 absorbing tower.

Conclusion

The key to boosting sulphuric acid plant profitability is to combine step-change improvements in energy recovery with substantial reductions in sulphur dioxide emissions and operating costs. Uniquely, the optimised design of a *MAX3*™ plant effectively addresses all three of these critical aspects. ■

Fig. 2: **SolvR® process**



Source: MECS

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phosphates & potash INSIGHT

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Phosphates 2018

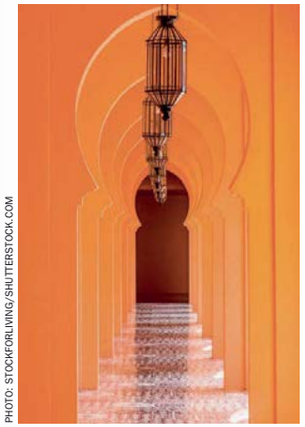

PHOTO: STOCKFORLIVING/SHUTTERSTOCK.COM

More than 530 delegates from 53 countries gathered at the Movenpick Hotel Mansour Eddahbi, Marrakech, Morocco, 12-14 March for CRU's Phosphates 2018 conference.

We report on the main plenary, trade dynamics and other selected presentations at CRU's 11th Phosphates International Conference and Exhibition held in Marrakech in March.

Market resilience

The strong resilience of the phosphates market was highlighted by OCP's **Hicham Benkirane** in the opening keynote plenary. The market has successfully adsorbed more than seven million tonnes of new fertilizer production capacity over the last three years, for example. The net increase in supply capacity (+2.7 million tonnes P_2O_5, ex China) between 2014/15 and 2016/17 was unable to match strong demand growth over this period (+3.8 million tonnes P_2O_5, ex China), with the shortfall being satisfied by additional Chinese exports. Despite the current down cycle, the nutrient value of diammonium phosphate (DAP) has also held up well in the last five years, remaining above 90 percent of its January 2013 value. An overview and update on OCP's investment programme was also provided

Prices diverge

CRU's **Chris Lawson** shone a spotlight on the current price divergence between phosphate rock and finished phosphate fertilizers. DAP prices, for example, are at their highest point in two years while rock prices have crashed – opening up what Lawson described as a "huge gap" between the two. The marked divergence between f.o.b. prices for Moroccan phosphate rock and Moroccan DAP – once ammonia and sulphur costs are stripped out – illustrates this. Last October's sulphur price spike and the "huge hike" in the 2018 Indian phosphoric acid price ($111/t rise for first quarter contracts) have both provided price support for finished phosphates. The phosphate rock market, in contrast, is oversupplied with new capacity outweighing demand. Energy price falls have also lowered rock production costs.

Overall, however, current market sentiment is much more positive than it was 12 months ago at the time of CRU's Phosphates 2017 event. Both supply- and demand-side shifts are now helping to "close the chasm" by correcting the market's supply/demand imbalance. Lawson said the market has seen "fantastic demand growth" in the last 12 months. NPS and NPK sales, in particular, had exceeded all expectations with "phenomenal" African growth. On the supply side, Mosaic's idling of Plant City had taken volumes out of the market. OCP will also focus on efficiency gains in the immediate future, rather than expansions, Lawson suggested, after its JPH-4 production unit is commissioned.

Looking ahead, the Indian market will hold the key to demand in 2018 with a 20 percent year-on-year rise in DAP imports expected. Brazil's 2018 outlook also looks strong, despite some downside risks. CRU's view on prices has firmed and become more optimistic in recent months. Gains are expected over the medium-term, especially beyond 2019, as the supply/demand balance tightens and the current wave of capacity additions in Morocco and Saudi Arabia taper-off. This could see DAP prices (Tampa f.o.b.) recover to above $425/t by 2022.

China, as always, holds the key – due to the scale of its phosphates industry, its unpredictable export behaviour and role as the market's marginal producer. Chinese DAP producers are moving up the cost curve and becoming less competitive. Whether these producers will maintain their current supply discipline remains an open question though – one that will be closely-watched.

Production investment

Yara Brazil's **Lieven Cooreman** explained how the $750 million Salitre project in the western part of Minas Gerais will help Brazil bridge the supply/demand gap for phosphate fertilizers. The joint venture between Yara and Galvani began construction in 2015. The project is currently on track to produce the first fertilizer product at Galvani's Paulinia production site in the second half of 2019. Some 150,000 tonnes of ore having already mined to date and the project's beneficiation plant was also successfully commissioned earlier this year. The project will eventually produce one million tonnes of granulated fertilizers annually, when it reaches full capacity in 2020/21, increasing Brazil's P_2O_5 production capacity by 20 percent.

He Yu outlined the future plans of Wengfu Group, China's second largest phosphate company. Diversification remains a priority.

The company currently generates revenues of $6.6 billion from four production sites. It mines and beneficiates 7.5 million tonnes of phosphate rock annually from reserves estimated at more than 600 million tonnes.

From this, Wengfu manufactures a range of downstream products including phosphoric acid (1.85 million tonnes P_2O_5), compound fertilizers (four million tonnes) and various chemical products (1.5 million tonnes). Notably, Wengfu is the world's largest producer of purified wet acid (PWA), with one million tonnes of production capacity split across three sites.

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Willelm Schipper on elemental phosphorus.

The company is also China's largest water-soluble fertilizer producer, selling over 150,000 tonnes last year. Wengfu was also the first Chinese producer to introduce trace elements such as sulphur, zinc, boron and copper into its finished phosphate products. It also has a strong presence in the food phosphates and feed phosphates markets.

Turkish production

Toros Agri's **Hakan Goral** gave a comprehensive overview of Turkey's fertilizer industry. The country's fertilizer consumption fell by nine percent year-on-year (y-o-y) in 2017 to 6.2 million tonnes, although urea consumption was up seven percent at 1.9 million tonnes.

Turkey produced 3.4 million tonnes of fertilizers in 2016 supplemented by a large import demand of 3.8 million tonnes – Turkey's exports generally running at less than 400,000 tonnes annually. Fertilizer imports in the first nine months of 2017 were up 18 percent y-o-y at 3.3 million tonnes. Ammonium nitrate imports almost ceased during this period – down 98 percent due to the introduction of Turkey's nitrates ban – but were more than offset by increases in ammonium sulphate (+122 percent) and urea (+39 percent) imports.

Technology trends

Investment in technology start-ups in the agriculture and food industry reached $10.1 billion in 2017, a 29 percent y-o-y rise, reported JBI Equity's **Kristian Bennetsen**. Technology trends to watch in the farming sector, suggested Bennetsen, include automation, precision farming, digitalisation, big data and the bio/circular economy.

Precision farming has made deep inroads in some countries, with GPS-controlled machines now farming 45 percent of Denmark's arable land, for example. Image recognition is a particularly important technology for measuring field variations in crop biomass and nitrogen uptake by crops. It can also be used in weed control and help cut herbicide use by more than 80 percent.

