

# Fertilizer INTERNATIONAL

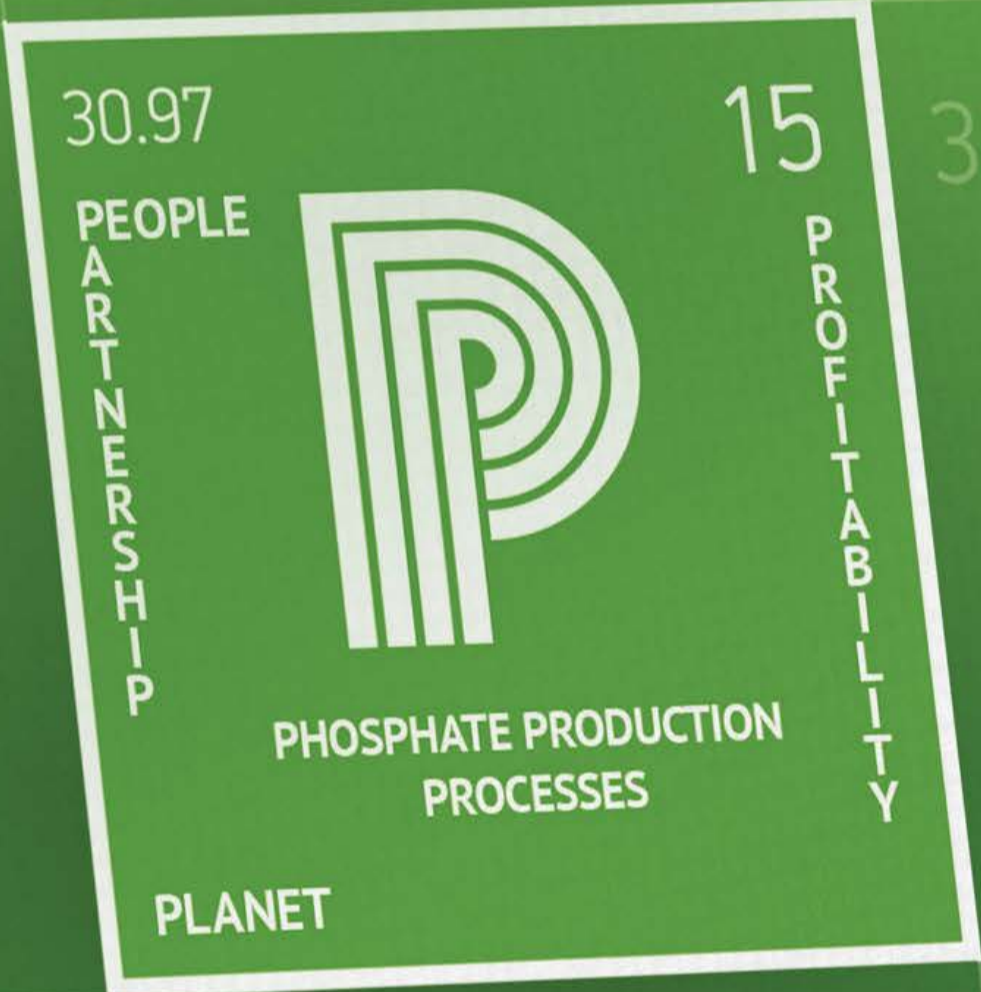
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**The future of Europe's fertilizer industry**  
**Micronutrient market moves**  
**NPK production options**  
**Potash mining and processing technology**

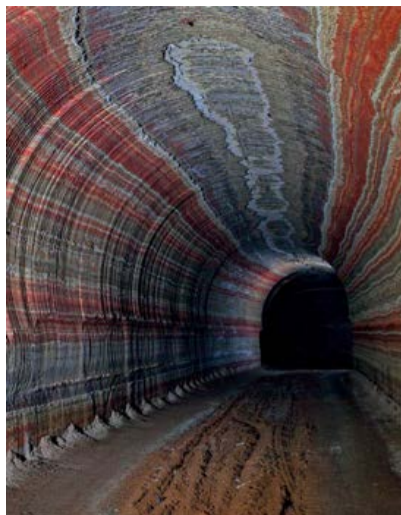
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Cover: The striking multicoloured banding of potash ore revealed by a mine tunnel.

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## Europe's fertilizer industry



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## Potash technology

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**BCInsight**

# Fertilizer INTERNATIONAL

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# Earnings and affordability

2022 was another very good year for Nutrien, the world's largest crop nutrient company. The Canadian-headquartered fertilizer giant produces around 27 million tonnes of potash, nitrogen and phosphate products annually from operations and investments in 14 countries, distributing these to agricultural, industrial and feed customers across the globe. Its agriculture retail business, Nutrien Ag Solutions, also serves more than 500,000 farmers worldwide.

Nutrien's revenues grew by 37 percent year-on-year in 2022 to \$37.9 billion. Earnings growth for the year was even more impressive; it rocketed by 71 percent to \$12.2 billion (adjusted EBITDA). Free cash flow – a measure of profitability – for 2022 more than doubled on the preceding year to \$8.1 billion.

Does all of that sound familiar? Well, yes... in fact there's an uncanny sense of déjà vu here. Especially if we roll back 12 months and see what we wrote then about Nutrien's 2021 results (*Fertilizer International* 508, p13):

"Nutrien's revenues grew by one-third year-on-year in 2021 to \$27.7 billion. Earnings growth for the year was even more impressive; it rocketed by 94 percent to \$7.1 billion (adjusted EBITDA). Free cash flow – a measure of profitability – for 2021 more than doubled on the preceding year to \$3.9 billion."

Indeed, placing these 2021 and 2022 financials side by side, the initial impression is of an identical script with only slightly different numbers.

What makes the results of the last two years even more remarkable is that Nutrien's 2021 financial performance was itself unprecedented and record breaking, with annual earnings up by more than 90 percent on 2020 (*Fertilizer International* 502, p13).

To place this in context, Nutrien's consecutive sequence of annual earnings (adjusted EBITDA), 2020-2022, has been \$3.7 billion, \$7.1 billion and \$12.2 billion – more than tripling in just three years.

Commenting on the company's 2022 performance, Ken Seitz, Nutrien's president and CEO, said: "Geopolitical events caused an unprecedented level of supply disruption and market volatility across agriculture, energy and fertilizer markets in 2022. Nutrien delivered record net earnings and cash flow in this environment due to the advantages of our world-class production, distribution and retail network. We returned \$5.6 billion to shareholders, invested in our global retail network and advanced a number of long-term strategic initiatives that position our company for future growth and sustainability."

These comments are straightforward and entirely factual. Yet possessing a world-class production, distribution and retail network also benefited Nutrien in one other rather obvious way – it placed the company in a highly advantageous position to capitalise on that key characteristic of post-Covid fertilizer markets: higher net realised selling prices.

To Nutrien's credit, the company is clear about this. Higher realised prices are specifically cited as factors in the record 2022 performance of its potash and nitrogen businesses. Higher selling prices also improved margins at its Nutrien Ag Solutions retail arm.

Higher fertilizer prices – and their underpinning of record earnings – have also shaped that other less welcome characteristic of post-Covid fertilizer markets: affordability. This has become ever more important in defining fertilizer consumption in recent times, with the International Fertilizer Association expecting affordability to drive global fertilizer use between 2021 and 2023 (*Fertilizer International* 512, p13).

Clearly, affordability has been – and currently remains – a key factor affecting buying decisions by farmers and, overall, a determinant of global market demand.

Nutrien's CEO Ken Seitz is right to identify geopolitical events for causing an unprecedented level of supply disruption and market volatility. Russia's invasion of Ukraine at the end of February last year, in particular, continues to cast a long shadow across energy, agricultural and fertilizer markets.

It is also facile and a misdiagnosis to make a causal connection between the earnings of fertilizer producers and high prices and poor affordability when, arguably, they are bystanders to global events like all of us. The part closure of Europe's fertilizer industry this winter is testament to that (p13).

But it is often perceptions rather than reality which shape public opinion. And, if energy companies are angrily castigated by European consumers for making excess profits during a cost-of-living crisis, it might be wise to guard against similar public attitudes shaping perceptions of our industry. ■

[Note: we will be taking a deep dive into the fertilizer industry's 2022 financial performance and full-year results in our forthcoming May/June issue.]

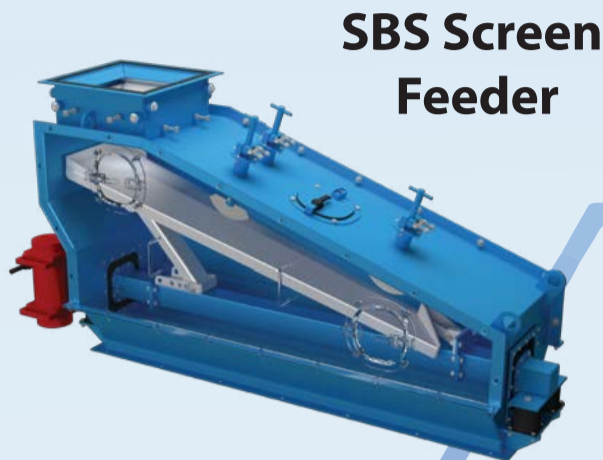
*S. Inglethorpe*  
Simon Inglethorpe, Editor

“Higher fertilizer prices – and their underpinning of record earnings – have also shaped that less welcome characteristic of post-Covid fertilizer markets: affordability.”

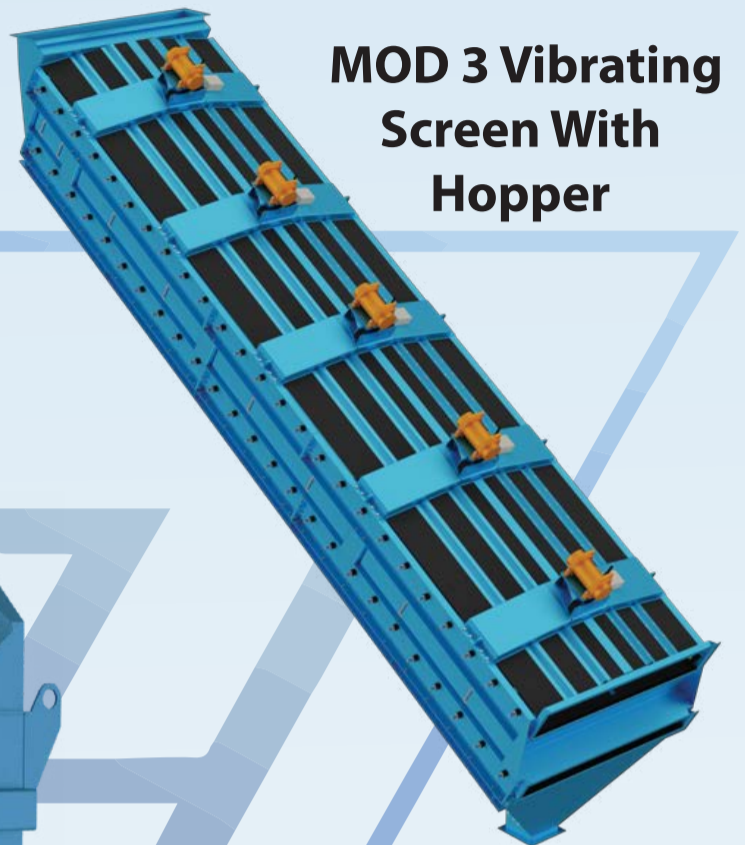


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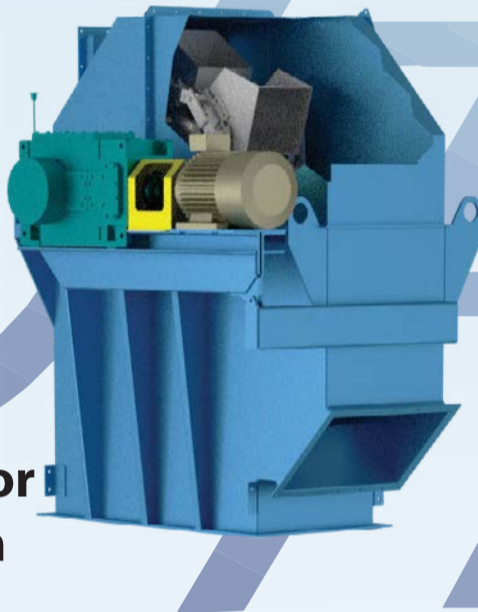
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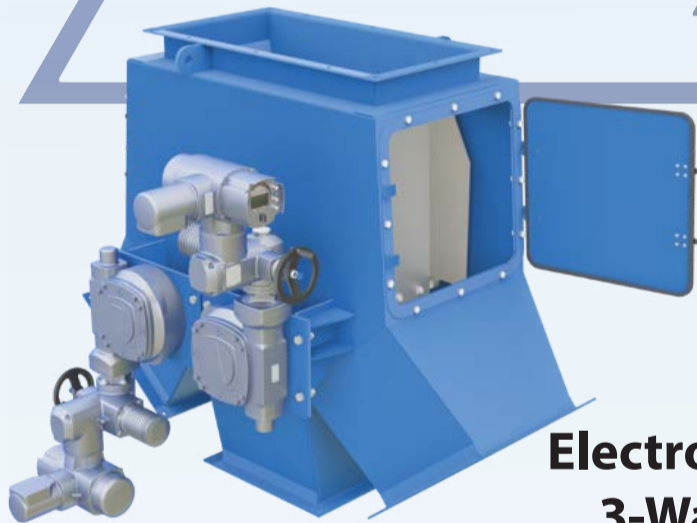
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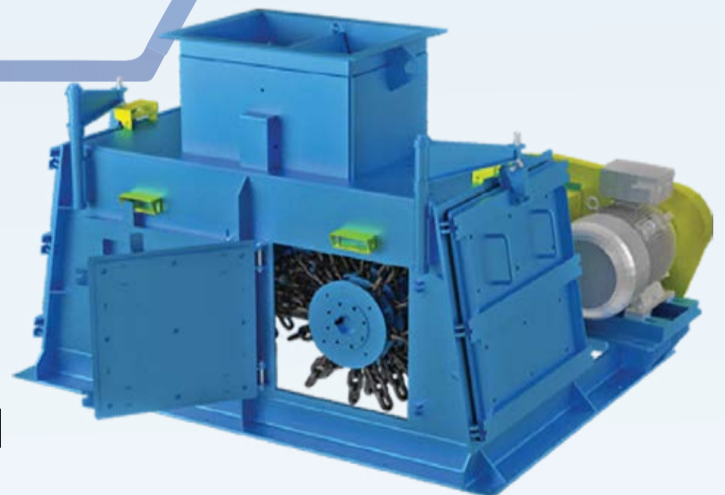
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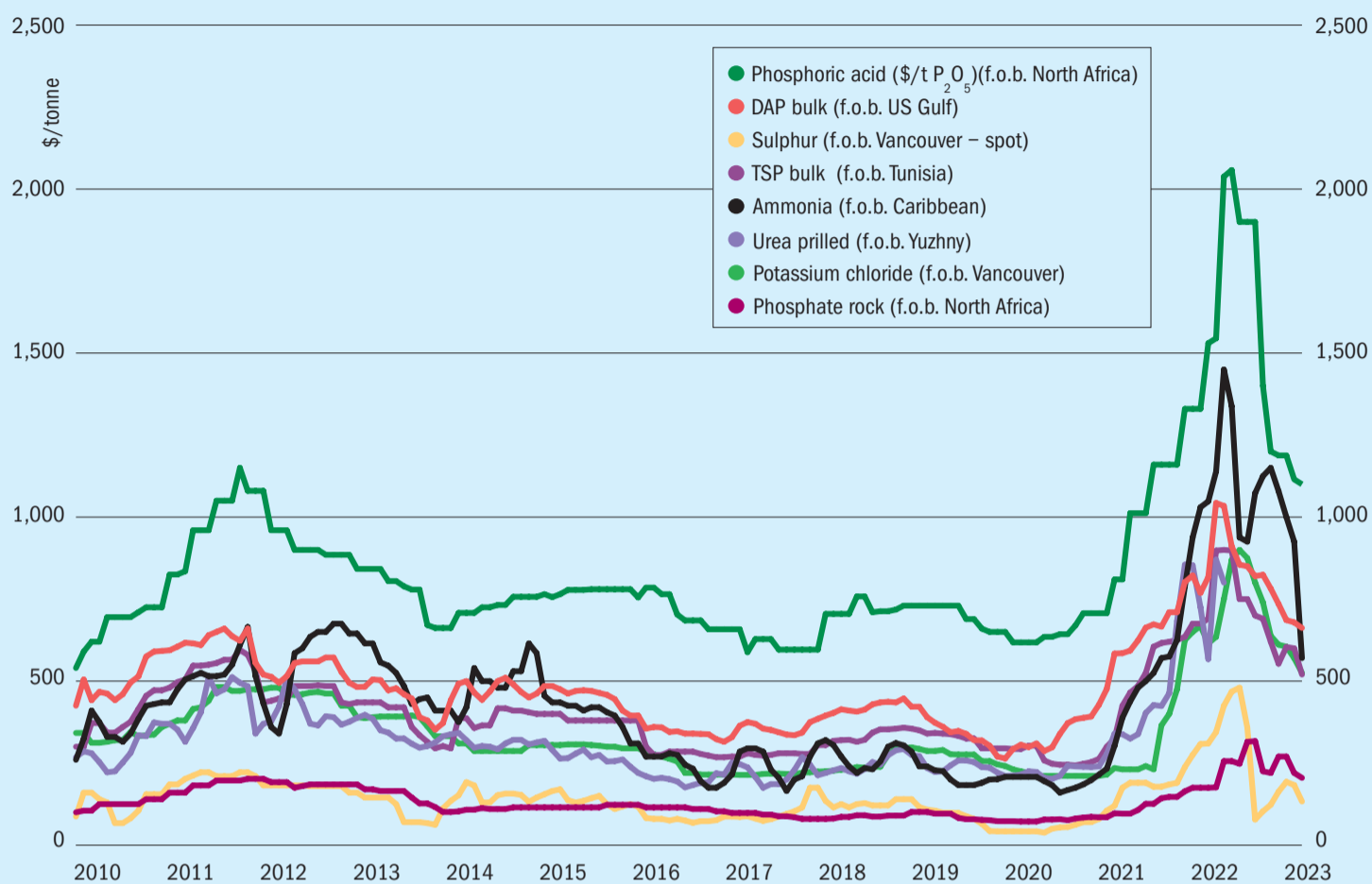


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# Market Insight

Historical price trends \$/tonne



Source: BCInsight

## Market Insight courtesy of Argus Media

### PRICE TRENDS

**Urea:** Prices fell in most global markets in early March as suppliers chased limited demand. Although India's purchase tender has yet to formally conclude, IPL looks set to book 1.15 million tonnes of urea at \$330-334.8/t cfr, with traders mainly sourcing from Russian and Middle Eastern producers.

Prices in both the US and Brazil fell to around \$320-325/t cfr following the India tender. European prices, meanwhile, stabilised on steady retail demand for spring applications, helping support Egypt and Black Sea prices at \$390-403/t f.o.b. These relatively high European price levels pulled supply from outside the region, particularly from the Middle East and Nigeria.

Key market drivers: In an overall softening market, there is a premium for prompt tonnes in Europe, with importers buying smaller than usual tonnages at the last minute. While domestic European urea production has increased – tracking falling

natural gas prices – price levels are again on the margins of profitability.

**Ammonia:** Prices slumped to 22-month lows in several regions in early March, with spot sales both east and west of Suez in the low-\$500s/t cfr. Global supply continues to heavily outweigh demand due to weak downstream demand and high stock levels in key consuming countries. Middle East prices have been in freefall, dropping by more \$300/t since the year's start, and are not expected to stabilise without further production curtailments in competing regions.

Seasonal US, European and Indian demand – which usually drives sentiment at this time of year – remains uncertain. Spot demand is largely absent from the market at current prices due to high stock levels.

Key market drivers: Turnarounds at Chinese ammonia plants in March have led to some supply shortages and a rise in domestic prices. Trafigura has sold

10,000 tonnes to a buyer in Samsun, Turkey at \$520/t cfr for April delivery. Trammo has also sold 2-3 cargoes to Turkish buyers in recent weeks at reported prices in the low \$500s/t cfr. A trader has reported a sale of 5,000-7,000 tonnes into Taiwan at around \$550/t.

**Phosphates:** Prices have dropped both east and west of Suez amid weak demand. Chinese DAP prices have fallen to \$610-615/t f.o.b., with some buyers pushing for lower levels. There was no fresh Indian business in early March, although RCF is due to close a DAP buy tender mid-month. West of Suez, US supplier Mosaic sold 6,000 tonnes of DAP at \$635/t f.o.b., down from offers of \$650/t earlier in March. In Brazil, MAP (11-52) fell to \$645-650/t cfr with demand still soft.

Key market drivers: Indian DAP inventories rose further in February, increasing by 311,000 tonnes. This follows a rise of 444,000 tonnes in January and takes levels at the start of March to as high as 2.8

**Market price summary** \$/tonne – Early March 2023

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	550-590	300-340	f.o.b. E. Europe 150-190	f.o.b. US Gulf	616-649	-	-
f.o.b. Yuzhny	Port closed	Port closed	-	f.o.b. N. Africa	605-670	475-550	1,000-1,200
f.o.b. Middle East	570-600	300-355**	-	cfr India	620-650	-	1,050*
Potash	KCl Standard	K <sub>2</sub> SO <sub>4</sub>	Sulphuric Acid	Sulphur			
f.o.b. Vancouver	420-600	-	cfr US Gulf	60-100	f.o.b. Vancouver	125-150	-
f.o.b. Middle East	430-620	-	-	-	f.o.b. Arab Gulf	120-140	-
f.o.b. Western Europe	-	900-1,050	-	-	cfr N. Africa	118-142	-
f.o.b. Baltic	425-600	-	-	-	cfr India	140-165+	-

Prices are on a bulk, spot basis, unless otherwise stated. (\* = contract \*\* = granular). Phosphoric acid is in terms of \$/t P<sub>2</sub>O<sub>5</sub> for merchant-grade (54% P<sub>2</sub>O<sub>5</sub>) product. Sulphur prices are for dry material. (+ Quotes for product ex-Arab Gulf). n.a. = not available.

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million tonnes. The March import line-up of around 670,000 tonnes will add further to stocks. Although Chinese export policy remains unclear, with the domestic season concluded, most observers expect restrictions to be eased, allowing further export rises in April-May.

**Potash:** The Indian contract price was a dominant topic at the Argus Asia conference in Dubai, 7-9 March. There was market disappointment – particularly among suppliers – that a contract has yet to be agreed. Expectations for the next contract price have dipped in recent weeks: market participants now expect a settlement around \$420-450/t cfr including 180 days' credit. Reports suggest, however, that India is now after a price, including credit, of around \$400/t cfr. Sentiment remains generally bearish with buyers awaiting news of the settlement and more clarity on pricing before returning to the market.

Key market drivers: Pupuk Indonesia, having postponed its auction round in early March, is expected to resume its tender to buy as much as 250,000 tonnes of standard MOP in the second half of March. MOP inventory levels at Chinese ports fell further in early March to 2.07 million tonnes, having dropped by 230,000 tonnes in a fortnight.

**NPKs:** Bearish sentiment persisted in early March, as key market participants gathered in Dubai for the Argus Asia conference, 7-9 March. Buyers have remained on the periphery, being unwilling to buy complex fertilizers in large quantities while prices for other products continue to fall. Despite the general market softness, NPK and NPS prices have remained largely sta-

ble, although falls are expected when fresh business eventually emerges.

Key market drivers: Fertilizer importer RCF has issued a tender closing on 14th March to purchase 50,000 tonnes each of 20-20-0+13S and 10-26-26 for delivery to India's east coast. The minimum offer quantity is 25,000 tonnes. Major MOP supply contracts – which should provide the potash market with some stability – have yet to be settled. The global phosphates market grew softer in early March with weak demand heaping downwards pressure on prices.

**Sulphur:** New sales to Indonesia priced at \$160s/t cfr emerged at the Argus Asia conference in Dubai, 7-9 March. A spot sales tender issued to the market by major supplier Adnoc is expected to provide market direction ahead of second-quarter contract negotiations. A sale to Indian fertilizer producer PPL in the low-\$160s/t cfr is scheduled for March-April delivery to India's east coast. Chinese buyers remained largely sceptical about top end offers in early March and consequently kept on the sidelines.

Key market drivers: Several spot cargoes sold to the Indonesian market in early March in the \$163-167/t cfr range. Chinese buyers, in contrast, were not prepared to countenance Indonesian price levels, having sufficient stocks to wait and see before booking further spot tonnes. West of Suez, buying at current price offers lacks immediacy, given that demand from fertilizer production remains relatively low during a period of sluggish sales.

**OUTLOOK**

**Urea:** During the recent Argus Asia conference in Dubai, sentiment was gener-

ally bearish on the nitrogen price outlook for the second half of the year – largely because of the structural oversupply in the urea market. A downwards price correction to rebalance the market, by forcing some production curtailments, now seems likely given the combination of high availability and muted demand.

**Ammonia:** Fundamentals suggests some further price deterioration is possible, as buyers wait out of the market until solid signs of price stability emerge.

**Phosphates:** Prices are likely to continue their slide, despite the pick-up in Brazilian imports expected in the next month or so. Indian buyers are also comfortable and will force prices lower. Price levels will drop particularly sharply if Chinese exports pick up.

**Potash:** The absence of a new Indian contract price, by suppressing demand, will act to push down prices. More market activity will result once the new price is agreed, which should help provide some price stability.

**NPKs:** Suppliers and buyers of complex fertilizers need other markets to find steadiness before expecting NPK prices to stabilise. Until then, further price decreases and buyer hesitation look set to continue.

**Sulphur:** The latest round of spot business at \$163-167/t cfr Indonesia on several shipments from the Middle East have supported sulphur pricing. However, with Indonesia thoroughly covered, some downward price pressure is now expected, with weakish downstream sales for fertilizer producers affecting raw material demand.

# Fertilizer Industry News

## UNITED KINGDOM

*The under-construction Woodsmith polyhalite mine in the UK.*



PHOTO: ANGLO AMERICAN

## Anglo American to invest billions in Woodsmith mine

Mining major Anglo American is to invest up to \$4 billion to complete its Woodsmith mine project in the UK.

The investment plans were unveiled as part of a long-awaited strategy update for the company's large-scale polyhalite mine project in North Yorkshire released on 23rd February.

Anglo American says it will now increase the mine's ultimate output – to 13 million t/a up from 10 million t/a – as part of the strategy update. It also expects initial production of its polyhalite fertilizer POLY4 to begin in 2027, with output ramped-up as the market for polyhalite develops.

Woodsmith will become one of the world's largest fertilizer mines when complete. It is expected to remain in production for at least 40 years.

"As noted in a number of market updates throughout 2022, we are enhancing the project's configuration – including the capacity of the shafts and other infrastructure to accommodate higher production volumes and more efficient and scalable mining methods over time – to ensure we deliver maximum commercial returns from Woodsmith over the expected multi-decade asset life," Anglo American said. "These project team proposals, endorsed by the Board at the end of the year, indicate an extension of the development schedule and the capital budget, compared to what was previously anticipated."

In light of these changes, the company now expect to bring POLY4 to market in 2027, with an annual capital investment of around \$1.0 billion. It is also proposing to increase Woodsmith's design capacity to around 13 million tonnes per annum, subject to further studies and approval.

Anglo has already approved \$0.8 billion of investment for Woodsmith in 2023, with most of this expenditure going to shaft sinking and tunnel boring activities. This comes on top of \$522 million in capital expenditure in 2022.

"There is no other natural mineral fertiliser with the scale of potential impact of POLY4, and Anglo American has the only scalable source of polyhalite globally. This mineral is distinct in its composition, behaviour, benefit, and therefore its value," said Duncan Wanblad, Anglo American's CEO.

He added: "Farmers today must produce more food for a growing global population, whilst meeting increasing consumer, supply chain and governmental expectations for improved sustainability. POLY4 is uniquely positioned to help simultaneously address these interconnected challenges, because it increases yield and nutrient use efficiency, is low carbon and improves the health of the soil compared

to conventional chemical fertilisers."

Polyhalite is a natural mineral fertilizer containing potassium, sulphur, magnesium, and calcium plus numerous micronutrients. Anglo's POLY4 product is suitable for organic farming and is made by simply crushing and granulating polyhalite. This provides POLY4 with a carbon footprint that is up to 85 percent lower than typical chemical fertilizers.

"POLY4 will help farmers achieve more balanced, sustainable fertiliser practices at a scale not seen in the industry for decades," said Alexander Schmitt, chief marketing officer for Anglo American Crop Nutrients. "The product delivers better results than the same blend of nutrients available from conventional sources today, delivering sustainability benefits beyond the nutrient content and setting POLY4 apart from traditional fertilisers."

"Our commercial trials have demonstrated that POLY4 can improve the efficiency of nitrogen and phosphorous by six percent compared to MOP, potentially reducing the amount of chemical fertiliser that needs to be applied," added Dr Schmitt. "This is down to its prolonged nutrient release profile and multi-nutrient nature; just like you or me, consuming a more balanced and nutritious diet makes plants stronger, healthier and more productive." ■



**INDIA**

**Coromandel launches new nanotechnology fertilizer**

Private sector Indian fertilizer producer Coromandel International unveiled a new nanotechnology-based phosphate fertilizer, Nano DAP, in February.

“Application with the government for the commercial release of Nano DAP is in the advanced stage of approval,” the company said in a statement.

Coromandel is setting up a new production plant to manufacture Nano DAP in Andhra Pradesh and plans to commercially launch the product later this year.

The new product was developed at Coromandel’s R&D centre at the Indian Institute of Technology, Bombay. The Chennai-based company – part of Murugappa Group – said the efficacy, biosafety and toxicity of Nano DAP is being investigated prior to its launch via extensive field studies.

“Nano DAP will go a long way in driving the sustainability of Indian farms through improving nutrient uptake, lowering water consumption and minimising environmen-

tal losses,” said Arun Alagappan, Coromandel’s executive vice-chairman.

The adoption of Nano DAP should also make farm economics more attractive by driving sustainable fertilizer usage and site-specific nutrient applications, Alagappan said. He also praised the Indian government for its help.

“I would like to thank the government for its continuous guidance, extending policy and regulatory support and providing the requisite impetus for adoption of new technologies in farming,” he said.

**SOUTH AFRICA**

**Elandsfontein makes inaugural bulk rock sale**

Kropz Plc has made the first shipment and sale of 33,000 tonnes of phosphate rock concentrate from its flagship Elandsfontein project in the Western Cape.

This was confirmed by Louis Loubser, Kropz CEO, on 23rd January: “After numerous challenges, we are delighted to announce our first bulk sale from our Elandsfontein phosphate project which is a very significant achievement for Kropz.

We would also like to take this opportunity to thank all the team for their dedication and hard work to reach this milestone.”

**NORWAY**

**Fertiberia joins Europe’s biggest blue ammonia project**

Fertiberia has joined Barents Blue, the largest blue ammonia project in Europe, as an equal partner with its developer Horisont Energi.

Fertiberia entered into a co-operation agreement with Horisont on Barents Blue at the start of February. The two companies plan to become equal partners in the project from 1st April, with both companies taking a 50 percent ownership share.

The new stake in Barents Blue advances Fertiberia’s plans to become net zero by 2035. The Spanish-headquartered fertilizer producer said Barents Blue, located in Finnmark in the far north of Norway, will be Europe’s largest clean ammonia production plant. It will produce one million tonnes of blue ammonia per annum when it comes online.

State-controlled Norwegian oil & gas company Equinor and Norwegian inde-



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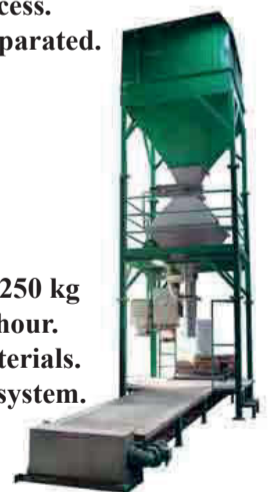


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pendent oil & gas operator Var Energi both exited the Barents Blue project at the end of January – immediately prior to Fertiberia coming onboard as a partner – after their co-operation agreements with Horisont expired.