New farming methods such as vertical farming, hydroponics and recirculating aquaculture systems (RAS) also look set to transform the way food is grown in future.

Simple, low-cost, rapid and innovative methods for assessing African soils were described by Rothamsted Research's **Stephan Haefele**. These include portable spectroscopic methods such as X-ray fluorescence (XRF), mid-infrared (MIR) and near-infrared (NIR) tools. These have been used to analyse 38,000 soil samples across sub-Saharan Africa as part of the Africa Soil Information Service (AfSIS) project led by Rothamsted. Results have been used to produce valuable maps of cropland liming requirements and soil nutrient retention (cation exchange capacity).

> **Despite improving market fundamentals, phosphate producers still lag behind the wider rebound in the commodity market.**

Facing market realities

Ingo Hofmaier of Hannam & Partners provided some useful insights into how the phosphates sector is viewed by the capital markets. Hofmaier noted that finished phosphate prices have risen in tandem with ammonia and sulphur raw material prices over the last year, while phosphate rock prices remain at a relative low-point. Better phosphates demand globally has also spurred strong export performances from leading companies.

Yet, despite improving market fundamentals, phosphate producers still lag behind the wider rebound in the commodity market seen recently. The market capitalisation of large diversified mining companies, for example, has increased by more than 200 percent over the last two years, compared to an average increase of just 35 percent for the major phosphate-producing companies.

This apparent disconnect with the wider commodity market is further illustrated by the fact that net debt levels in the fertilizer industry have continued to rise – at a time when mining majors have rapidly shed debt and cut their borrowing. Hofmaier does, however, expect fertilizer companies to change priorities from production investment to refinancing. He ended by highlighting Africa's enormous growth potential, both as a fertilizer market and as a manufacturing centre for phosphate fertilizers.

New agricultural market realities are affecting farm spending on fertilizers, advised Rabobank's **Stefan van Merrienboer**. Relying on rising sales volumes and higher application rates are not the only way to drive business growth in his view. Instead, adding value as well as volume offers a constructive way forward for fertilizer players. Producers can grow and add value, suggested van Merrienboer, by focussing on fertilizer application techniques (foliar and fertigation) and/or by offering a wider range of innovative, speciality products. This approach, the selling of customised products in smaller volumes, should allow fertilizer producers to achieve higher gross margins, although it does require a higher level of customer support for farmers.

AFAP's Jason Scarpone talks as CRU's Chris Lawson listens in.

The African market

In Africa, medium-scale fertilizer wholesalers ('hub agro-dealers') have a vital role to play as a link between small, rural retails outlets and smallholder framers, on one hand, and large fertilizer manufacturers and importers, on the other, argued AFAP's **Jason Scarpone**. He explained how the African Fertilizer and Agribusiness Partnership (AFAP) is helping to set up these type of distribution hubs as a way of increasing private investment, and public-private partnerships, in fertilizer supply chains across Africa.

OCP's new subsidiary OCP Africa is aiming to sustainably transform the continent from largely subsistence agriculture to more commercial farming, according to OCP's **Imane Belrhiti**. This new enterprise has established a presence in 16 African countries to date, with further expansions into other countries planned. OCP Africa's joined-up and 'farmer centric' approach, explained Belrhiti, encompasses production, sales & marketing, logistics and agronomy.

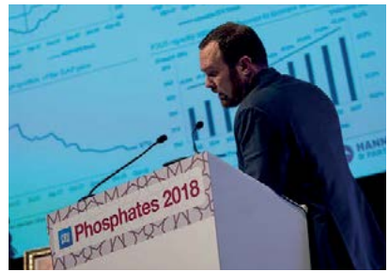
Market outlooks

Prayon's **Raphael De Rijcke** gave an overview of the world market for water-soluble phosphates. Popular product lines include water-soluble MAP and DAP, MKP, urea phosphate, phosphoric acid, polyphosphates, DKP and HKP. Water-soluble MAP is by far the bestselling product globally with a world market share of 72 percent currently, followed by MKP with a 16 percent share.

China is the main market for water-soluble MAP, being responsible for almost three-fifths of worldwide consumption. The European market, while next in importance, is only responsible for 10 percent of global water-soluble MAP demand. The world market for water-soluble MAP, and water-soluble products overall, is growing at a healthy 4-5 percent annually.

CRU's **Calvin Ball** looked at the current shift in the market away from ammoniated phosphates (DAP and MAP) to compound fertilizer (NP/NPK) production, and the reasons behind this. South Asia, Southeast Asia, the CIS countries and the Americas have all markedly increased NP/NPK capacity in recent years. China has also massively hiked its compound fertilizer capacity from 45 million tonnes to 113 million tonnes between 2000 and 2016.

The higher selling price of NPKs versus DAP – as much as $200/t on a P_2O_5 basis – is driving this trend, as producers search for higher margins. Compound fertilizer demand in Southeast Asia and Africa is forecast to grow particularly strongly over the next four years, reaching six million t/a in Africa by 2022. China and India, however, will remain the largest world markets for NPK and NP, respectively.



A capital markets lesson from Ingo Hofmaier.

CRU's **Alexander Derricott** cast an expert eye over the traded phosphate rock market. He noted that, after rapid expansion in China, phosphate rock capacity growth is now expected to come from North Africa and the Middle East.

Trade still plays an important role in the phosphate rock market, argued Derricott. Indeed, the merchant market excelled last year with trade in phosphate rock outstripping the growth in captive demand. Rock prices also fell in 2017 – partly due to better availability from OCP which exported over 11 million tonnes – boosting the competitiveness of non-integrated producers, especially in India. CRU expects the traded rock market to continue to grow modestly out to 2022.

CRU's **Seán Mulholland** presented a combined sulphur and ammonia market outlook, exploring what this would mean for the phosphates sector. The costs of both these raw materials are key determinants of the competitiveness of finished phosphates production, Mulholland pointed out. Price volatility is also a strong feature of both markets, as was seen in 2017. That makes a procurement strategy particularly important for phosphate sector consumers.

More than two million tonnes of merchant ammonia capacity is expected to come onto the market this year, although very few medium-term additions are expected after this. Russia and Indonesia combined are expected to account for 80 percent of global ammonia export growth over the next four years, while Morocco and India will account for 60 percent of import demand growth over the same period. Although merchant capacity additions will pressure prices this year, ammonia prices are still expected to gradually recover to $300/t by 2022.

The phosphate sector will drive sulphur demand over the medium-term in Mulholland's view. Sulphur supply growth is currently decelerating, he added, with the Middle East mainly accounting for any remaining capacity increases. After loosening this year, market tightening over the medium-term, particularly west of Suez, should see the sulphur supply/demand balance revert to a deficit by 2022. This tightness will lift sulphur prices beyond 2019, Mulholland concluded.

Consultant **Willem Schipper** gave his annual update on the market for elemental phosphorus (P_4, white phosphorus) and its derivatives. China, Japan, the US and the EU remain the largest consuming regions. The overall market for most applications is stable to slightly growing. Some larger end-uses such as glyphosate are becoming increasingly mature, with higher growth found in smaller segments of the market. Detergent additive sodium triphosphate (STPP) is now banned in 81 countries, although the remainder of the technical phosphates market is stable. Demand growth for food phosphates while modest in the US/EU (up to two percent per annum) is stronger in other world regions (2-5 percent annually). ■

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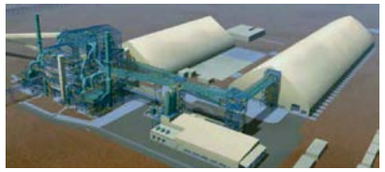
Mosaic changes trains at New Wales



The Mosaic Company recently converted a dual-train diammonium phosphate (DAP) plant at its New Wales site to the production of MicroEssentials and granular monoammonium phosphate (GMAP). This massive undertaking was Mosaic's largest phosphates project to date.

In 2016, The Mosaic Company and its engineering partner Hatch successfully completed the largest granulation plant expansion in the United States in 30 years. This $200 million capital project provides Mosaic with the additional production capacity it needs to meet fast-growing demand for *MicroEssentials*, its market-leading premium phosphate product.

In a first for the company, Mosaic assigned its own dedicated core team to the conversion project. The project was executed in partnership with Hatch and a team of general contractors, including:

- CCC Group
- The Roberts Company
- Electro Design Engineering
- Dale C Rossman
- Dome Corporation

The original diammonium phosphate (DAP) granulation plant at New Wales was constructed in 1981. Known as DAP2, the plant comprised of two 125 ton per hour (tph) granulation units and a 25,000 ton product warehouse. The aim of the New Wales conversion project was to convert this dual-train plant to *MicroEssentials* and granular monoammonium phosphate (GMAP) production. The project required a raft of major modifications, including:

- The installation of new closed-circuit scrubbing systems
- New ammonia vaporisers
- A new 65,000 ton product warehouse with an automatic reclaimer
- A new sulphur pit with molten sulphur transfer systems
- An unloading, storage and pneumatic conveying system for the micronutrients used in *MicroEssentials* production such as zinc

Hatch were involved throughout. The company's Tampa office provided full engineering, procurement and construction management (EPCM) services for the conversion project, from the pre-feasibility stage all the way through to pre-commissioning and commissioning services.

For pre-project planning, Hatch used a 'stage gate' front end loading (FEL) process. This cost effective, step-by-step approach allowed equipment, technology and layout options to be properly evaluated in a methodical manner at the pre-feasibility and feasibility stages, so avoiding later more expensive changes in the field.

As complicated as it gets

The project presented major logistical and safety challenges. Crucially, phosphate fertilizer manufacture at Mosaic's New Wales complex in Mulberry, Florida, had to continue with minimal disruption. The project was therefore carried out at a 'redfield' site – one where construction and production were taking place simultaneously.

Scheduling for the two-year (100+ weeks) construction phase was particularly critical – as the project required the shutdown and demolition of the east production train at DAP2 while the west train was still operating. Timing was crucial as the subsequent shutdown and demolition of the west train was only possible once the new east train was completed.

Effective communication and coordination between Mosaic, Hatch and the various contractors was also required to ensure the plant conversion was successfully and safely executed. This was a major challenge, given that construction was divided between seven major contractors,

The DAP2 Conversion Project in numbers

CONSTRUCTION	
Hatch construction management man-hours	53,000
Hatch commissioning man-hours	7,583
Field construction months	24
Contractor man-hours on site	1,257,863
Contract personnel on site	1,670
Construction contractors on site	82
Construction contracts	13
Fabrication contracts	4
Service contracts	3

MATERIAL QUANTITIES	
Tons of structural steel	1,913
Tons of handrails, grating	449
Tons of steel reinforcing bars	914
Tons of steel sheet piling	594
Concrete piles	883
Cubic yards of concrete	14,620
Lineal feet of pipe	34,000
Linear feet of electrical cable	152,445
Linear feet of control cable	151,975
Linear feet of cable tray	10,509
New instruments	841

SAFETY	
Lost time incidents	0
Medical aid incidents	1
First aid incidents	38
Near miss incidents	49
Property damage incidents	24
Total recordable incidents	1

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Clockwise from top left: Sulphur pit, warehouse roof, lifting reclaimer, installing the reclaimer.

working on a total of 13 construction contracts, and involved a total of more than 1,600 personnel. Approvals and permitting, at both state and county level, added to the project's complexity, especially as the construction site crossed the border between two separate Florida counties.

If converting two large-scale phosphate fertilizer production trains at a single manufacturing site under redfield conditions – using multiple contractors to a tight timetable – wasn't challenging enough, the nearby construction of Mosaic's new one million tonne capacity sulphur melter was another complicating factor that needed to be allowed for.

Process re-design

For Hatch, the replacement of existing plant scrubbers at the DAP2 plant with new closed-circuit systems was a major component of the overall process re-design. The new scrubbing systems – required as part of the switchover to *MicroEssentials* production – had multiple elements including new dust cyclones, ventilation systems, fans and scrubbers.

Hatch also developed detailed heat and material balances for the converted dual-train *MicroEssentials* production plant. Based on these balances – and Mosaic's product quality requirements – it was concluded that recycle rates at the converted plant would need to be increased to more than 500 tph as part of the project. This was a substantial upgrade requiring:

- Significant modifications to existing rotary process equipment
- Replacement of existing recycle system elevators
- Increased equipment capacity for drying, screening, crushing and material handling in both granulation plants

The conversion project also required a host of other significant equipment changes and modifications. These included:

- Removing the existing dust collection system baghouse and installing new dust cyclones on a new floor at the roof level of the existing buildings
- Replacing the existing common product conveyor system with separate product belt conveyors for the east and west plants – to allow different products to be manufactured simultaneously in each granulation plant
- A new 65,000 ton *MicroEssentials* product storage warehouse with an automated reclaimer

Staged approach

Hatch was awarded the **pre-feasibility study (FEL2)** in January 2013. Existing plant processes were evaluated, as were the heat and material balances for the conversion process. Various process options were considered and preliminary equipment specifications and equipment budget quotations were prepared. A cost estimate for the project (+/-30 percent) was also obtained.

The project proceeded to **feasibility study (FEL3)** in July 2013. The closed-circuit scrubbing systems and ammonia vaporisers were added to the project's work scope at this stage. A three-dimensional model of the plant was also developed from a laser scan of the existing granulation plant buildings. Virtually every piece of existing plant equipment needed modelling due to the complexity of the modifications required. Equipment specifications were also refined further, enabling Hatch to provide Mosaic with an improved capital cost estimate (+/-10 percent) in December 2013.