Barents Blue is aiming to produce blue ammonia derived from North Sea gas reserves at a site near Hammerfest, the world’s most northerly town. The carbon generated from the ammonia production process (steam methane reforming) will be captured, transported and stored in an underground North Sea geological reservoir – a part of an associated venture known as the Polaris carbon capture & storage (CCS) project.

The Norwegian ministry of petroleum and economy awarded a CO<sub>2</sub> storage licence to the Polaris CCS project and its then operator Equinor in April 2022. The site has a potential storage capacity of 100 million tonnes, meaning it could permanently store CO<sub>2</sub> from other sources as well.

However, the exit of Equinor now leaves Barents Blue looking for a new CCS operator. Responding to this, Horisont says it will now “invite new partners into the Polaris CO<sub>2</sub> storage licence, including a qualified operator”. The company expects to have a new CCS operator in place within 2-4 months.

Barents Blue is backed by a NOK 482 million (\$48.5 million) EU grant, secured under the important projects of common European interest (IPCEI) scheme. Horisont said this funding is unaffected by the changes to the consortium.

Argus has estimated that Barents Blue needs a minimum carbon price of \$84/t to be viable – unless the developers are able to sell their low-carbon blue ammonia at premium over the market price for conventional grey ammonia. This is close to the current EU ETS allowance prices. These have averaged €82.94/t CO<sub>2</sub>e over the past month (for December 2023 delivery).

**SAUDI ARABIA**

**Ma’aden names Phosphate 3 project partners**

The Saudi Arabian Mining Company (Ma’aden) has selected Worley and JESA International S.A. (JESA) as engineering and construction contractors for the initial phase of its Phosphate 3 mega project.

Ma’aden issued a preliminary agreement (notice of award) to both companies on 1st February. This covers engineering, procurement, and construction management (EPCM) services for phase 1 of the project.

“The parties expect to work towards a definitive agreement for the... EPCM contracts in the next few months,” Worley said in statement.

These EPCM contracts cover the design and construction of new process plants in the industrial cities of Wa’ad Al Shamal (WAS) and Ras Al-Khair (RAK) in Saudi Arabia. Both cities will form part of an integrated production complex that is expected to produce up to 1.5 million t/a of phosphate fertilizers, once operational.

Worley will provide in-Kingdom services for the project from its offices in Saudi Arabia and India. JESA, meanwhile, will provide out-of-Kingdom services, executed by its offices in Morocco.

“We are pleased that Worley has been selected for providing services to Ma’aden’s Phosphate 3 development program that is expected to make Saudi Arabia one of the leading phosphate fertilizer exporters worldwide,” said Chris Ashton, Worley’s CEO.

**GERMANY**



*Bedeschi staff celebrating the opening of their new German subsidiary and centre of excellence for materials handling.*

**New Bedeschi centre of excellence**

Italy’s Bedeschi S.p.a. has opened a new centre of excellence for materials handling in Saarbrücken, Germany. Dr Reza Poorvash will act as the new subsidiary’s CEO.

It follows the company’s opening a new branch in Australia.

“Bedeschi S.p.a. is excited to announce the opening of the new Bedeschi materials handling excellence centre in Germany!” Bedeschi said in a statement. “This centre enriches our already strong engineering backbone in Italy and will focus on the fields of port handling, stockyard equipment and wagon unloading.”

The company added: “Together with our recently established Australian branch, we keep on increasing our know-how in engineering, sales and after sales thus strengthening even more our position in the global material handling industry.”

**NETHERLANDS**

**Next generation prilling machine**

Kreber has received an order for an innovative urea prilling machine developed in cooperation with Stamicarbon.

This ‘next generation’ prilling machine has a nameplate capacity of 3,850 t/d and will be manufactured at Kreber’s Vlaardingen construction plant in the Netherlands.

The prilling unit will be installed in a Stamicarbon-designed, large-scale, state-of-the-art greenfield urea plant in India. This is scheduled to start up in 2024.

The design of the new machine is based on a single prilling bucket. This enable the large-scale and efficient production of urea prills and prills from other fertilizer types.

The prilling machine is a major upgrade to conventional prilling tower design – and has been developed by Kreber and Stamicarbon using more than a century of combined prilling knowledge. The machine produces large-diameter urea prills with a uniform particle-size distribution very efficiently. It is suitable for both natural and forced draft prilling towers. The unit can also be retrofitted at existing plants to improve product quality.

The new machine performs over a wide range of operating conditions and helps reduce particulate emissions from prilling towers. It can generate high-quality, large-diameter urea prills, while at the same substantially reducing particulate and ammonia emissions and plume opacity – especially when installed alongside Stamicarbon’s Jet Venturi™ scrubber.

**UNITED STATES**

**Argus launches new fertilizer sustainability event**

Argus is running a new Sustainable Fertilizer Americas Conference this summer. The event will explore ways of improving industry sustainability and maximising returns on investment in the fertilizer markets of the Americas.

The inaugural event is being held at the Grand Hyatt Tampa Bay, Tampa, Florida, 5-6th June 2023. The main conference topics include:

- The importance of sustainable fertilizer management and practice
- How to finance and build a sustainable fertilizer economy
- Regional case studies on policy and how companies are pushing fertilizer market sustainability further

- The developments that are still necessary to support sustainable fertilizer management.

Introducing the event, Argus said:

“Global fertilizer markets have experienced unprecedented changes in recent times, with supply lines disrupted, global inflationary pressures driving prices up, and in 2022 the world’s population soaring to over eight billion – to name just a few. As a result, the pressing concern across the global fertilizer community is how to work together to ensure food security, improve fertilizer self-sufficiency, and how to do so while meeting growing sustainability targets for the sector.

“The Argus Sustainable Fertilizer Americas Conference will provide participants a platform to network and hear from leading industry speakers and pioneers on the opportunities in the Americas fertilizer markets surrounding the central themes of sustainability, security, and affordability of fertilizer supply and management.”

Argus expects 150+ participants from across the fertilizer value chain to attend the two-day event, representing key producers, trading houses, financing, storage

and logistics, governments and industry associations and AgTech companies.

**CANADA**

**Soilgenic launches Visio-N Supra**

Soilgenic Technologies launched an innovative urease inhibitor product, Visio-N Supra, in January.

Visio-N Supra contains 40 percent of the organophosphorus compound NBPT as its active component. The product can be used as a coating agent for commodity urea to create enhanced efficiency fertilizers (EEFs).

Soilgenic, which is headquartered in Calgary, Alberta, described the technology behind the product as a “breakthrough in making nitrogen fertilizers more efficient”.

“The development of the Visio-N Supra 40 percent NBPT formulation sets a new standard for... concentrated urease inhibitor technology,” said Jeff Ivan, Soilgenic’s president & CEO. “A high concentration formula combined with the ability to coat evenly at low application rates is critical, especially at low temperatures.”

He added: “Our FLX-Sol penetrating solvent technology has a low viscosity and

low surface tension that also allows for reduced application rates with our highly concentrated NBPT formulation. Testing [has] showed excellent coverage down to -20°C (-4°F) – whereas other technologies will gel around 0°C (32°F).”

NBPT has become the standard urease inhibitor globally due to its ability to protect against above ground nitrogen losses. The inhibitor has been in particularly high demand this season, according to Soilgenic, due to high nitrogen costs and growing pressure on farmers to reduce the emissions associated with their fertilizer use.

Historically, NBPT has been available as a 26.6 percent formulation. Visio-N Supra, in contrast, is a high-quality and highly concentrated 40 percent NBPT formulation that, says Soilgenic, incorporates exclusive stabilisation technology that prevents NBPT from falling out.

The ability to deliver urease inhibitors at a higher concentration has added benefits, suggests Soilgenic, including reduced logistics, storage, and treatment costs. The company hopes these cost efficiencies will drive a further expansion in the market’s adoption and use NBPT. ■

## OBITUARY

### Bo Levander, the founder of ChemTrans and a leading industry figure, has sadly passed away



Swiss-headquartered sulphuric acid trading company ChemTrans Trading AG has announced the passing of its founder Bo Levander. In a statement on behalf of the family and company, Bo's son Henrik Levander said:

"It is with heavy hearts that we have to announce the passing of my dear father and founder of ChemTrans Bo Levander on 5th February 2023.

His successful sulphuric acid career started in the late 1960s at Boliden in Stockholm.

In 1971, Bo moved to Switzerland where he was responsible for the Boliden

office in Zug.

Later, in 1981, he decided to start his own business and founded ChemTrans AG.

Bo was a very respected and esteemed person in the sulphuric acid world, and a light for all of us at ChemTrans. We will continue shining his light by carrying it within us in our own lives.

Death means to say goodbye, but never to leave a loved one behind."

The directors and staff of BCInsight wish to express our sadness on this loss and offer the Levander family and Bo's colleagues our condolences. ■

**Antoine Hoxha** became the new Director General of Fertilizers Europe on 1st March. He takes over from **Jacob Hansen**, who has stood down having led the trade association for the past twelve years.

"We are pleased to announce Antoine Hoxha as our new Director General and are confident he will advocate for a strong domestic fertilizer industry and a smooth decarbonisation of European assets – which is key to ensuring Europe's strategic autonomy in fertilizers and food," said Andreas Steinbuechler, Fertilizers Europe's president. "We thank Jacob Hansen for his commitment and dedication to the European fertilizer industry during his mandate."

Florida's Kimre, Inc is expanding and making changes to its engineering and technical sales teams to best serve customers worldwide. The company, which designs and manufactures innovative,

high-performance mist eliminators and fibre bed filters, is celebrating its 50th anniversary in 2023.

**Brian Clancy** has been promoted to become Kimre's director of engineering. Brian is a seasoned chemical engineer with both field and design experience in the metals & mining industry. With a passion for practical design and innovative engineering, Brian holds a BSc in chemical engineering from the University of Florida and an MBA from the University of South Florida.

General manager **Miles Valentine** has decades of industry knowledge and engineering field experience. He will expand his engineering design expertise to include both fibre bed mist eliminators and monofilament solutions. Miles is a registered professional engineer with a bachelor's degree in mechanical engineering from Louisiana State University.

**Maria Acevedo** has been promoted to the role of director of technical sales and market development. She holds a bachelor's degree in chemical engineering from the University of South Florida and a bachelor's degree in accounting from the University of Havana. Maria has a passion for combining her business acumen with her expertise in chemical engineering. Kimre is leveraging her industry knowledge to train, grow, and expand its sales rep network.

Kimre has named **Bob Klinewski** as its fibre bed sales director and industry specialist. He is recognised throughout the filtration and clean air industry for his extensive experience in fibre bed sales, contract negotiations, and business development. In this role, Bob will provide Kimre's clients with solutions that effectively and efficiently solve their filtration needs. ■

## Calendar 2023

### APRIL

18-19

New Ag International Annual Conference, BARCELONA, Spain  
Contact: Naomi Brooker, portfolio director.  
Tel: +44 7973504783 Email: naomi.brooker@informa.com

This annual event is the leading specialty fertilizer conference in Europe. It is typically attended by 300 industry professionals keen to hear insights and case studies into the latest developments in slow-, controlled-release and stabilised fertilizers (SCRSFs), water-soluble fertilizers (WSFs), biofertilizers, biostimulants and micronutrients. This year, delegates can either attend in-person or virtually to hear expert presentations from Nutrien, Ferba Internacional, EFCI Register, Sulphur Mills, BioConsortia, GC Biologicals, Verdesian Life Sciences and many others.

### MAY

22-24

IFA Annual Conference 2023, PRAGUE, Czech Republic  
Contact: IFA Conference Service  
Tel: +33 1 53 93 05 00  
Email: ifa@fertilizer.org

### JUNE

5-6

Argus Sustainable Fertilizer Americas, TAMPA, Florida, USA  
Contact: Argus Media  
Tel: +44 (0)20 3923 0741  
Email: conferences@argusmedia.com

CF Fertilisers UK announced the closure of its Ince, Cheshire fertilizer production complex last June due to cost pressures.



# The future of Europe's fertilizer industry: a year of shocks

PHOTO: CF FERTILISERS UK

Russia's invasion of Ukraine has hit European fertilizer producers hard. Ammonia plants across the continent have been inactive over the winter due to prohibitively high feedstock costs. The future of nitrogen fertilizer production in the region will depend on access to an affordable, secure and sustainable energy supply and the switchover to low-carbon technologies.

**A**s CRU summed up recently, 2022 was a turbulent year for the global fertilizer market. Prices rallied to record highs at the end of March last year following Russia's invasion of Ukraine, with the market fearful of drastic supply shortfalls.

But across the world, producers, farmers and policymakers subsequently responded with ramped-up output, application cuts and softer sanctions, respectively. Fertilizer prices consequently ended 2022 significantly below their March peak.

Europe's fertilizer producers, though, have experienced a uniquely tough 12 months since Russia invaded Ukraine on 24th February 2022.

## Anatomy of a crisis

The shock to the European nitrogen industry first began at the height of last summer when BASF announced ammonia production cuts in Germany in reaction to high gas prices.

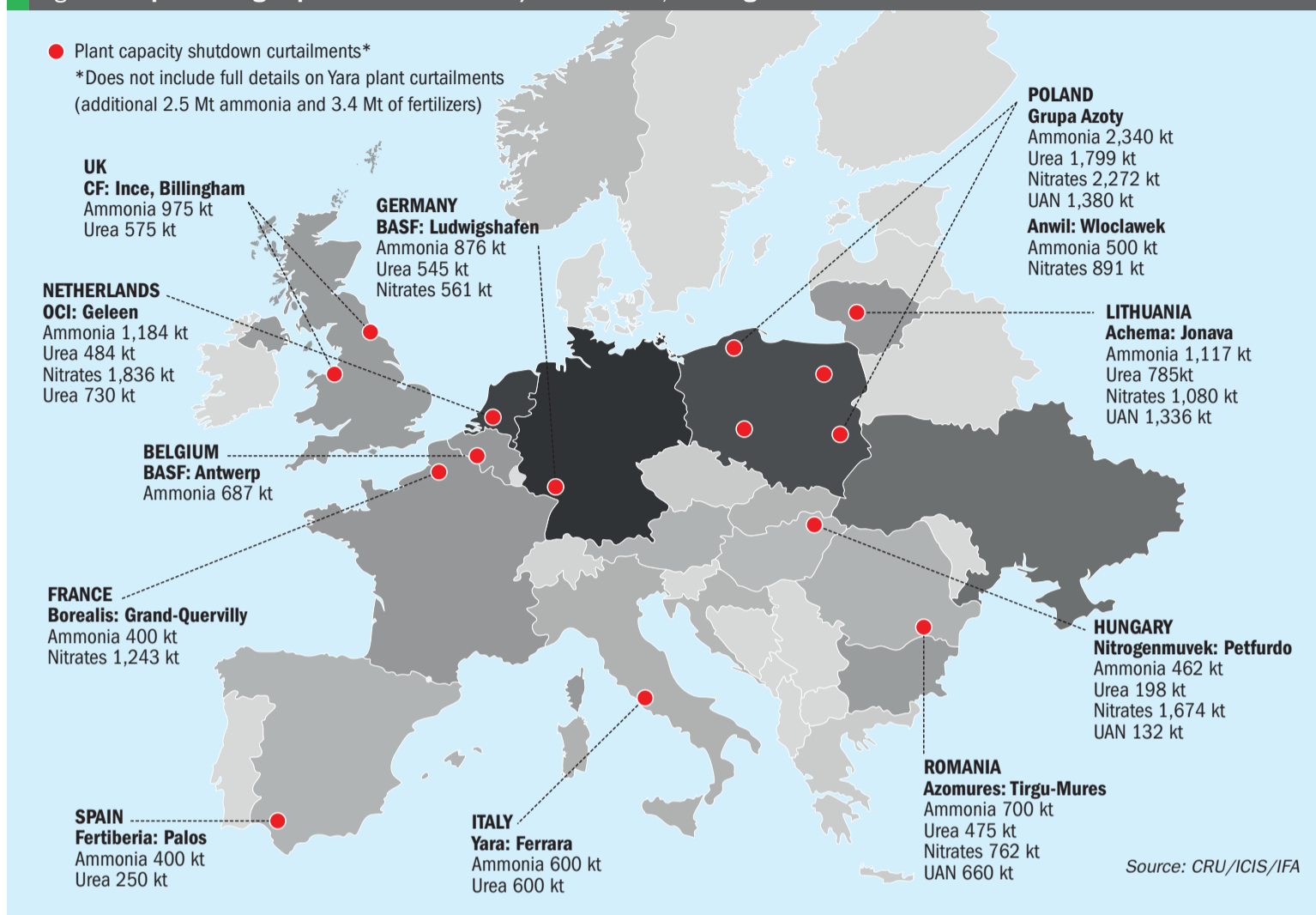
"We are reducing production at facilities that require large amounts of natural gas, such as ammonia plants," BASF's CEO Martin Brudermueller said in an earnings call on 27th July. "We are monitoring developments very closely, particularly at our largest site in Ludwigshafen, where we use considerable amounts of gas."

BASF said falling gas supplies from Russia were behind its decision. Ammonia pro-

duction was particularly vulnerable, being responsible for one quarter of its overall natural gas consumption. The company said it would fill some of its ammonia supply shortfall with purchases from external suppliers, but warned that farmers would still face higher fertilizer costs in 2023.

"[A cut in ammonia production] would put additional pressure on an already extremely tight market. Russia is a major exporter of ammonia and fertilisers. Exports from Russia are currently in sharp decline. A reduction in gas supplies in Germany would further exacerbate the shortage of fertilisers worldwide, reduce food production and lead to further price increases for basic food-stuffs," BASF said in a statement.

Fig. 1: European nitrogen production shutdowns/curtailments, end-August 2022



But the European industry crisis really kicked in at the end of August 2022, as record natural gas price rises triggered a spate of ammonia production curtailments across the continent. These included major shutdown announcements from CF Fertilisers UK, Grupa Azoty, Yara International and others.

“We have now confirmed that 50 percent of total European ammonia capacity (excluding Ukraine) is shuttered or curtailed, up from 26 percent the week prior,” CRU reported on 25th August.

CF Fertilisers UK, for example, announced the halt of ammonia production at its Billingham complex on Teesside on 24th August. The company, a subsidiary of US-headquartered CF Industries, continued to produce ammonium nitrate (AN) and nitric acid at the site using imported ammonia instead.

“At current natural gas and carbon prices, CF Fertilisers UK’s ammonia production is uneconomical, with marginal costs above £2,000 per tonne and global ammonia prices at about half that level. The current cost of natural gas at NBP\* is

more than twice as high as it was one year ago, with the NBP forward strip suggesting that this price will continue to rise in the months ahead,” said CF Fertilisers UK at the time.

(\*NBP is the wholesale trading point for UK natural gas.)

The company said it expected “to fulfil all ammonia and nitric acid contracts and all orders of AN contracted for delivery in the coming months” by switching to imported ammonia instead.

The ammonia production halt at Billingham followed the closure by CF of its Ince, Cheshire fertilizer production complex in June last year. This ended more than 55 years of production at the site (*Fertilizer International* 509, p8). Ammonia production at Billingham and Ince had also been halted in mid-September 2021 due to high natural gas prices, although the Billingham plant restarted a few weeks later after the UK government stepped in to cover costs (*Fertilizer International* 505, p8).

CF’s announcement of UK curtailments came the day after Poland’s Grupa Azoty halted nitrogen fertilizer production at Tar-

now, Poland, and also reduced production at its Pulawy site. In total, the company has the capacity to produce 524,000 tonnes of ammonia, 375,000 tonnes of urea and one million tonnes of NPKs annually, according to ICIS.

The decision was prompted by record natural gas prices. Azoty said its natural gas costs had rocketed from €72 per megawatt hour (MWh) to €276/MWh over the six months between 22nd February 2022 by 22nd August.

Yara International also reacted to these record high gas prices by announcing large-scale production curtailments on 25th August. These reduced its total European ammonia output to around 35 percent of capacity.

As a consequence, Yara effectively reduced its annual production capacity across its European production sites by the equivalent of 3.1 million tonnes for ammonia and 4.0 million tonnes for fertilizers (1.8 million tonnes urea, 1.9 million tonnes nitrates and 0.3 million tonnes NPK).

“Yara will where possible use its global sourcing and production system to

optimize operations and meet customer demand, including continued nitrate production using imported ammonia when feasible. Yara will continue to monitor the situation and adapt to market conditions going forward,” the company said at the time.

As the end of August, ICIS was reporting widespread disruption to ammonia and nitrogen fertilizer production across Europe linked to soaring wholesale gas prices. Partial or full shutdowns or reduced production rates (Figure 1) were reported at the following sites:

- Yara Sluiskil and OCI, the Netherlands
- CF Fertilisers Ince, UK
- BASF Ludwigshafen and SKW, Germany
- Fertiberia Huelva, Spain
- Yara Ferrara, Italy
- Petrokemija, Croatia
- Azomures, Romania
- Grupa Azoty Tarnow and Pulawy, Poland
- Achema, Lithuania.

“At least 50 percent of European ammonia capacity has been curtailed. The reality is likely higher than this. The repercussions could be extraordinary and expand well beyond agriculture and fertilizers,” Chris Lawson, CRU’s head of fertilizers, said on 27th August.

Additional to the above list, CRU was also reported that Anvil had ceased production in Poland, Duslo in Slovakia was also facing downtime, and that Austrian producer Borealis had partly shut down its French production unit.

## Half a million tonnes of lost production capacity

According to CRU, the planned shutdowns announced in late August 2022 represented a cut in Europe’s installed nitrogen capacity of 400,000 tonnes per month – across urea, AN, calcium ammonium nitrate (CAN) and urea ammonium nitrate (UAN). It estimated that Europe would be operating less than half of its installed capacity for these products as the northern hemisphere’s summer ended and autumn began.

Argus separately calculated a total European nitrogen production loss of half a million tonnes per month. It estimated that 17.85 million t/a of Europe’s ammonia production capacity was offline at the start of September.

However, this unfolding crisis was affecting some fertilizer products more than others, reported Argus. It expected

less than 30 percent of regional UAN capacity to be operating by the start of September 2022. The relative abundance of cheaper US supply was, however, likely to replace some – although not all – of this lost volume. Regional AN output, meanwhile, was likely to have been cut by half, with CAN down by between one third and one half.

“Unlike UAN, there is much less spare capacity outside Europe for dry nitrates and so buyers have been turning to ammonium sulphate and urea imports for replacement supplies,” commented Argus.

“On urea, European-wide production appears to be operating at less than a quarter of normal capacity,” Argus added. “Of more than eight million t/a of potential production capacity, just two million t/a is planned to remain operational – mostly Yara but also Germany’s BASF, Borealis and Spanish producer Fertiberia.”

Ammonium sulphate, mostly produced as a by-product of caprolactam manufacturing, was also badly affected, suggested Argus, with shutdowns and cuts to operating rates in Belgium, the Netherlands, Germany and Poland reducing European output to around half of maximum capacity.

## Replacing lost European output

So, how could Europe make up for this large-scale loss in nitrogen output?

“Combined, all the lost production in Europe represents around 500,000 tonnes of nitrogen/month,” commented Argus. “If all that were converted to imported urea demand, it would mean almost 1.2 million tonnes per month of additional urea imports – four times the normal rate.”

Yet Europe would simply be unable to import that much urea, suggested Argus, for logistical and other reasons. In any case, meeting even a small fraction of this demand would be an overwhelming challenge for the global urea trade. While China could theoretically boost international urea supply using its major reserve capacity, the continuing suppression of Chinese urea exports since 2021 is a policy that remains in place.

With supply inelastic, a more likely scenario, suggested Argus, was an extended period of demand destruction for nitrogen fertilizers – particularly in those markets without significant grain exports and/or fertilizer subsidy support. Such a scenario would result in major adjustments to nitrogen trade flows.

## A return to profitable ammonia production?

The good news for producers was that European natural gas availability and pricing both began improving in early December.

“Prompt prices at Europe’s most liquid gas hub, the Dutch Title Transfer Facility (TTF), have progressively dropped over the past seven weeks as mild weather, limited demand and LNG imports remained quick,” Argus reported at the end of January. “As Europe approaches the end of winter and forecasts suggest more mild weather, the immediate risk of a gas shortage has lessened dramatically in recent weeks.”

This started to make European ammonia production look economically viable again.

“European ammonia production costs fell below import prices in late December, and were estimated at \$660/t for northwest European plants, excluding carbon costs as of 27th January,” said Argus. “Northwest European import prices are trading \$170/t above the cost of production, at \$830/t cfr duty free.”

Despite rapid price falls, European natural gas prices at the end of January remained historically high and elevated compared to other gas-producing regions, noted Argus:

“Argus’ TTF everyday prices so far this year have been assessed at around €64/MWh on average, almost half the roughly €121/MWh average last year. However, they still remain dramatically above historical levels of roughly €17/MWh in 2017, €23/MWh in 2018, €13.50/MWh in 2019, €9.35/MWh in 2020 and €46/MWh in 2021.

“European gas prices also remain well above benchmark prices in other major gas-producing and consuming markets like the US, Iran, Russia and Oman.”

## A change in fortune?

As already stated, CRU was reporting that at least 50 percent of European ammonia capacity was curtailed at the end of August last year. Yet November 2022 saw an upturn in fortunes with the reversal of some curtailments.

With regional natural gas prices falling, Lawson was much more upbeat. “A turn of fortune for European nitrogen producers: lower spot gas prices mean profitability has returned. We now estimate that 37

percent of ammonia capacity is curtailed, down from the peak of 67 percent.”

Yet the prospects for a return to production normality remain mixed. Indeed, European ammonia producers had largely failed to respond to falling European gas prices, Argus said at the end of January, with the caveat: “That ...could change if gas prices decline further and the next planting season spurs stronger demand for fertilizers.”

In an end-January update, Argus reported that:

“Yara’s Ferrara plant in Italy remains shut, but the firm is mulling a restart in February. Ameropa’s Azomures plant in Romania has yet to announce a restart, while Borealis’ plants in France and Austria continue to run at reduced levels.

“Fertilizer producer CF, which operates plants in the UK, switched to importing ammonia in August and continues to do so, having received several shipments this month, while Borealis also pointed towards the continued imports of cheap feedstocks and sufficient existing stocks at plants as a reason for muted ammonia production.”

Argus also reported high stock levels across key European ammonia import hubs as January ended, with most buyers having already sourced their requirements before gas prices began to fall. High inventory levels at Antwerp and Rotterdam, for example, had created a backlog of 50,000 tonnes of ammonia waiting outside the port. This glut removed the immediate incentive for European producers to recommence ammonia production.

### Major falls in Polish production

According to figures published at the end of January, Poland’s ammonia production fell by 19 percent in 2022. The country is one of Europe’s largest producers. Grupa Azoty operates four production sites in the country, while PKN Orlen runs one at Wloclawek through its subsidiary Anwil. Together, these sites have a combined ammonia production capacity of more than 2.9 million t/a.

“The 32 percent decline in Polish ammonia output in the second half of the year was much steeper than the six percent in the first half, as high gas prices forced a reduction and then shutdown of Polish ammonia output,” reported Argus. “In outright terms, [Polish] ammonia production fell to 858,000 tonnes from about 1.25 million tonnes.”

### Yara ramps up its European ammonia output

Yara’s European ammonia production was once again operating at 65 percent of its capacity by the second week of February. The company did, however, end up cutting its European ammonia output by 1.7 million tonnes last year – equivalent to 35 percent of its regional capacity. Its European weighted-average gas cost was an eye-watering \$31.80/mn Btu in 2022, up from \$11.70/mn Btu in 2021.

Yara says the resumption of ammonia production in Europe depends on its profitability, saying it “will not produce or sell at negative margins”. Yara is fortunate to be able to access external ammonia sources and, with Russian output unavailable, the company shifted to ammonia supplies from the Middle East, north Africa, North America and the Caribbean in 2022.

### Shut ammonia production unlikely to return?

Some expert industry observers are questioning how much of the ammonia production shut down on the back of high European natural gas costs last year will ever return. Speaking last October, Andreas Gocke, global lead for chemicals at Boston Consulting Group (BCG), predicted that Europe’s ammonia producers would remain under strain as the prices of the natural gas feedstocks they relied on were unlikely to return to levels seen prior to the war in Ukraine.

“[Before the war] The entire cash cost of ammonia production in Europe was already bad, but [with current gas prices] there is a brutal translation: there is no chance anymore for cost-competitive production of ammonia in Europe,” Gocke told delegates at the European Petrochemicals Association (EPCA) 2022 annual meeting.

“We have modelled how the European natural gas price could develop [and] we will not get back to the levels we had in 2019 – this has very strong implications,” concluded Gocke.

In addition to fertilizer industry impacts, he predicted a wider production downturn in other parts of the European chemicals industry, including downstream products such as polyamide 6 (PA6) and the ammonia by-product carbon dioxide (CO<sub>2</sub>), which is used by the food and drinks industry and other industrial sectors.

### The policy response

European Commission president Ursula von der Leyen unveiled the EU’s plans for electricity and gas markets in a speech on 14th September. These included ‘solidarity contributions’ to energy-intensive industries, windfall taxes on excess profits, and a cap of €180/MWh on some power producers. While Europe’s fertilizer industry agreed with these necessary measures, representatives argued they did not go far enough.

Trade association Fertilizers Europe welcomed the commission’s promise to explore further options such as an alternative gas benchmark and a natural gas price cap. The association said that the proposed solidarity contribution mechanism “might provide an immediate relief to energy-intensive industries” as long as it was implemented quickly. However, rapid agreement on further steps was also necessary, in its view, as some changes required time that “our industry doesn’t have”.

### Outlook for the year ahead

While gas prices are now much lower than last year’s peaks, Europe’s energy crisis was not yet over, CRU predicted in its 2023 outlook:

“Energy markets face a trilemma of competing issues – energy security, affordability and the required transition to clean energy,” said CRU. “The war in Ukraine has been a key driver of current pressures and, while natural gas prices have fallen back in recent weeks, the energy crisis is far from over.”

CRU also warned of volatile gas prices and possible permanent capacity closures in Europe with some energy-intensive industries migrating to other regions.

“There is a high probability European gas prices will once again move above current levels and remain volatile. The European industry has cut its consumption of gas considerably, with widespread curtailments of capacity in energy- or gas-intensive sectors,” CRU added. “If high and volatile prices persist, many of these curtailments will become permanent or the industry could relocate.”

Despite energy security concerns and high energy prices, factors which should be conducive to greater investment in low-carbon production technologies, industrial decarbonisation has been held back in the short-term, suggested CRU, because



of the need to address more immediate and pressing energy supply problems.

In its top 10 calls for the fertilizer market in 2023, CRU said:

- **European nitrogen production will continue to be plagued by high gas prices.** But government support and ample supply from elsewhere will see prices decouple from marginal costs. Demand is set to recover, albeit modestly.
- **The momentum behind low-emissions ammonia will continue,** and supply-side subsidies may be more forthcoming in response to the US inflation reduction act.
- **Nitrogen prices will linger below marginal cost.** European nitrogen production costs are expected to increase again in 2023. TTF gas prices are projected to remain high as Russian gas supply is slashed. But nitrogen prices are expected to decline, decoupling from costs due to ample supply, with 2023 urea Middle east f.o.b. prices forecast at \$556/t, down from \$675/t in 2022.
- **Expect some government support for producers in Europe.** The likelihood that European governments will provide financial aid to distressed nitrogen producers will further support the decoupling of nitrogen prices and costs. With support for fertilizer and its by-products (pure CO<sub>2</sub>) being prioritised. This will help maintain the operations of unprofitable plants and boost European nitrogen supply.

CRU expects European gas prices to average €150/MWh in 2023. Although well below last August's high of €338/MWh,

this predicted price remains eleven times higher than 2019 levels:

"This autumn the TTF European gas benchmark price slid dramatically from its August peaks, pushed down by robust EU gas storage levels. This has reduced some of the pressure on economies in Europe, and led some commentators to argue that the end of the energy crisis is in sight. However, we think this is premature and believe there is a high chance of prices moving above current levels and remaining volatile.

"More of Europe's gas supplies will come from LNG, which is more likely to be sold in the spot market instead of through long-term contracts. Although the European Commission is proposing to cap the wholesale price at €275/MWh, this would only have an effect in the most extreme circumstances, and has still not been agreed by all member states."