Project work edged closer to construction at the start of 2014. Hatch began detailed engineering between February and April 2014 and used bridging funds provided by Mosaic to procure critical 'long lead' equipment. Mosaic obtained final approvals for the execution of **detailed engineering and construction (FEL4)** shortly afterwards in May 2014. This allowed Hatch to mobilise and deploy its construction management team at the New Wales site in July. This date marked the formal start of construction work.

Clockwise from top left: warehouse finishing, installing scrubbers, new stacks.

Weather was a particular challenge for the construction team during the first few months of construction. Work was regularly interrupted by thunderstorms on an almost daily basis from July through to October 2014. Work stopped and personnel were required to go to safe shelters every time Mosaic's plant security sounded 'code blue' alarms. These were triggered each time a lightning strike was detected within a 20 mile radius of the New Wales site.

Project timeline

Construction proceeded month-by-month from the start of 2015 until mid-2016 in a carefully coordinated sequence, as the following monthly snapshots show:

- **January 2015:** Site preparation.
- **February 2015:** Sulphur pit construction.
- **March 2015:** Large columns and foundations for storage warehouse.
- **April 2015:** Large glue-laminated wood beams for warehouse arches arrive from Alabama.
- **May 2015:** Warehouse arches assembled by crane.
- **June 2015:** Zinc micronutrient systems, including storage siloes. East production train taken out service and dismantled.
- **July 2015:** Warehouse product reclaimer lifted into position by four cranes.
- **August 2015:** Close liaison between different contractors allows the reclaimer to be moved into the warehouse at the same time as the warehouse is being built out further.
- **September 2015:** Installation of warehouse membranes and finishing off the warehouse structure, just four months from the laying of foundations.
- **October 2015:** Scrubber vessels installed into position on east train. Extension of conveyor galleries.
- **November 2015:** West train taken out of service and dismantled. Further expansion of the conveyor galleries.
- **December 2015:** Conveyor gallery completed inside product warehouse. New stacks installed on each plant.
- **January 2016:** East granulation train completed and commissioned.
- **February 2016:** Around the clock working. Large concrete pours and structural expansions in new scrubber areas to house new equipment. Modular conveyor galleries assembled on the ground in sections to minimise work up in the air.
- **March 2016:** Work on the east finishes allowing east granulation train to be brought into production. Start of commissioning of the west train. The commissioning process for existing and new equipment took four months on each side.
- **April 2016:** Final pieces of equipment lifted into position on west plant. Finishing off duct work. Final commissioning of systems.
- **May 2016:** West train completed and commissioned.
- **June 2016:** West train started up followed by the end of construction operations.

Two months were particularly important markers of project progress. Firstly, the east granulation train was shut down in July 2015 to allow old equipment to be demolished and replaced by new higher capacity equipment. This also allowed the new floor level for the new cyclones to be installed, as well as other modifications for the *MicroEssentials* conversion. Secondly, in November 2015, the west granulation train was shut down so that the old common product belt conveyor used by both trains could be removed and replaced with separate product conveyors for each. Other common equipment shared by the two trains, such as electrical and instrumentation systems, were also demolished.

The west train was still running as a fully operational granulation plant for most of 2015, during the whole time that construction on the east train was going on. Construction and production work were sometimes separated by a distance of just 15 feet. As many as 500 construction workers were on site at peak periods.

A safe and successful conclusion

It is a testament to the shared safety culture of Hatch and Mosaic – as well as the project's safety plan and the training provided to more than 1,600 contractors – that the project logged more than 1.2 million worker-hours without a single lost time incident. This is an exemplary safety record given the large number of contractors and the potentially chaotic redfield site conditions. Indeed, remarkably, the only recordable injury occurred when a contractor stepped on a piece of wire that pierced the sole of his shoe.

Mosaic has every reason to be pleased with the outcome of the *MicroEssentials* conversion project. The new east granulation train exceeded its production design capacity just two weeks after its start-up in February 2016. The west granulation train, which entered production in June 2016, has also exceeded its design capacity subsequently. Hatch also managed to deliver the project some 10 percent under budget. ■

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Understanding and avoiding fertilizer whitening

The undesirable whitening of finished phosphates has been an issue for as long as these fertilizers have been manufactured, although inquiries about the problem appear to be on the rise. **Leon Willis**, global process consulting director at ArrMaz, explains the root causes of fertilizer whitening, and how it can best be prevented or mitigated.

In simple terms, whitening occurs when salts dissolve and recrystallize on the surface of fertilizer granules. The underlying salt deposition process is, however, fairly complex and not always easy to understand. In this article, the root causes of whitening are explained. A number of practical mitigation measures are also provided.

DAP fertilizer made in the same plant, at the same time, under the same conditions. Whitened sample (left): kept under roof but exposed to humidity. Non-whitened sample (right): kept in a climate-controlled office and not exposed to humidity.

Movement of water

To completely understand the causes of whitening, and to help avoid this phenomenon, the behaviour and movement of water within and on the surface of fertilizer granules needs to be properly understood.

One of the main mechanisms in whitening is the movement of dissolved salts, in the form of a saturated solution, from the inside of granules to their surface. Water holds the key to whitening as it is the medium which allows salts to dissolve, become mobile and eventually recrystallize, forming a surface efflorescence. The water responsible can be residual, originating at the production stage. Ammonium phosphate fertilizers also tend to absorb water from air during transport, storage and handling due to their hygroscopic nature.

In particular, two naturally occurring processes – deliquescence and efflorescence – are behind the deposition of crystalline salts on the surface of granules. As well as being more pure, these surface salt deposits often lose their colour-bearing constituents. As a consequence, they reflect much more light than unaffected fertilizer granules. It is this 'bleaching' effect which causes the surfaces of individual granules and whole storage piles to whiten.

Warehouse humidity

Fertilizer granules stored in warehouses in contact with air can be exposed to repeated rises and falls in relative humidity. During these cycles of changing humidity, one of two things happens: fertilizer granules either absorb moisture from the air, or their internal moisture migrates to the surface.

Granules absorb water vapour from air – adding to any internal water from the production process – when atmospheric moisture is above a certain level. This is known as the critical relative humidity (CRH).

The whitening of fertilizers during warehouse storage is generally a consequence of a sequence of steps:

- The dissolution of granules by internal or adsorbed water
- The mobilisation of the resulting dissolved salts
- Their final deposition by surface evaporation

This sequence ends with fertilizer salts being deposited and left to dry on the surface of the granules, as water evaporates, resulting in whitening. This process is not isolated to warehouses and can potentially occur at every stage of storage and handling between production and application to the crop.