### European industry weighs up production shift

The US is an obvious location for new ammonia production, commented Yara's CEO Svein Tore Holsether in mid-January, while stopping short of announcing any new investments there. Speaking to Argus, Holsether said Yara had received offers to relocate to the US in response to Europe's high energy prices:

"We already have ammonia production in Freeport, Texas. We are evaluating further production opportunities in the US through Yara Clean Ammonia. But we're not yet at a point where we are announcing a specific investment with a location.

"It would be a natural place. I see

this happening in our industry. Look at announcements on where new ammonia production is being considered. For sure it's the US. That's a direct result of the incentives [Inflation Reduction Act] being put in place to build this industry."

Earlier in January, Yara announced modifications to its ammonia terminals in Germany to enable the company to raise its import capability to three million tonnes.

"We're the world's largest ammonia trader. And we have 12 ammonia ships, terminals and production across the world," Holsether said. "We've been using that flexibility to bring ammonia in to compensate."

Yara has been lobbying the EU to remove bureaucratic hurdles preventing the expansion of renewables. Holsether wants to see a quick and massive renewables build-up to power European green hydrogen and green ammonia production.

"It's not happening fast enough. Too much bureaucracy, red tape. We have to be prepared for a situation where we need to bring in hydrogen from the outside. Here Yara can play a role using ammonia as the hydrogen carrier," he said.

Norway was the "natural place" for renewables expansion to happen, suggested Holsether, thanks to its abundant hydropower resources. "But it is not happening fast enough," he said.

The energy situation in Europe is currently much better than expected, said Holsether. In his view, a lot of this was down to the mild winter weather, the good response of industry and households in reducing their energy consumption, as well as new routes for bringing natural gas into Europe. ■



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A complete listing of all articles and news items that appeared in *Fertilizer International* during 2022.



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# ONE-STEP MIXING & GRANULATING



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More than 1,000 delegates attended FLA in Rio which was hosted by CRU in January/February, making it the most successful year in the event's history – which stretches back more than three decades.

# Fertilizer Latino Americano 2023

More than 1,000 delegates from 500 companies and 60 countries gathered at the Sheraton Grand Rio Hotel & Resort, Rio de Janeiro, Brazil, 29 January – 1 February, for the 2023 Fertilizer Latino Americano (FLA) conference. The event was hosted by CRU in collaboration with Argus. With attendance at record levels this year, we present selected highlights from this year's four-day FLA event.

## What's next for prices?

In this opening conference session, a panel of CRU analysts provided an overview of the nitrogen, potash and phosphates markets. Their key messages were:

- Nitrogen prices are falling in a market characterised by ample supply and demand resistance
- Phosphate prices are normalising after the 2022 supply shocks from Russia and China
- The potash supply disruptions of the last 12 months are set to fade away as we move into 2023 and beyond.

**Shruti Kashyap**, CRU's head of nitrogen, set the scene. Although global grain prices look set to follow a modest downwards trajectory, she suggested, they will still be supported by tight stocks, given that these



Shruti Kashyap, CRU's head of nitrogen, opened the conference by heading up the markets overview panel.

ended 2022 at the lowest stock/use ratio for more than 20 years. And while fertilizer affordability is improving, the reluctance to pay high prices remains, in CRU's view.

In Europe, around 30 percent of nitrogen capacity (across ammonia, urea, nitrates and UAN production) was still down, as of January 2023. The TTF gas price (weekly average day ahead), which reached a high of \$98/MMBtu at the end of August had, however, fallen back to around \$25/MMBtu at the time of the conference. This price decline had improved European nitrogen production economics and partly reversed the widespread autumn/winter curtailments. These had peaked at more than 70 percent in September 2022.

Looking at nitrogen market prospects for 2023, CRU is expecting:

- Modest improvements in Latin American nitrogen consumption this year after poor affordability dragged this lower in 2022
- Support for Latin American urea imports driven by better affordability and stock build-up
- Support for global urea exports from the entry of new production capacity and China's return to the export market
- Ample supply looks set to pressure

urea prices, while ammonia prices also face a downturn on a weaker gas outlook and returning Russian exports.

CRU forecasts that Russian ammonia exports from Black Sea and Baltic Sea ports could resume in the second half of this year, after recent UN reports suggested that an agreement may be close. Exports from both ports ceased after the start of the Russia-Ukraine conflict at the end of February last year.

Phosphate prices are continuing to recover from their excessive 2022 peak, said **Maurício Fortuna**, CRU's phosphate fertilizer analyst. Prices have fallen across the board with Brazil MAP (monoammonium phosphate) prices correcting and stabilising particularly fast. Phosphate supply disruptions resulting from the Russia-Ukraine conflict were not as dramatic as many had expected, said Fortuna, a factor that had encouraged prices to stabilise.

Phosphate sales to Brazil fell by nine percent year-on-year in 2022. Inventories swelled from April onwards and were filled by August. "We expect the return of normal demand in 2023, with imports likely to pick up in coming months, even as

Brazil enters the year with strong inventories," Fortuna said.

The key potash market observations from **Logan Collins**, CRU's senior potash markets editor, were:

- **Potash prices are now mostly in decline** – following the record highs of 2022. MOP (muriate of potash) spot prices surged in 2022 on supply fears, with Brazil reaching \$1,210/t cfr in April last year. The Brazil MOP price is, however, now largely stable at \$515/t cfr.
- **Affordability has improved in Brazil** – supporting a rebound in demand. Potash affordability in Brazil is now at its most favourable level since mid-2021 with a barter ratio of around 17 bags of soy per tonne of MOP.
- **Supply disruptions are fading** as Russian/Belarusian volumes reach those markets that will accept them. Potash exports from Belarus and Russia were 4.8 million tonnes (61% down y-o-y) and 7.7 million tonnes (32% down y-o-y), respectively, in 2022. China has largely maintained its MOP imports from both countries. Russian shipments have proved most resilient with imports



NPCT's director general Luís Prochnow explaining how best to manage fertilizer use at a time of high prices – in a well-received and authoritative presentation.

across American and some Asian markets keeping in line with historic norms.

- **Effective production capacity continues to grow** – especially in Canada. Around 15.3 million t/a of MOP capacity additions are expected between 2022-2026, outpacing forecast demand growth of 7.7 million t/a over this period.
- **Prices will remain under downwards pressure** during 2023 as supply returns.

### Fertilizer use in a time of high prices

The use of fertilizers needs to follow the science – especially in times of high prices. That was the clear message from **Luís Prochnow**, the director general of Brazil's NPCT (Nutrição de Plantas Ciência e Tecnologia). He listed the following 12 strategies to help growers adjust their fertilizer management and achieve better returns:

- Evaluation and control of soil fertility
- Good nutrient management practices that follow the 4Rs (right source, right rate, right place, right time)
- Liming to improve nutrient use efficiency (NUE)
- Soil profile improvements to boost root growth through no-tillage practices and/or phosphogypsum use
- Selection of the right crop varieties to ensure better plant development, stronger roots and greater nutrient uptake
- Greater adoption of no-tillage systems to improve organic matter content, soil physical properties and nutrient availability
- Crop rotations, especially those that include grasses in the cropping system
- Monitoring and improving soil health by microbial testing and the application of microbial products
- Farmer education programmes on the wise use of nutrients
- Ensuring farmers can access crop consultants experienced in plant nutrition
- Finally, knowing exactly how much knowledge to apply per hectare and per plant – fast operational procedures should not surpass good quality ones!

Luis quoted the late Dirceu Gassen, Brazilian agriculture's great visionary, who said: "Farmers and crop consultants need to act like engineers in measuring, calculating and interpreting – and then make decisions." He also pointed out that none of the above measures were quick fixes.



*Pedro Paul Dias, economist at BNDES, explains the financing options for Brazil's fertilizer sector.*

Most were strategies for the longer term – and therefore not just for times when fertilizer prices were high.

### Nutrient use efficiency

How to increase nitrogen efficiency. That was the focus of the presentation by **Augusto Meneses**, vice president at Verdesian Life Sciences. Two Verdesian products were able to achieve this goal – one by increasing nutrient use efficiency (NChargeG) and the other by controlling nitrogen losses (Trident).

NChargeG incorporates Verdesian's cation exchange resin technology. This combines the benefits of long chain polymers with high cation exchange capacity and lower pH – and is proven to increase nitrogen efficiency in soils. Rice field trials with NChargeG in Puerto Gaitán, Colombia, for example, delivered a 23 percent yield improvement, compared to growers' standard practice.

Trident, meanwhile, protects against nitrogen losses due to volatilisation and denitrification-leaching, respectively, by incorporating nBPT (15%) and DCD (5%). The other active ingredients are a patented co-polymer that maximises the efficiency of nBPT and DCD and a patented solvent that stabilises the formulation. In a US corn trial, Trident treated urea delivered a yield of 12.5 t/ha versus 12.1 t/ha for untreated urea.

Another of Verdesian's innovative products, AvailT5, is designed to improve phosphorus availability by reducing soil fixation. It contains anionic polymers which complex with soil iron and aluminium ensuring that more phosphorus remains plant-available in the soil solution. In corn trials, the application of AvailT5 with MAP improved agronomic efficiency by increasing corn yield from 8.1 t/ha to 10.0 t/ha at an optimum MAP application rate of 110 kg/ha

### Fertilizer Industry financing in Brazil

**Pedro Paulo Dias**, economist at the Brazilian Ministry of Mines and Energy (BNDES), outlined the available financing options for Brazil's fertilizer sector. BNDES has leveraged BRL 5.6 billion of support for more than 3,600 fertilizer-related activities in Brazil since 2002. This was delivered via BRL 3.4 billion in direct support and BRL 2.2 billion in support from financial partners.

With the launch of the National Fertilizer Plan last year, the Brazilian government was very much focussed on growing domestic production capacity, Dias said. The plan was supported by reforms to the tax regime (ICMS Agreement 100/97) which will equalise taxation on imports and domestic fertilizer products from 2025.

BNDES is supporting new fertilizer production projects by offering long-term

corporate finance of up to 20 years and covering up to 80 percent of the necessary investment. FINAME (Financing Fund for the Acquisition of Machinery) loans are also available for equipment acquisitions.

The recovery of degraded pasture was another priority for the Brazilian government and the country's agricultural sector. Pedro quoted Carlos Favaro, Brazil's Minister of Agriculture: "In Brazil, there are 40 million hectares of pastures with very low productivity, which can be and are suitable for agriculture. They can and should be restored – making it possible to increase production without the need to convert new areas."

Recovery would also create more demand for fertilizers and agricultural lime. The restoration of 10 million hectares of degraded pasture, for example, would require 20 million tonnes of lime and between 9.7-15.7 million tonnes of fertilizers, depending on agricultural land use. Restoring 20 million hectares of degraded land would cost more than BRL 90 million, according to some estimates. Fertilizer applications make up most of the restoration cost, although its contribution to costs

**“Farmers and crop consultants need to act like engineers in measuring, calculating and interpreting – and then make decisions.**

varies greatly depending on the agricultural use – being as high as BRL 4,559/ha for pasture/cropland systems.

**Brazilian market deep dive**

2022 was a year to remember for soft commodities. The soybean price, for example, averaged a spectacular \$15.09/bushel last year. That compares to the \$13.60/bushel average for 2021 and the \$9.27/bushel price average over the preceding four-year period 2017-2020.


Nevertheless, **Bruno Fonseca**, senior economic analyst at Rabobank Brazil, described 2022 as a frustrating year. Fertilizer deliveries to Brazil went into reverse and fell back by 5.6 million tonnes last

year, having risen year-on-year by 4.3 million tonnes in 2020 and 5.3 million tonnes 2021. Fertilizer affordability in 2022 did not do farmers any favours either, Fonseca suggested, with crop nutrients generally at their least affordable since the 2008 fertilizer price peak.

However, another way of assessing the market over the last two years, said Fonseca, was by asking: "Was 2022 a frustrating year – or was 2021 too good?" The stars certainly did seem to align for Brazil in 2021 with, for example, low potash prices (<\$250/t) and high soybean prices (\$13.60/bushel average) combining to provide record soybean margins (70%) for growers.

A similar analysis might also conclude that Brazilian fertilizer deliveries in 2021 (46 million tonnes) were an above-trend outlier and that the downwards correction seen in 2022 was mostly a return to trend.

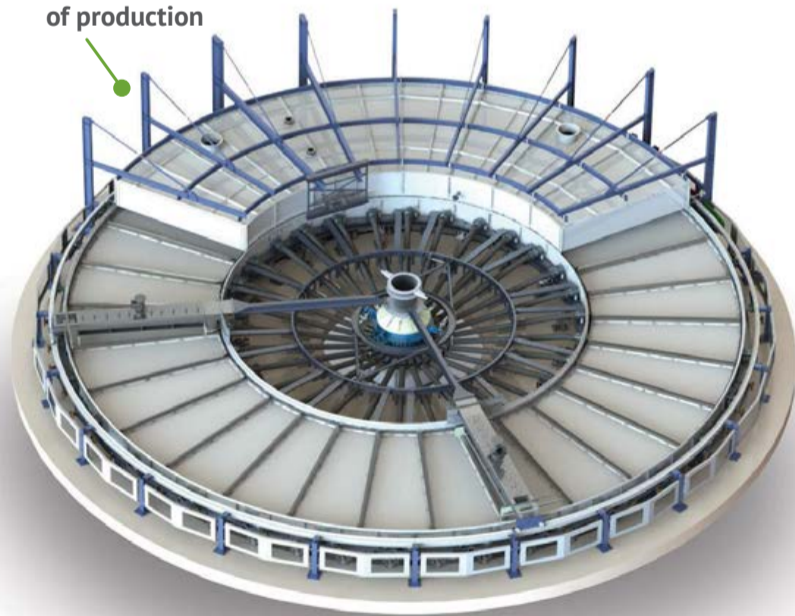
Looking ahead, Rabobank expects to see a recovery in Brazilian fertilizer demand in 2023. This is likely to be accompanied by fertilizers taking up of a smaller share of operational costs and overall margins improving for growers – if current agricultural commodity price levels are maintained. ■




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# Micronutrient market moves

Micronutrient products are one of the fertilizer industry's fastest growing segments. In response, ICL, Koch Agronomic Services, Leivity Crop Science, Omex and SQM have all strengthened their micronutrient portfolios.

## ICL

### The Brazilian launch of Nutriduo – a highly innovative foliar product

Guilherme Amarel, technical development manager, Robson Mauri, portfolio & services director, and Ithamar Prada, VP, marketing and innovation



ICL's manufacturing site in Suzano, São Paulo, Brazil.

ICL in South America offers a wide range of plant nutrition and growth products covering all of Brazil's main crops. Its specialty product portfolio includes:

- Slow and controlled release fertilizers
- Soil applied and foliar micronutrients
- Biostimulants
- Seed treatments
- Adjuvants.

These cover the entire agricultural value chain.

ICL serves over 32,000 farms in Brazil and has a presence in 25 of the country's 26 states. The company's large field sales force provides commercial coverage in all of Brazil's agricultural regions. Its well-established domestic assets base includes eight production sites.

#### Soil nutrient deficiencies

Currently, most cultivated areas in Brazil are nutrient deficient to some extent. This is linked to the natural and widespread

occurrence of poorly fertile acid soils and/or the extraction of nutrient by crops without subsequent replenishment. Low soil pH values and nutrient deficiencies – for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), boron (B) and zinc (Zn) etc. – are widely reported and act to limit crop yields. In Brazil, it is therefore essential to manage and improve soil nutrient content to maintain and increase crop productivity.

#### Foliar fertilization

To maximize the effectiveness of crop inputs and boost crop productivity, fertilizer producers are turning to technologies capable of improving nutrient use efficiency and meeting the nutritional demands of plants. The use of foliar fertilizers, for example, is increasing – both in Brazil and globally. This is shown by the rise in foliar product sales and the higher adoption rates for foliar application technologies. Foliar fertilization is also a growing area of academic research.

#### Plant, animal and human nutrition

Plant nutrition is fundamental for and directly related to human health, as many of the elements that are vital for plant metabolism and healthy crops are also essential to animals and humans. Despite this, the drive for ever greater crop productivity – necessary to satisfy growing food consumption globally – has caused a decline in the nutritional quality of harvested produce, especially after Asia's 'Green Revolution'.

Nowadays, therefore, in addition to raising crop productivity, the major challenge for agriculture is to improve nutritional quality – in plants, animal and humans – alongside the equally pressing need to guarantee food security.

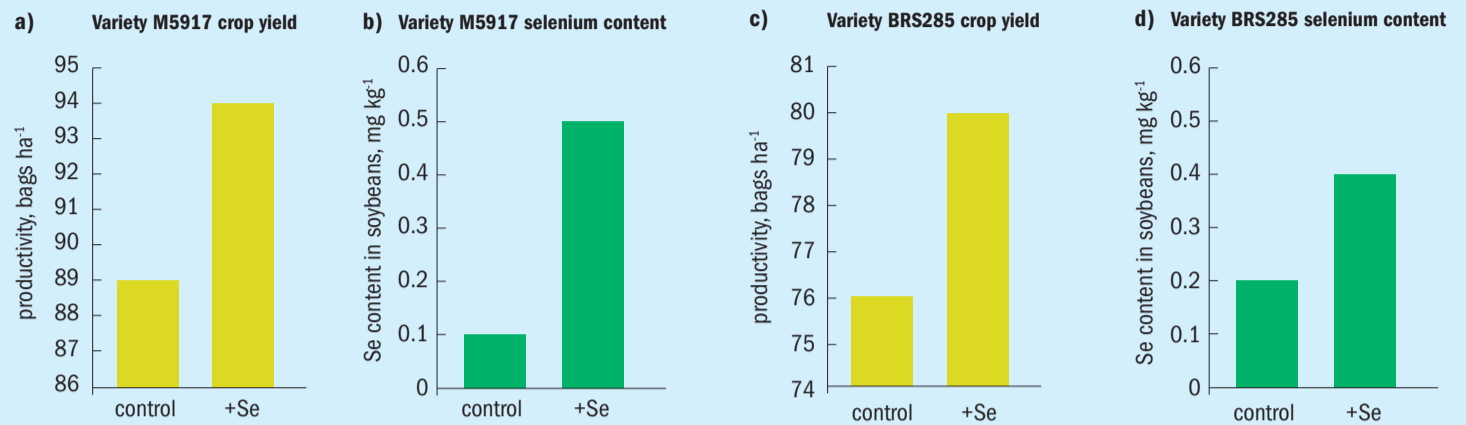
#### The launch of Nutriduo

ICL recently brought Nutriduo, a disruptive and innovative new micronutrient product, to market in Brazil. This plant-active foliar product is enriched with selenium (Se), magnesium (Mg) and zinc (Zn) and functions via three modes of action:

- **Improves photoprotection** – the presence of selenium (Se), by increasing carotenoid production, helps prevent sun damage in plants by improving energy dissipation during photosynthesis.
- **Activates the plant's antioxidant system** – the application of micronutrients in low concentrations (including Se) has a positive and direct effect on the enzymes that combat oxidative stress in plants and influences their secondary metabolism.



Fig. 1: Response of two soybean cultivars to Nutriduo application at the R1 stage: crop yield and grain selenium content



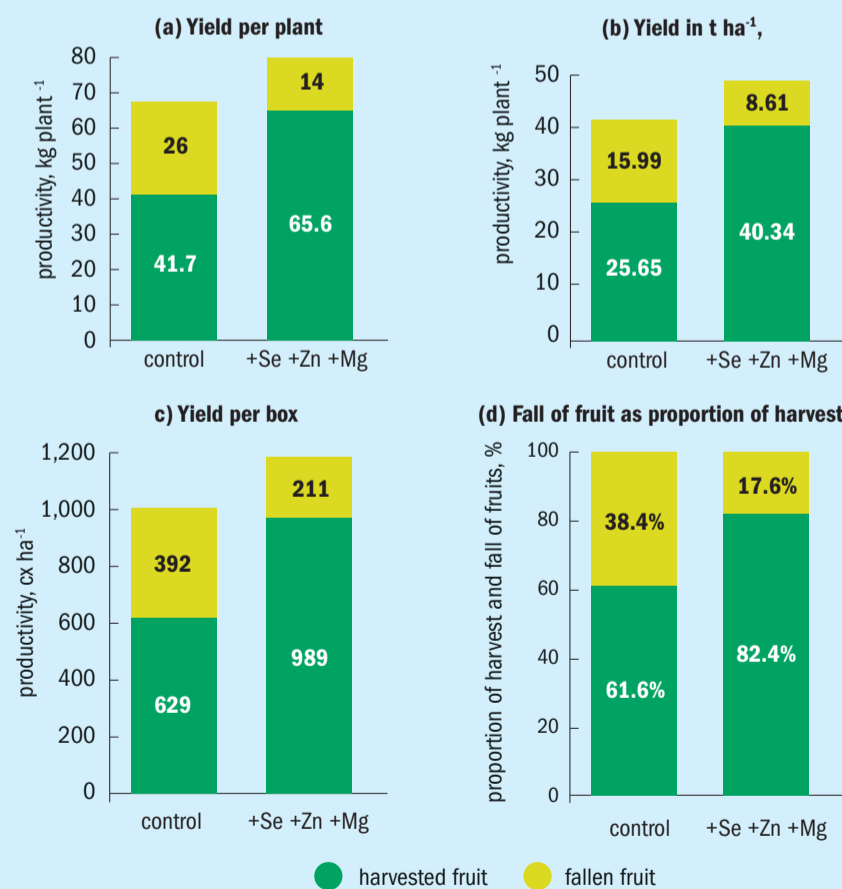
Source: unpublished data from Guilherme (2021)

Fig. 2: Murcott Tangerines: reductions in fallen fruit with Nutriduo application

Visual results for fallen fruit: (a) control treatment versus (b) combined treatment with selenium (Se) + zinc (Zn) + magnesium (Mg)



Results of control treatment versus combined treatment with selenium (Se) + zinc (Zn) + magnesium (Mg)



Source: ICL Market Development Department

- **Increases photoassimilate transport** – nutrients such as magnesium, potassium and selenium improve the flow of photoassimilates in the phloem vessels. This is beneficial as it increases the partition of carbohydrates from the leaves (source) to the harvested parts of the plant (drains) such as roots, tubers, pods and fruits.

In addition, Nutriduo also add Se to crop nutrient supply. This is a beneficial micronutrient for plants as well as being an essential element for animals and humans. Importantly, the application of Nutriduo – while helping plant metabolism and attenuating plant stress by enrichment with Se, Mg, and Zn – will also benefit human lives at the far end of the supply chain!

As a cutting-edge plant nutrient company, ICL’s launch of Nutriduo brings three new innovations to Brazilian agriculture:

- A patent-protected Mg-chelate
- A selenium complex to improve plant metabolism
- A balanced mix of crop nutrients that improves both yields and food safety conditions for the population.

### Proven field trial results

Field trials with two soybean varieties have shown that foliar spraying with Nutriduo:

- Increases crop productivity by around five percent
- Raises the Se content in the grains of this legume by 2-5-times (Figure 1).

Other field studies on Murcott tangerine (*Citrus reticulata* Blanco x *Citrus sinensis* L.) have shown that Nutriduo increases



Fig. 3: Murcott tangerines: visual appearance one day after harvest and 25 days after harvest, respectively, for control treatment (a, c) versus Se+ Zn + Mg (b, d).



PHOTO: ICL

ICL's Innovation Center at Iracemapolis, Sao Paulo, Brazil.

**“Nutriduo increases soybean crop productivity by around five percent and raises the selenium content in the grains of this legume by 2-5-times.**

both productivity and fruit retention in plants. Application of Nutriduo delivered greater profitability to the grower by increasing total productivity by 18 percent and reducing fruit drop by 46 percent (Figure 2). The visual properties of tangerines are among the main influences on consumer buying decisions. Beneficially, the application of Nutriduo improved the coloration and shelf life of these fruits compared to the control treatment (Figure 3).

### Chelated micronutrients

Nowadays, there are many types of foliar products available on the market – including those based on chlorides, sulphates, nitrates and chelates. Academic reviews of foliar fertilizers have highlighted the advantages offered by chelated micronutrients. The stability of the chelate bond protects micronutrients from hydrolysis and/or precipitation. Chelates, by supplying micronutrients to plants more efficiently, are generally able to quickly and fully correct nutritional deficiencies. Furthermore, nutrient absorption can be assisted by the affinity of the plant for the chelating agent.

Chelating agents do, however, need to be compatible with the enzyme system of plants so that there are no phytotoxicity problems. ICL has therefore been working to develop chelates using stable and mainly sustainable sources. (This is important at a time when the use of chelating agents is being questioned in parts of the world.) These new generation of chelates will be placed on the Brazilian market in 2023 and rolled out to other new markets subsequently.

ICL operates three research centres in different regions of Brazil to bring these and other innovations to market. These centres, such as the one in Iracemapolis (see photo), provide quick and reliable test results and are accredited by Brazil's agriculture ministry.

## LEVITY CROP SCIENCE

## New silicon and iron technologies

**B**ritish crop nutrition company Levity Crop Science has recently developed two new products designed to help growers better manage silicon and iron and prevent deficiencies across a variety of crop types:

Its new Zeme product features Si-X silicon technology, while Elona-Fe employs the company's well-proven LimiN system – a chemically stabilised amine nitrogen formulated with Levity's nutrient uptake stimulant.

### Silicon – vital for plant structure and metabolism

“Although silicon often doesn't register on the ‘essential nutrient’ scale,” says Levity's founder Dr David Marks, “it plays a vital role in plant metabolism and structure.

“Metabolically, it confers stress tolerance on plants to help them counter both abiotic and biotic factors, and it's instrumental in the transport of phosphate, zinc, manganese and copper through the plant.”

Plants also use it to build up a hard layer of opal, a type of silica, in the cuticle. This opaline layer has a dual-purpose:

- First, it slows the speed at which fungal pathogens can colonise the plant
- Second, it improves structural robustness by increasing stem thickness and reducing the plant's susceptibility to lodging – this being especially evident in cereals.

Dr Marks says that, while awareness of its role is growing, silicon is a difficult nutrient to tackle.

“Those opals are great for physical protection. But once they're formed, the silicon's no longer bioavailable for metabolic needs.

“Silicon constitutes around half the content of any typical soil, although most of it's not bioavailable. Also, what little there is – usually in the form of silicic acid ( $H_4SiO_4$ ) – is subject to fierce competition between plants and soil bacteria.”

There have been attempts to make foliar applications of silicon, says Dr Marks. “But there's another obstacle: silicon isn't phloem mobile.”

Levity responded to this challenge by developing Si-X technology (patent-pending) to stimulate the plant's naturally occurring

silicon transporters. This overcomes the problems associated with the ‘lock-up’ of conventional foliar silicon, says Dr Marks.

Si-X underwent its first major field trials in 2020 as part of Levity's Zeme formulation. Its application to spring wheat at T1 and T2 timings in tank-mix with conventional fungicides delivered a yield response of 1.2 t/ha.

### The iron deficiency challenge

Elona-Fe, meanwhile, has been developed mainly to help growers address the long-standing problem of iron deficiency on high pH, calcareous soils.

“Traditionally, iron chelates such as EDDHA have been pushed as a solution,” says Dr Marks. “But once you understand the reasons for the iron deficiency, it's easy to see that EDDHA is only a sticking-plaster.”

That's because there's a strong link between nitrogen uptake and iron demand and deficiency, he explains. “The more nitrogen plants receive, the more iron they require. Iron's used as an essential enzyme co-factor when plants process nitrates into proteins.

“But when plants take up non-nitrate forms of nitrogen, such as ammonium and amine, the roots release protons during the exchange process. These protons then go on to dislodge soil-bound nutrients such as iron, allowing their absorption by the roots.

“Research shows that plants can use as much as 70 percent of their available iron for processing nitrates. Most of the nitrogen we apply to crops around the world is picked up by the plant in the form of nitrates, so we're feeding plants in a way that increases their need for iron, while decreasing its supply.”

Once armed with this information, priorities for reducing iron deficiency can then be identified and acted on. These should include reducing the overall need for iron, improving harvesting of soil-bound iron, and only then supplying any additional requirement.

“Yet the traditional approach – EDDHA – simply ignores these first two points,” suggests Dr Marks. “Repeated applications of synthetic chelates are not resource-efficient in our view.”

Levity's R&D team turned to one of its earlier technologies, LimiN, when developing Elona-Fe. This chemically stabilised amine nitrogen (SAN) allows the plant



Dr David Marks, founder and managing director of Levity Crop Science inspects a Dutch onion trial.

to access a non-nitrate form of nitrogen, thereby reducing the plant's iron demand and helping to unlock natural iron sources in the soil. Furthermore, by linking iron to the stabilised amine, the plant absorbs iron alongside the nitrogen.

Levity has enhanced this process by formulating Elona-Fe with its proprietary nutrient uptake stimulant, Catalyst. After application, this helps eliminate short-term deficiencies immediately by increasing the speed of uptake and iron utilisation by the crop.

“Iron's another vital element needed by the plant. The reason iron deficiency shows up as chlorosis [yellowing of the leaves] is because it's directly involved in chlorophyll synthesis – if there's no iron, there's no chlorophyll and therefore no photosynthesis!”

Both new products demonstrate Levity's problem-solving approach to crop nutrition, comments Dr Marks. “We identify ways in which we can work with, or enhance, the plant's own metabolic pathways. It's about helping the crop to help itself, effectively by supercharging its own systems – in a way that maximises resource-use efficiency, something we should all be committed to.”

### A growing portfolio

Both new products, Elona-Fe and Zeme, are available from Levity's UK and international distributors. They join a growing range of ‘smart’ products from this R&D focused company, such as LoCal and Damu.

LoCal is a calcium transport stimulant that improves quality and shelf-life in fruit crops. The boron-based Damu, in contrast, helps regulate carbohydrate transport in plants – a property that can optimise yield and yield distribution by manipulating plant growth stages and the way nutrients partition within the plants. ■

OMEX AGRIFLUIDS

# Micronutrient coatings

Andrew Lawrence, export manager

It is well understood that young plants can benefit from extra nutrient supply. Early nutrient availability is therefore essential, given that the first 30 days are particularly critical if crops are to reach their ultimate yield potential.

Providing both the macronutrients and micronutrients required for seedling development, Omex's MDS coatings provide an excellent way to accurately deliver micronutrients alongside early applied granular fertilizer. They can also be delivered as a seed coating.

## Crop benefits

Using soil testing, growers can adjust the MDS dose rate for coating field-applied fertilizers such as urea, diammonium phosphate and monoammonium phosphate (DAP/MAP) and NPKs (bulk blends or compound fertilizers). This makes the application both cost effective and accurate by ensuring that the micronutrients supplied are what is needed for that crop/season.

The early uptake of nutrients helps plants get off to a strong start and ensures they can cope with transplant stress and other early-season stresses. Improved crop establishment and better early development of the plant's root system ultimately delivers higher crop yields by increasing nutrient uptake efficiency. This holds true even where growers are reducing their overall fertilizer application rates. This is an important consideration for growers currently, given factors such as high and volatile fertilizer prices, the environmental focus on nutrient losses, and the drive to improve fertilizer efficiency. For example, when using urea coated with MDS Zinc, some growers are reporting solid results on a variety of crops at application rates 25-50 percent below their traditional levels.

When measuring the improvement in P<sub>2</sub>O<sub>5</sub> uptake by wheat for DAP coated with MDS Zinc, results also showed improved uptake across all of the nutrients tested for (Table 1).