Coating agents

The inevitable question is: how do coating agents affect whitening? ArrMaz coatings incorporate a proprietary formulated 'hydrophobic membrane' which is applied to the outside of fertilizer granules. This adheres to both the granule and any fugitive dust particles. To some extent, this membrane prevents the movement of water, both into and out of granules. However, the effectiveness of any coating agent will generally depend on how evenly it is applied and how completely the surface of the granule is covered. The following factors also contribute to how well coatings act to limit water movement:

- The moisture content of granules leaving the production plant
- Coating dosage rate
- Effectiveness of the coating application system
- Total surface area of the granules

Fertilizers with a higher median particle size (Size Guide Number) and narrower particle size distribution (Uniformity Index) will have less surface area per tonne than smaller, jagged granules.

Discussion

ArrMaz has received a number of inquiries about the whitening of phosphate fertilizers. These mainly concern diammonium phosphate (DAP) and monoammonium phosphate (MAP) produced by the customers of a number of coating agent suppliers. Whitening is an issue that has existed for as long as phosphate fertilizers have been manufactured – but is becoming more prevalent as raw material quality changes.

A decrease in the quality of phosphate rock reserves has been a general industry trend in recent times, at least in some regions. This has increased the levels of impurities in fertilizer-grade DAP produced by some manufacturers. This in turn has lowered critical relative humidity, presenting certain phosphates producers with storage and handling problems.

Conclusion

There is strong evidence that whitening is caused by fertilizers dissolving and recrystallizing due to surface moisture variation. To some extent, fertilizer whitening can be mitigated by:

- Keeping the amount of free moisture in ammonium phosphate fertilizers as low as possible
- Controlling the Size Guide Number and Uniformity Index to reduce surface area
- Maintaining a moisture-free environment in warehouses
- Using best operating procedures when reclaiming storage piles
- Minimising levels of impurities in phosphate rock feed to avoid increasing critical relative humidity, although this may not be economically achievable

ArrMaz coating agents can significantly reduce fertilizer whitening by interrupting the mechanisms described in this article. To help prevent whitening, tighter control of production processes and storage/handling conditions is likely to be necessary – both by manufacturers and those responsible for handling and distributing fertilizers to customers.

Further reading

This article is a summary of a recently-published ArrMaz technical paper on fertilizer whitening by Leon Willis, the company's global process consulting director. A download of the paper is available free online at: **arrmaz.com/fertilizer-whitening**

The complete technical paper includes:

- Practical examples of whitening
- An extended discussion section
- A comprehensive set of conclusions
- Useful and practical advice about whitening for production plant operators, warehouse managers and others ■

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Simon Inglethorpe and Mohamed Takhim.

Pierre Becker Memorial Award

Mohamed Takhim, the CEO of EcoPhos, received the 2018 Pierre Becker Memorial Award on 10 April. His career was celebrated during the presentation ceremony at the International Fertilizer Association's Global Technical Symposium in Madrid.

"In recognition of your outstanding contribution to the understanding, exploitation and application of phosphate resources, the directors and staff of *Fertilizer International* magazine honour **Mohamed Takhim**. Your long standing commitment to the practical application of innovative phosphate technology globally has justly earned you the lasting admiration of many colleagues and friends in the fertilizer world."

This is the citation on the 2018 Pierre Becker Memorial Award presented to Mohamed Takhim in Madrid in April by Simon Inglethorpe, the editor of *Fertilizer International* magazine. Mohamed is a highly deserving recipient of this valued, long-established award. During a meteoric career, he has worked with great energy and imagination to advance sustainability in the phosphates sector through inventive yet practical engineering.

The untimely death of Pierre Becker in 2001 was widely mourned by the international fertilizer industry. This was not simply because Pierre was a renowned world authority on the phosphoric acid process and phosphate fertilizer production technology. In addition to these unique talents he was also a person who inspired great affection, loyalty and friendship.

To perpetuate Pierre's memory, *Fertilizer International* launched the Pierre Becker Memorial Award in 2004 to celebrate originality and excellence in the phosphates sector. This year, the International Fertilizer Association (IFA) kindly hosted the presentation ceremony at their Global Technical Symposium on 10 April. This spring conference, held at the Madrid InterContinental Hotel, was the perfect backdrop to present the 2018 Pierre Becker Memorial Award to Mohamed in person.

Pierre Becker Memorial Award winners

2018	Mohamed Takhim, EcoPhos
2016	Paul Smith, P Smith & Associates
2014	Theodore 'Tip' Fowler, JDCPhosphate
2012	G Michael 'Mike' Lloyd Jr, FIPR
2010	John Sinden, JSA
2008	Robert De Coster, Prayon
2006	Heinz Huyer, Intertrade Group
2005	Dr Millkha Aulakh, Punjab Agricultural University
2004	Dr Norman S H Chien, IFDC

Luc Maene, the former director general of IFA and current president of the International Fertiliser Society, knew Pierre Becker personally, and was kind enough to make some opening remarks explaining the history of the award and why Pierre was so widely admired.

Congratulations to Mohamed Takhim

Simon Inglethorpe, editor of *Fertilizer International*, celebrated and paid tribute to Mohamed Takhim and his career in the following short speech at the presentation ceremony on 10 April:

"I'd like to thank the International Fertiliser Association for allowing us to present this award as part of its Global Technical Symposium here in Madrid.

The Pierre Becker Memorial Award itself dates back to 2004. Over the years, the award has been presented to nine individuals, including the 2018 recipient who we are announcing today.

The award is about celebrating originality and excellence in the field of phosphates. This year's award recognises a very talented, highly-respected and well-regarded entrepreneur and innovator, an individual who hopefully will be familiar to many of you – by reputation alone if not personally.

His career in the industry goes back to the mid-1990s. What is so striking and remarkable about this person is that he is doubly gifted. Not only an exceptional scientist – this individual is also a natural born businessman.

It is no exaggeration to say that this person's rise has been meteoric. He filed his very first patent in 1994, as a young researcher at the tender age of 18. Two years later, in 1996, while still a twenty year old student, he founded his fledgling start-up business, somehow managing to attract more than three million euros of venture capital – a remarkable achievement.

20 years later, this still-growing company now employs some 300 people and has an annual turnover of €133 million. Its business success is based on ground-breaking production technology that allows low-quality phosphate rock, and secondary phosphate resources, to be transformed into high-quality products. Investments to date of more than €45 million in ten international patents exemplify the unstinting commitment to innovation by this business.

The company currently operates three feed phosphates production plants in the Netherlands, France and Bulgaria. As part of ambitious growth plans, two new production plants – one for Evergow in Egypt and the other a joint venture with GNFC in India – are due to enter operation this year and next.

BCInsight wishes to celebrate the achievements of a unique entrepreneur and innovator. He is the remarkable founder of an equally remarkable company. Ladies and gentleman, with great pleasure, on behalf of *Fertilizer International* magazine, I announce that the 2018 Pierre Becker Memorial Award goes to Mohamed Takhim, the CEO of EcoPhos."