## Micronutrient fortification

As well as the expected plant growth and yields benefit of using MDS coatings, the nutritional value of the final product can



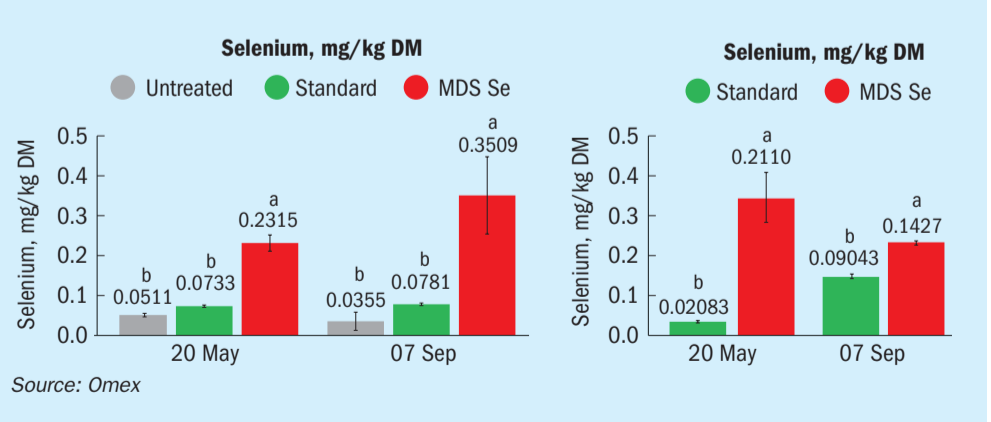
PHOTO: OMEX

Table 1: Uptake of nutrients by wheat: flag leaf stage test results for untreated DAP versus DAP coated with MDS Zinc

Nutrient	Unit	Untreated	Treated	% change
N	%	2.68	3.52	31.34
Fe	ppm	105.00	148.00	40.95
P	%	0.33	0.41	24.24
Mn	ppm	40.00	43.60	9.00
K	%	3.53	4.70	33.14
B	ppm	3.27	3.57	9.17
Ca	%	0.33	0.45	36.36
Cu	ppm	8.81	9.78	11.01
Mg	%	0.20	0.22	10.00
Mo	ppm	1.05	1.30	23.81
S	%	0.27	0.36	33.33
Zn	ppm	32.70	38.70	18.35

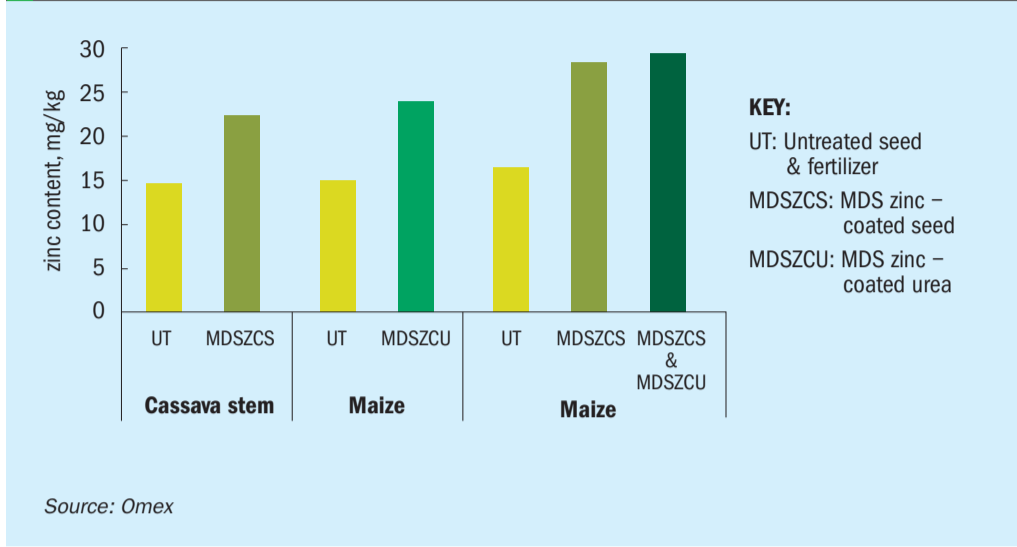
Source: Omex

Fig. 1: Selenium fortification for cattle. UK trials on grassland with urea coated with MDS Selenium significantly increased the Se content available to animals in both established pasture (left) and new ley (right).



Source: Omex

Fig. 2: Zinc fortification: the zinc content of harvested cassava and maize after MDS applications



Source: Omex

be improved via fortification with essential nutrients, such as zinc for humans and selenium for cattle.

In UK testing on grassland (new ley and established pasture), urea coated with MDS Selenium significantly increased the Se content available to animals (Figure 1). Existing test results on crops such as cas-

sava and maize also show large increases in the zinc content of the harvested product (Figure 2). Other trials on rice, using MDS Zinc as both a seed and fertilizer coating, are ongoing currently. Omex is also carrying out further research on the fortification of different crop types with a range of nutrients essential for humans and animals.

Additional benefits

Extra to the already mentioned crop benefits, the use of MDS coatings has other production and handling advantages. The reduction in dust during blending, for example, is a major health & safety benefit for workers. Because MDS physically coats each granule, nutrient segregation during mixing is also eliminated. This improves the performance of NPK products when applied to the field.

MDS application rates are adjustable to suit any crop or soil type – and therefore deliver what is required for the next crop cycle, so growers are not over applying and overspending. MDS coatings can also be combined with Omex’s urease inhibitor when applied to urea to reduce nitrogen losses via volatilisation.

Finally, applying additional nutrients as a coating to standard granular fertilizer products can reduce the number of applications required and therefore cut labour costs. This is a major advantage for many growers who are facing both higher input costs and a dwindling labour pool currently.

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KOCH AGRONOMIC SERVICES (KAS)



Above: Michael Berry, Director of Innovation and Business Development at KAS.

# The critical role of micronutrients

In an exclusive interview, **Michael Berry**, Director of Innovation and Business Development at Koch Agronomic Services (KAS), talks to *Fertilizer International* about the company’s micronutrient product range.

**PROTIVATE is available in three formulations and provides both macronutrients and micronutrients to a variety of crops. It puts nutrition right where the crops need it.**

**In 2021, Koch Agronomic Services (KAS) acquired the brands WOLF TRAX™ DDP™ micronutrients and PROTIVATE™ nutritional seed enhancer. What was the thinking behind their purchase and how do these brands add to and complement your pre-existing crop nutrition product range?**

Growers already recognize the importance of keeping vital macronutrients, like NPK, available in their soil for optimum plant uptake. However, they’re also realizing how critical the role of micronutrients is in the plant’s growth cycle.

By adding these market-leading micronutrient solutions to our portfolio, KAS has expanded on our commitment to provide our customers with innovative, value-added solutions. The micronutrient product portfolio – by improving nutrient use efficiency through balanced fertilization – complements our nitrogen stabiliser portfolio.

With WOLF TRAX DDP and PROTIVATE, growers have additional tools to manage the distribution of micronutrients across their fields and increase their maximum yield potential.

**What crop types benefit most from seed enhancers, how are they applied and what can growers expect in term of yield improvements and better net returns?**

PROTIVATE nutritional seed enhancers are designed to give young crops the nutrients needed for optimal crop establishment, while also eliminating the need for talc, so plants thrive in the early stages of growth and growers optimise yield advantages.

PROTIVATE is available in three formulations and provides both macronutrients and micronutrients to a variety of crops. It puts nutrition right where the crops need it. Growers appreciate the flexibility of application too – either self-applied in the planter with the seed or upstream with a retailer or seed provider.

The NU4-DRI formulation, for example, is designed to work with corn, wheat, soybeans, rice and cotton, and incorporates nitrogen, phosphate, manganese and zinc to promote root growth and seed flowability. The NU5-DRI

formulation, meanwhile, contains ideal amounts of phosphate, manganese, zinc, iron and molybdenum to aid root growth in soybeans, legumes and pulse crops, as well as improving flowability through the planter. The remaining formulation, NU5-LUX, is a seed finisher applied upstream and contains nitrogen, phosphate, manganese, zinc, molybdenum together with a shine component.

By giving seedlings easy access to vital nutrients, PROTIVATE gives those plants the ability to overcome early season challenges such as cold soil and extreme moisture events. These products also help plants develop a deeper root system.

Our trial results for PROTIVATE [NU4-DRI] show root growth two times larger than the untreated control. In other studies, PROTIVATE [NU4-DRI] provided an additional 4 bu/acre yield advantage over talc and graphite alone.

**Which micronutrients do WOLF TRAX DPP provide and how do these products function?**

WOLF TRAX is already a popular and well-established brand in North America designed to simplify nutrient management, boost crop performance and maximise nutrient use efficiency.

The portfolio consists of single element formulations including zinc, boron, copper, iron, manganese, magnesium, and calcium. These can be applied individually or in combination onto a dry fertilizer blend to achieve the optimal nutrient mix needed for the field and crop.

The WOLF TRAX portfolio also contains three formulations that offer a pre-mixed combination of macro and micronutrients. These formulations are designed to improve the operational efficiency at the fertilizer blender while delivering an optimal nutritional mix for the crop.

I should also mention that EvenCoat™, a patented KAS technology, is included in all WOLF TRAX formulations. This ensures the adhesion of micronutrients to the entire surface of dry fertilizer granules. In turn, that allows for even distribution of nutrients across the field, giving

plants better access for uptake when and where those micronutrients are needed.

**Could you explain more about Nu-Trax P+™, an innovative phosphorus-based formulation designed to improve early-season crop nutrition?**

NU-TRAX P+, as one of WOLF TRAX's three nutrient blends, is a unique formulation. Its high concentration of phosphate and zinc plays a critical role in the early development of plants. [Its composition is 4% nitrogen, 25% available phosphate, 20% zinc, and 5% manganese.] Growers, by using NU-TRAX P+ with this custom blend, are therefore placing critical macro and micronutrients where plants need these most.

Why is this valuable? Well, we know that when plants have the right amounts of nutrients at the right time in the right place, they are more likely to overcome early season challenges, particularly with soil temperatures and moisture events.

**Is farmer education equally important for demonstrating the benefits of the company's relatively new micronutrient product range?**

Yes, that's absolutely right – grower education is very important. A key advantage for both WOLF TRAX and PROTIVATE is they both offer proven solutions. They stimulate root growth and overall plant health by placing the right amounts of micronutrients in the field in the right place at the right time. Growers have already experienced or seen the advantages of using these tools as part of their micronutrient management plans.

KAS offers multiple educational resources to growers including articles on the 'Knowledge Center' section of our website [KochAgronomicServices.com]. There, growers can find information on topics including the role of zinc in crop nutrition, the yield-limiting effects of hidden hunger as well as boron as an essential nutrient in crop production.

KAS also publishes a successful podcast called 'Field Notes' – which can be found on popular podcast streaming services. It provides another excellent resource for growers to learn more about WOLF TRAX, PROTIVATE and other KAS nutrient solutions.

**Are additional WOLF TRAX and PROTIVATE products in the pipeline and is KAS targeting new crop types and/or regions for these products?**

We're always making efforts to grow as a crop nutrient enhancement leader. So, yes, expanding our portfolio for growers around the globe – to improve nutrient efficiency, utilisation and uptake – continues to be a focus for us.

Adding value for our retailers and growers is one of the many goals that KAS tries to achieve with every new product announcement. Talking and listening to growers is particularly important. Because of that, our scientists and agronomists are in constant contact with our customers to find out what they require to improve their operations from a nutrient management standpoint.

It's that customer feedback that drives new product formulations – as well as growth into key markets such as Latin America. ■

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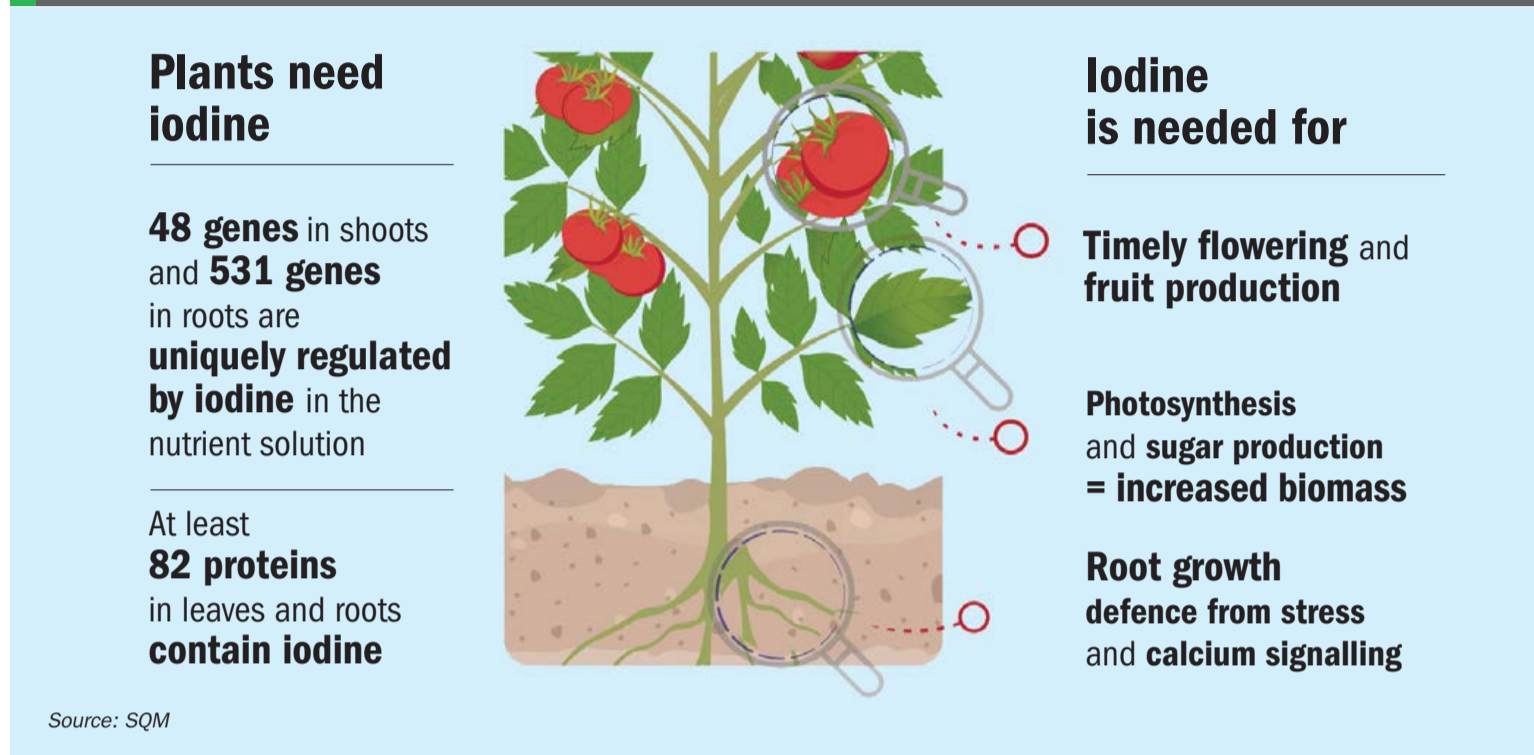
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SQM

## Ultrasol®ine K Plus – a new speciality iodine fertilizer

Fig. 1: The nutritional role of iodine in plants



### Iodine as a plant nutrient

“**R**esults are strongly suggestive of the role of iodine as a plant nutrient.” That was the main conclusion of a landmark paper published by Italian scientists last year<sup>1</sup>.

It has long been known that iodine is essential for human and animal health. But these researchers have now demonstrated that plants need micro doses of iodine as well. For the first time, they identified and described the presence of 82 naturally-occurring iodine-containing proteins in higher plants (Figure 1).

Their research has shown – based on phenotyping, genomics and proteomics studies – that plants need iodine for:

- Leaf and root growth
- Efficient photosynthesis
- Timely flowering
- Increased fruit and seed production
- The activation of a valuable early warning system that defends the plant against damage from abiotic and biotic stress.

Iodine deficiency may also cause lower crop yields and poorer fruit quality, particularly in growing regions where the soil and water are naturally low in iodine.

### New iodine fertigation product launched

SQM, the leading global speciality fertilizer producer, has been quick to follow up on these latest discoveries. In response to new information highlighting the importance of iodine as an essential plant nutrient, the Chilean-based company has developed a speciality fertilizer with iodine for fertigated crops. This allows growers to apply iodine as a plant micronutrient in a form that is guaranteed to be safe and at an effective science-based dose.

The newly-launched product, known as Ultrasol®ine K Plus, combines two essential plant macronutrients – potassium and nitrate nitrogen – with iodine. The product ensures that they are applied at well-defined application rates. This makes it easy for the grower to maintain an effective and safe concentration of iodine in the root zone. As a result, Ultrasol®ine K Plus can prevent iodine deficiency in crops without the risk of excessive iodine application.

The product has already been extensively tested globally and is backed by more than 100 well-documented trials with growers. The experience of these growers has confirmed that iodine can deliver distinct benefits – including improvements to:

- Root growth
- Above ground plant growth
- Photosynthesis
- Nitrogen metabolism
- Tolerance to abiotic stress
- Flowering and fruit quality with less fruit rot and better shelf life.