BCInsight would like to thank the International Fertilizer Association (IFA), particularly Volker Andresen and its director general Charlotte Hebebrand, for hosting and helping organise this year's awards ceremony. Luc Maene, president of the IFS, is also kindly thanked for his participation.

K+S: ambitious growth strategy

K+S Group recently unveiled *Shaping 2030*, an ambitious new long-term growth strategy, one designed to ensure the company's continuing success well into the next decade. The Group's CEO **Dr Burkhard Lohr** explains how *Shaping 2030* will deliver excellent growth prospects for K+S, building on its very strong existing business position.

How did Shaping 2030 come about?

We had reached an important milestone with the opening of the Bethune mine in Canada. It was the right time to develop a clear picture of how K+S is to be structured in 2030. To this end, we examined all growth options with a no-holds-barred mindset. Geared for the long-term, *Shaping 2030* offers maximum value creation potential paired with great robustness.

What will it mean financially?

We deliberately published our EBITDA [earnings] ambition, as that makes it clear that K+S has long-term value prospects – if we continue to persistently develop our business. As a first step, this means tapping into at least €150 million in synergies per year by the end of 2020, halving our leverage, and laying a solid foundation for future growth.

How will the new strategy change K+S?

The persistent focus on our customers and moving towards 'one K+S' marks an important change for K+S. This also represents a transformational change in culture – in the way we see our business and the way we work together.

How important is cultural change?

We need to learn new ways to cooperate, and to develop a real team spirit across departments, plants and countries. Making customers central and a constant focus requires us to become faster, more flexible and more agile. One of our fundamental principles is this: we believe in the success of K+S. That means that we start by recognising opportunities, not problems. We also need to be bolder and act entrepreneurially.

Are the goals set out in the strategy (see box) realistic?

The ambition is definitely challenging, but, yes, it's realistic. We want to be the most strongly customer-focused mineral product provider in 2030 – and achieve an EBITDA [earnings] of €3 billion – and we know precisely what we need to do to get there. We've calculated it all in detail. Around two-thirds of our earnings ambition will come from developing our existing business further and delivering synergies. It's also clear where those synergies are. The remaining one-third will be achieved by aggressively pursuing new growth options.

What are the options for new growth?

Well, we do have some very specific growth options in mind, even though we can't make all of them public just yet – after all, we don't want to tip-off our competitors! That being said, we have already named fertigation and the trading platform in Africa as examples.

THE *SHAPING 2030* STRATEGY: An ambitious plan for growth

The aim of the *Shaping 2030* strategy is to reposition K+S, transforming it from a manufacturing-driven company to a more market-focused, customer-driven business instead. The strategy will be delivered in two phases.

Transformation phase: 2018-2020. K+S plans to connect more with customers and better address their needs by realigning the business to reflect four key product markets – agriculture, industry, consumers and communities. Creating 'one company' through the integration of the current Potash and Magnesium Products business unit and Salt business unit is also expected to deliver considerable operational savings (synergies). Reducing indebtedness will be another priority.

Growth phase: 2020-2030. Beyond 2020, K+S aims to grow strongly and increase its earnings, while at the same time reducing its business exposure to external risks such as the weather and the market price of potassium chloride (MOP). To deliver these objectives, K+S will expand its specialty business and target the fertigation market. It will also step-up its business presence in high-growth regions such as Asia and Africa.

In summary, *Shaping 2030* has the following goals:

- Focus on customers in four key product market segments: agriculture, industry, consumers and communities
- Integrate current business units to create 'one company'
- Deliver at least €150 million in annual synergies by the end of 2020
- Generate positive free cash flow by 2019
- Half indebtedness (net debt/EBITDA) by the end of 2020, and regain an 'investment grade' rating by 2023
- Realise the growth potential of existing assets and grow in new business areas
- Target €3 billion in earnings (EBITDA) by 2030 as an overarching ambition for the company

Sustainability is also integral to the strategy.

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Fig. 1: Köppern roller press.

Advances in potash technology

We report on the latest developments in potash mining and processing technology from Andritz, Ebner, GHH Fahrzeuge, Köppern and Veolia.

Load haul dumper (LHD) innovation

Load haul dumpers (LHDs) are widely used in the haulage of potash ore in underground mines. Germany's **GHH Fahrzeuge** has been manufacturing LHDs for the mining industry since 1964. Its potash industry clients include K+S and Cleveland Potash.

The productivity of LHDs is controlled by two main factors. Machine specifications, such as driving performance, loading and dumping speed, are one major constraint. Machine availability – the period of productive use versus downtime – is also important. This second factor is linked to the frequency and duration of maintenance and repair stoppages – which in turn are heavily influenced by the reliability and lifetime of machine components, as well as damage caused by drivers. The number of machine failures caused by driver error can be significantly cut by reducing fatigue. This is usually achieved by taking steps to improve visibility and better ergonomic design.

GHH recently developed the Load Haul Dumper (LHD) LF-21H. This comes equipped with the company's Efficient Drive System (EDS), an innovative type of hydrostatic drive. With a payload of 21 tonnes, the LF-21H is also the largest, most powerful and efficient machine in its class. The EDS is specifically designed for highly testing underground mining conditions, and offers significant gains in both efficiency and productivity, compared to conventional hydrodynamic drive trains[1].

Fitted with an 'intelligent' monitoring system, the company also guarantees that EDS-equipped LHDs are simpler to operate and maintain.

Reduced fuel consumption, very low brake and tire wear, and the robust overall design of the LF-21H, help minimise operating costs. The 'eco-friendly' engine also complies with the latest standards – such as EU Stage IV and EPA Tier 4 final – so keeping underground ventilation requirements to a minimum.

Hydrostatic drives such as EDS are a type of continuously-variable traction drive. By enabling combustion engine speed to be decoupled from the driving speed, the machine's engine operates much more gently over a restricted speed range. This reduces engine acceleration and wear on drive train components. This improves component life and, as a consequence, increases machine availability and productivity[1].

Electric LHD machines also have operational challenges. In particular, the relocation of tethered/cable-powered electric LHDs can be a time consuming and resource-intensive business that reduces productivity. Typically, diesel generators need to be provided during relocation, as cables are often not long enough. Improvements in electric battery technology, however, can remedy this situation. The battery added by GHH to its latest tethered 19 tonne LHD design allows for independent relocation. This battery can also cope with load peaks during the haulage of mine materials. This reduces mine infrastructure requirements while increasing machine performance and productivity[1].

Potash compaction-granulation

Köppern, a family-run business founded in Hattingen, Germany, has been manufacturing briquetting, compaction and comminution machinery since 1898. The company has been supplying compaction and granulation equipment and plants to the fertilizer industry for more than 70 years. Its sales include several hundred roller presses (Figure 1) in over 60 countries.

Granular potash is produced almost exclusively by a compaction-granulation process. Fine-grained potash feed is generally compacted on roller presses to produce flakes with a density close to that (>95%) of natural potash. These flakes are then crushed and screened to produce a closely-sized (often 2-4 mm) granular product.

A typical compaction-granulation plant for MOP (muriate of potash) consist of three key components – roller presses (compactors), crushers and screens – configured in closed-circuit. The feed is firstly compacted at an elevated temperature. Köppern typically employs a large compactor (a roller press with a 1,150 mm diameter and 1,000 mm width) in plants with a gross potash capacity of 30-50 t/h. This press has a maximum throughput of approximately 140 t/h. After compaction, impact and roller mills, working in a closed-loop cycle with multi-deck screens, crush the flakes into granulate with an approximate density of 1.9-1.95 g/cm³.

Plant production capacity ultimately depends on the properties of the raw material and the desired product size, as well as on the types of crushing and screening machines employed. For most

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Veolia: Potash solution mine case study

Veolia Water Technologies successfully installed *HPD*® evaporation and crystallization technology at a greenfield mining project in Saskatchewan, Canada. This project produces two million t/a of potash (KCl) using solution mining. The ore is mainly sylvinite (NaCl and KCl) but contains small amounts of carnallite ($KCl.MgCl_2.6H_2O$) and other minor impurities ($CaCl_2$, $CaSO_4$, NaBr, etc.).

Process description with water and energy optimisation

The ore is dissolved by injecting hot water underground. The brine solution produced is treated to recover pure, economically valuable potassium chloride. Evaporation is used as an initial treatment step to remove sodium chloride.

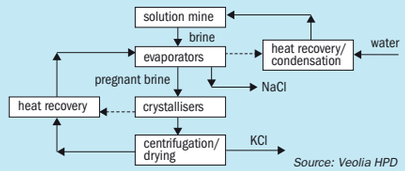
The use of an integrated thermo-compressor in the multiple effect evaporation system improves energy efficiency. NaCl removal takes place in a forced circulation crystallizer with an elutriation leg. The brine from the solution mine is saturated in calcium sulphate. This needs to be managed throughout the evaporator system to prevent scaling in the evaporator heaters.

The mother liquor obtained from the NaCl evaporator system is a hot solution nearly saturated in potassium chloride. KCl is crystallized from this pregnant liquor in a multiple-stage, adiabatic cooled crystallizer system comprised of DTB crystallizers. Each stage operates at a progressively lower pressure/temperature and KCl precipitates as the liquor cools. Product purity and crystal size is controlled by adding water and adjusting process flows.

Solution mining initially requires large volumes of water to dissolve the ore and additional water is also required throughout the evaporation and crystallization process. However, evaporated water is recovered and reused to minimise the amount of make-up water consumed during the solution mining process.

Veolia's KCl crystalliser being transported to the project site.

Diagram of the solution mining process to produce KCl



Source: Veolia HPD

Complex supply logistics

Due to the size of the project, it was necessary to source equipment from multiple locations. Some vessels were pre-fabricated in China and shipped to Houston then trucked to Saskatchewan. The vessels transported were over 12 metres high, in excess of 50 metres long and weighed about 330 tonnes. It was desirable to minimise the amount of site construction work and do as much of the vessel fabrication in shops as possible. Equipment supply logistics were therefore complex and required careful coordination. ■

types of potash, the plant yield is between 30-45%[2].

Finishing is not required if the granulate obtained already has good abrasion resistance properties. However, significant quality improvements can be achieved by conditioning, especially when extremely high quality granulate is required for long distance overseas transport. Conditioning typically involves a multi-step process to modify physical and/or chemical properties. Process steps can include mechanical, hydrothermal and chemical conditioning and coating[2].

Köppern has analysed every single part of the potash granulation-compaction process. Results have helped to optimise new compaction-granulation plants that the company designs and delivers to its customers. They have also been used to improve the yield and/or quality of granular potash output at existing plants. The results of Köppern's optimisation findings can by summarised as follows[2]:

- **Compaction.** State-of-the-art compactors produce high-quality flakes, with more than 95 percent of the natural density of potash, at capacities of up to 140 tonnes per hour.
- **Crushing.** Various crusher types and flow sheets have been tested and optimized to maximize the granular yield up to 45 percent.
- **Conditioning.** Conditioning steps can significantly increase granular quality and match market requirements.

Since the 1990s, the preferred flake capacity of potash compactors has increased to 110-130 t/h. The majority of new compactor investments made by potash producers in recent years have been in designs of at least 100 t/h flake.

Köppern has introduced a number of innovations and design changes to ensure compactors of this size are safe, reliable to operate and deliver excellent flake quality. This has involved the modification of various sub-assemblies, including the frame, feeder, roll design, roll drive and the hydraulic systems.

Vibrations are a particular operational problem when deaerating and compacting potash – as they can result in severe juddering that damages equipment. The risk of this can be reduced by lowering roll speed and/or feed rate. However, changing the compactor drive design to increase mechanical stiffness is a preferable way of solving this problem at source. This approach also maintains throughput, and is therefore less of a compromise for customers.

For many years, Köppern has stiffened the drive train of large roller presses by manufacturing these with planetary gear reducers mounted directly onto the roll shafts. The company delivered its first large potash compactor (130 t/h) with this drive technology to Germany in 1998. Since then, compactors with this drive design have been widely-adopted worldwide. For example, Köppern's fertilizer compaction customers in Brazil, Canada, China, Croatia. Hungary, Jordan, Italy, Russia, Serbia and Spain have either modified or ordered new roller presses fitted with this type of main drive.

All large potash compactors supplied by Köppern since the early 1990s have also been supplied with a hinged frame. This allows quick access to rollers for assembly or maintenance. Rollers can be picked up easily without dismantling any part of the frame or feeder.

The feeder is an important component of the compactor. It needs to transport large volumes of material, deaerate this effectively and distribute it evenly over the entire working width of the roller. The ability to independently adjust screw speeds also prevents misalignment by controlling the gap between rollers. Meeting these requirements prompted Köppern to develop a special double-screw feeder design. This design was first introduced into the potash industry in the mid-1990s in roller press upgrades in Germany and Belarus. The newly developed double-screw feeder was subsequently supplied to K+S in Germany and a client in Chile.

It is also economically advantageous to provide the roller body with exchangeable tyres, as this allows refurbishment of the tyre profile after wear.

Most of the above improvements and new design features, developed by Köppern over the years, can be found in many compactors used today by the potash industry globally.

Reducing energy demand

Germany's **Ebner** has wide-ranging expertise and experience in the design and manufacture of evaporators and crystallizers for the potash industry. In 2016, the company won a contract from the largest potash producer in Belarus to plan, deliver and install a multi-stage vacuum cooling crystallization plant. In 2013, Ebner was also awarded the contract to plan and deliver two large-scale evaporation-crystallization plants for a well-known global potash and salt producer headquartered in Germany.

Ebner also advises on potash plant energy savings. Energy consumed during potash manufacturing contributes to costs and affects competitiveness. There is particular scope for saving energy during evaporation and crystallization, often the most energy-intensive stages of potash processing[3].

Three types of evaporation and crystallisation plants are typically used in potash processing:

- Two-stage evaporation
- Three-stage evaporation
- Cooling crystallization

Upgrades and conversions at evaporation and crystallization plants – by reducing steam consumption – can potentially deliver large energy savings (Table 1). Increasing the number of evaporation stages, for example, can deliver a 25-35 percent reduction in steam consumption. The option of converting a multi-stage evaporation plant to a mechanical vapour recompression (MVR) plant offers even higher potential steam consumption savings[3].

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Table 1: **Potential energy savings from upgrades and conversions at evaporation and cooling crystallization plants**

Evaporation	
Action	**Potential steam consumption saving**
Upgrade a two-stage plant to a three-stage plant	35%
Upgrade a three-stage plant to a four-stage plant	25%
Upgrade the pre-heating section	Up to 10%
Upstream connection of a MVR-plant*	Depends on application
Conversion of a multi-stage plant to a MVR-plant*, or operation of a new MVR-plant instead of multi-stage plant	Up to 100%**
Cooling crystallisation	
Action	**Potential steam consumption saving**
Increase in the number of crystallization stages with heat recovery	Up to 15%
Enlarging heat transfer surfaces of surface condensers in stages with heat recovery	Up to 20%
Design first stage with direct condensation on recirculated mother liquor	Up to 10%

**Mechanical vapour recompression. The vapour steam evaporated in the evaporator is mechanically compressed and used to heat the stage itself.*
***40-55 kWh of electrical energy is, however, required per tonne of water evaporation* Source: Ebner

Andritz: Dewatering at Belaruskali

During potash processing, the overall aim of dewatering is simple: to profitably produce volumes at large-scale with easy handling and minimal maintenance. For plants equipped with thickeners and flow-operated vacuum filters, dewatering is a continuous process with little room for improvement and scope to boost margins.

The challenge

Belaruskali, one of the world's largest potash producers, approached Andritz with the ambitious goal of replacing their rotational vacuum filters with more innovative and productive technology. There were three particular objectives for this process redesign: increasing capacity; reducing energy and investment costs; and minimising the moisture content of filter cakes.

This called for the reconsideration of every process step, while ensuring production standards and ease of maintenance were both maintained.

The solution

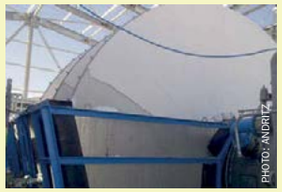
Andritz proposed a new, more efficient approach to dewatering – one that separated the brine slurry into a fine and course fraction. This made it possible to handle the two size fractions separately, using the most efficient equipment for each.

For the coarse fraction, a pusher centrifuge with gentler acceleration was

Andritz pusher centrifuge.

installed to minimise the breakage of solids during dewatering (above). As well as delivering higher yields and filtration rates, this improved capacity by 25 percent for the same moisture content. The presence of fewer coarse particles, by reducing wear and downtime, also cut maintenance costs.

To dewater the fine fraction, a high-capacity vacuum disc filter (below) was installed with a dry solids handling capacity of up to 200 t/h. This immediately cut operating costs by 15 percent. The individual piping system added to each filter cell also raised capacity further, while reducing final moisture content.



Andritz vacuum disc filter.

The outcome

Thanks to its collaboration with Andritz, Belaruskali was able to improve site output and performance, beyond the original design expectations. The dewatering modifications at the site have delivered 10 percent higher capacity, 15 percent lower energy costs, and a 30 percent reduction in residual moisture. The total on-site equipment footprint is also one-third smaller than before. This has provided extra space for a direct-feed dewatering system, as well as improving maintenance access.

The major operational benefits of the pusher centrifuge were:

- 15 percent higher yield
- Minimal solid breakage
- 25 percent higher filtration rate
- 15 percent lower total cost of ownership

Similarly, the vacuum disc filter delivered equally impressive operational benefits for Belaruskali:

- Increased capacity
- 60 percent reduced footprint
- 20 percent lower capex
- 16-17 percent lower total cost of ownership ■

For cooling crystallization stages, adding heat recovery and improving heat transfer could potentially reduce steam consumption by up to 20 percent. Whether the above actions are economically worthwhile, however, depends on the how quickly the investment cost can be repaid through the operational energy savings achieved[3].

Process optimisation can also save energy during industrial evaporation and crystallisation[3]. Examples of energy saving measures include:

- Efficient control of water pumps with frequency converters
- Prevention of unnecessary water inflow into plants by using flow sensors/meters at all entry points

Solid/liquid separation

Andritz is a market-leading supplier of liquid/solid separation equipment to the potash industry, with over 85 years of experience under its belt. The company's conical screen bowl decanters, large-diameter disc filters and proprietary fluidized bed systems have been adopted by many major, large-scale potash producers globally.

Indeed, Andritz is the brand behind some of the best-known suppliers in the potash industry – including Bird and KHD Humboldt Wedag AG to Krauss Maffei centrifuges and filters. The company's fluidized beds were also previously sold under the renowned Escher Wyss trade name. Andritz has a total of around 600 potash references around the world, including:

- 425 centrifuges,
- 100 fluidized bed systems
- Dozens of filters, plate dryers and thickeners

Impressively, these have been installed on five continents in every major potash-producing market. Andritz continues to invest in innovative potash separation and drying technology. Recent sales include a series of eight large-diameter disc filters to Belarus, Russia, and South America. The company's innovative conical screen bowl decanters are also now in operation in North America.

Andritz recently installed a high-capacity, energy-saving dewatering system for Belaruskali's Plant No 1 (see box). "As a global leader in potash production, we had incredibly tough requirements for reducing costs and boosting capacity and quality. That Andritz could do all this in a third less space was frankly astonishing," commented Alexander Gorbatchev, the plant's manager. ■

References

1. Strassburger, F. & Thomas Deimel, T., 2017. Productivity Increase of Diesel-Driven and Electric Large Load-Haul-Dumpers (LHDs) Through Innovative Drive Technology. *Ercosplan International Symposium, The Potash Industry in the 21st Century*, Erfurt, Germany 8-10 June 2017.
2. Horbert, F., 2017. Optimization of Compaction-Granulation Plants for Potassium Salts. *Ercosplan International Symposium, The Potash Industry in the 21st Century*, Erfurt, Germany 8-10 June 2017.
3. Ebner, S., 2017. Industrial Evaporation and Crystallization. *Ercosplan International Symposium, The Potash Industry in the 21st Century*, Erfurt, Germany 8-10 June 2017

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