Typically, the application of iodine to crops delivers 10 percent more marketable yield. This is the average yield improvement from trials on 52 farms located in 14 countries with coverage of 19 different crops. These trials compared Ultrasol®ine K Plus to potassium nitrate without iodine for the same crop, on the same planting date with the same fertilizer programme. Crops included: tomato, lettuce, sweet pepper, cucumber, musk melon, sugarcane, pomegranate, papaya, banana and coffee.

Overall, the trials demonstrated that Ultrasol®ine K Plus enables iodine to be easily applied and improve crop performance – with this leading to higher yields, improved quality and therefore better revenues. The product was made available in the European market in July 2022. ■

### References

1. Kiferle, C., et al., 2021. Evidences for a nutritional role of iodine in plants. *Front. Plant Sci.*, 17 February 2021.





PHOTO: INTERNATIONAL PLANT NUTRITION INSTITUTE

Sulphur is a vital secondary crop nutrient. It can be delivered in sulphate, thiosulphate and elemental form. The range of product and process options are outlined.

*Above: Urea-ES/ Special-S maize field trial, Siaya, Kenya.*

### Increasing agricultural value

**S**ulphur is becoming an increasingly important crop nutrient due to three main factors (*Fertilizer International* 497, p24):

- **Falling atmospheric deposition.** Soil sulphur deficiency, a relative rarity 20 years ago, is becoming more common. The deposition of sulphur dioxide emissions from the atmosphere used to guarantee that soils in many regions were automatically enriched and replenished with sulphur. This is no longer the case as increasingly stringent environmental regulations and the introduction of low-sulphur fuels have sharply cut emissions.
- **The prevalence of high-analysis fertilizers.** Farmers are continuing to switch to high-analysis products, containing little or no sulphur, at the expense of sulphur-rich, lower analysis products. This long-term buying trend has also put sulphur replenishment on a downward path.
- **Rising cropping intensity.** Improving crop yields are withdrawing ever larger amounts of sulphur from the field.

These three factors are, however, opening up opportunities for fertilizer producers. A number of leading manufacturers are capitalising on the value of sulphur by broadening their portfolios and supplying sulphur-enhanced fertilizers as premium products to meet growing market demand. New processes to coat fertilizers with sulphur, or disperse sulphur within fertilizer granules, are also being developed and commercialised.

### Product and process innovation

AgriTech company **Sulvaris** manufactures innovative sulphur-containing fertilizers for sustainable and regenerative agriculture. The Calgary-headquartered company has commercialised its micronised sulphur technology (MST®). This economically micronises elemental sulphur to an average size of less than 10 microns. In collaboration with Nutrien, the world's largest fertilizer producer and retailer, Sulvaris has incorporated this enhanced efficiency technology within mono-ammonium phosphate (MAP) to create a MAP + MST® product. This is marketed by Nutrien under the brand name SmartNutritien™.

Sulvaris has also created a patented urea + MST® product. This is manufactured by incorporating micronised elemental sulphur directly into the urea melt during the granulation process. Urea + MST® can produce granules with a 5-12 percent elemental sulphur content.

Sulphur is evenly dispersed throughout the granule and therefore provides maximum soil-to-fertilizer contact. The presence of tiny micron-size particles also increases surface area dramatically. This speeds up the microbial oxidation needed to convert insoluble elemental sulphur into soluble plant-available sulphate.

Unlike elemental sulphur products made up of larger sized particles, which may not fully oxidise during the application season, MST® begins to oxidise within days of application and provides the crop with season-long sulphur nutrition. MST® can also be co-granulated with a variety of other N, P, K and sulphate fertilizers.

- MST® offers the following advantages:
- It can be mass produced economically and safely in a single step via a low temperature and pressure process

# AGRICULTURAL CONSUMPTION OF SULPHUR

Global agricultural consumption of sulphur is around 13.3 million tonnes (Figure 1), according to a first-of-its-kind assessment by the International Fertilizer Association (IFA). This volume is much higher than the frequently quoted estimate of 10-11 million tonnes. However, this latest tonnage is probably still an underestimate, suggests IFA, as it excludes data for some NPK+S products<sup>1</sup>.

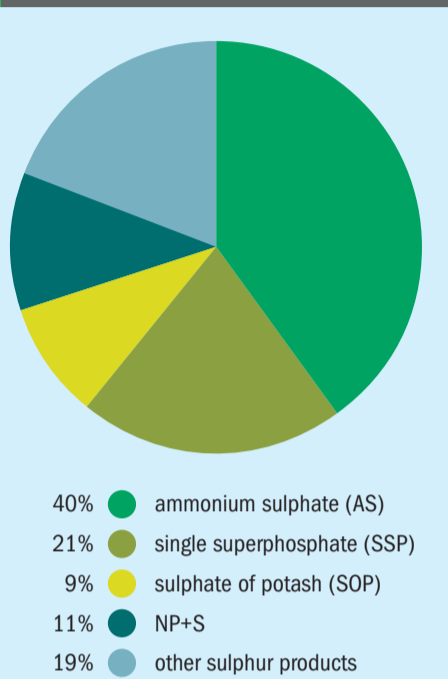
The sulphur fertilizer market divides into two main categories – traditional sulphate fertilizers and sulphur-enhanced fertilizers. These have a wide range of nutrient compositions. Liquid sulphur products – thiosulphates – are also favoured in some countries and regions, particularly in North America and Europe.

## Sulphate fertilizers

Traditional sulphate fertilizers have long dominated global demand (*Fertilizer International* 476, p19). They include:

- **Single superphosphate (SSP)**. The second largest-selling phosphate fertilizer on the market after diammonium phosphate (DAP). Consumption is concentrated in four main markets, China, Brazil, India and Australia, which collectively account for around 85 percent of total global demand.
- **Ammonium sulphate (AS)**. Consumption is on the rise even though its nitrogen content is much lower than urea and ammonium nitrate. World supply (26.4 million tonnes) has been boosted by the massive growth of ‘involuntary’ production capacity in China. The use of AS in NPK blends has become increasingly popular as awareness of sulphur deficiency in soils has become more widespread.
- **Sulphate of potash (SOP)**. This is valued as a chloride-free source of potash for lucrative cash crops such as tobacco, tree nuts and citrus fruits. Agricultural consumption is 7-8 million tonnes currently. China accounts for more than half of global use. North America and Europe also offer sizeable markets. Global demand is supply-constrained meaning that SOP trades at a premium.

Fig. 1: Agricultural sulphur consumption by product, 2015



Source: IFA (2017)

- **Sulphate of potash magnesia (SOPM)**. The market for SOPM, similar to SOP and SSP, is highly concentrated with just four countries, China, the US, Canada and Germany, accounting for the lion’s share of consumption. Global demand has grown strongly in recent years.
- **Ammonium phosphate sulphate (APS)**. This is a commonly produced grade of NP+S fertilizer (16-20-0-14S) with a 60 percent ammonium sulphate and 40 percent monoammonium phosphate (MAP) composition. It is directly applied to forage crops in many countries, particularly legumes, and is also a popular choice of fertilizer for small grains and oilseed rape (canola).

Overall, the global sulphur fertilizer market is still dominated by AS, SSP and SOP, with these three products combined being responsible for 70 percent of agricultural sulphur consumption (Figure 1).

## Sulphur-enhanced fertilizers

Global crop requirements for sulphur are rising and are thought to exceed 24 million tonnes, a volume far in excess of current consumption levels. Fertilizer producers have reacted to this widening demand gap by developing sulphur-enhanced fertilizers. Many of these premium products are manufactured by incorporating elemental sulphur into high analysis fertilizers, either within granules or as an external coating.

Introducing a liquid sulphur spray to urea, TSP, MAP or DAP during drum or pan granulation, for example, results in NPS products with a 5-20 percent elemental sulphur content. Sulphur-enhanced fertilizers combine nutrient availability with high use-efficiency, and also have good storage and handling properties. Examples include:

- Sulphur-bentonite
- Sulphur-coated urea, MAP or TSP
- Sulphur-enriched SSP
- Sulphur-enhanced MAP enriched with sulphate.

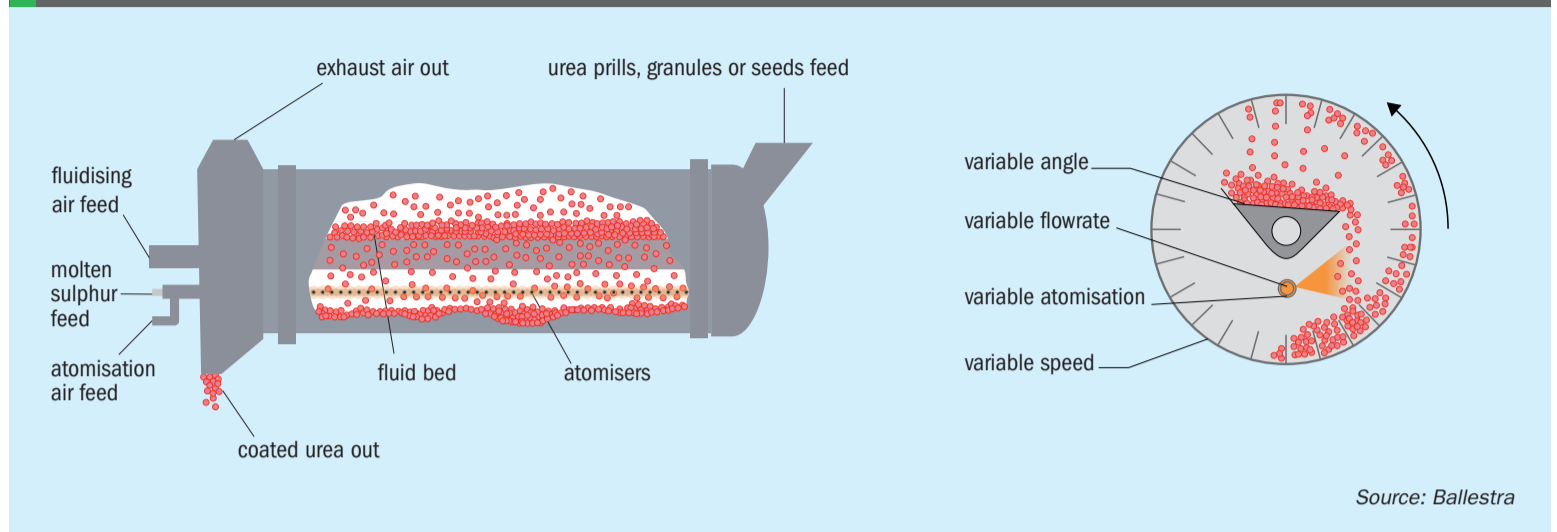
- It can be incorporated directly into the urea melt pipeline for granulation or prilling
- The process has low capex and opex costs, by avoiding expensive modifications and production losses at the urea plant, and produces excellent quality products.

**Shell Sulphur Solutions** developed the successful and pioneering micronised sul-

phur product Thiogro, which it licenses to key fertilizer producers around the world. The company successfully commercialised and patented technology for incorporating sulphur into ammonium phosphates in the early 2000s. Sulphur-enhanced phosphate lines have subsequently been licensed and installed at fertilizer plants in Asia, North America and Australia. This include a major collaboration with SinoChem in China (*Sulphur* 381, p24).

Shell also landed a major licensing deal with OCP Group in 2016. This allows the Moroccan phosphate giant to produce its own range of highly-concentrated sulphur-enhanced fertilizers by using Thiogro technology to incorporate elemental sulphur into ammonium phosphates, NPKs and other products manufactured at its Jorf Lasfar site. By adding new and potentially highly-lucrative premium products to its existing fertilizer range, the licencing deal

Fig. 2: Schematic of Ballestra's fluid drum granulator



Source: Ballestra

with Shell is an important long-term strategic move by OCP.

A more recent breakthrough was Shell's development of Urea-ES (enhanced sulphur), a dispersion of micronised sulphur in urea. This innovative technology – introduced to the market by Shell in 2016 – suspends 7-20 percent elemental sulphur in a urea matrix with a nitrogen content of 43-37 percent.

Shell subsequently introduced Special-S, a further refinement of the technology, in 2017. This produces a co-granulated high sulphur content (11-0-0-75ES) urea product (*Fertilizer International* 492, p44). Shell has successfully collaborated with both thyssenkrupp Fertilizer Technology (*Fertilizer International* 510, p17) and IPCO, leading providers of fluid bed granulation and Rotoform finishing technology, respectively.

These partnerships mean Urea-ES and Special-S technologies are now widely available to producers wishing to expand their portfolios to include sulphur-enhanced fertilizers. H Sulphur Corp, one of Asia's leading sulphur suppliers and sulphur-bentonite producers, has licensed Shell's Special-S technology, commissioning the first ever production plant in South Korea. H Sulphur subsequently begun manufacturing and selling Special-S under its own Super S brand name. This product has been successfully sold and shipped to customers in Canada, Australia and Brazil (*Fertilizer International* 492, p44).

An innovative bi fluidised drum granulation (BFDG) process developed by Italy's **Ballestra** is capable of coating urea using a wide variety of seeding materials in combination with a urea melt. This includes sulphur-coated urea production, according to Ballestra.

BFDG produces spherical granules by spraying a molten salt, suspension or clear solution onto seeds or recycled product. The process combines together drum granulation and fluidised bed technology as follows:

- The drum granulator consists of a cylindrical drum rotating around its axis equipped with lifters
- A fluidised bed installed inside the granulator is supplied with atmospheric/hot/cold and recycled air
- The BFDG also incorporates unique bi-fluid spraying nozzles that are able to generate granules with fine and coarse surfaces.

Essentially, the BFDG unit is a rotating drum with a fixed table inside made of a perforated metal sheet (Figure 2). The rotation of the drum lifts the granules onto the table, where they are kept in fluid bed conditions by air flowing through holes in the metal sheet. The perforated table is slightly inclined to one side. This allows dry granules from the fluid bed to fall back to the lower part of the rotating drum. While doing so, they pass through an incoming spray of fresh urea, which creates a further layer of material.

The North American market for **The Mosaic Company's** successful and pioneering sulphur-enhanced MAP product range, MicroEssentials, broke through the one million t/a barrier at the end of 2013. Mosaic's sales of 7.7 million tonnes of finished phosphates in 2021 included 3.8 million tonnes of MicroEssentials speciality products (and feed ingredients).

These versatile premium fertilizers are now applied to more than 10 percent of US farmland. They are suitable for both direct

application and bulk blending and their increasing use is backed by more than a decade of field data and over 1,200 crop trials globally.

The proprietary Fusion process used in the manufacture of MicroEssentials joins together nitrogen, phosphorus, sulphur and zinc to create a nutritionally-balanced granule capable of boosting crop yields by 3-7 percent, compared to conventional MAP or DAP. Three main formulations are offered by Mosaic, all of these containing a 50:50 mix of elemental sulphur and sulphate.

**Sulphur Mills Limited (SML)** is the world's largest manufacturer of water-dispersible granules (WDGs). The Mumbai-based company has been expanding rapidly and increasing the availability of these innovative sulphur-based products across the globe.

WDGs are extremely fine granules (2-4 micron size) manufactured by SML using a patented process. SML's flagship products, Techno-S® and Techno-Z®, are the world's first low-dose WDG fertilizers. They represent a technological leap forward in soil-based fertilizer applications, according to the company, and are helping to change the way sulphur-based fertilizers are perceived.

Both products have excellent water dispersion properties and are offered as either standalone sulphur microgranules (Techno-S®) or zinc-fortified microgranules (Techno-Z®). Techno-S® is a 90 percent sulphur fertilizer, while Techno-Z® combines 15 percent zinc with 70 percent sulphur.

Both fertilizers function at very low dosages and offer high nutrient use efficiency. They undergo quick oxidation, making S and Zn readily available to the plant throughout the season from early crop stages onwards.

SML has thoroughly tested WDGs agronomically – across countries, crop types and on different soil types. This has demonstrated their ability to improve various crop growth and quality parameters, including:

- Better crop yields
- Improved protein and oil content in oil seed crops
- Higher starch content in tubers
- Longer shelf life in final produce such as onions.

The versatility of these micron-sized granular fertilizers, particularly their flexibility when it comes to the choice of application method, is an added advantage. Both products are suitable for various farming practices – including micro-irrigation (drip) systems, sprinklers, overhead irrigation equipment, or conventional broadcasting and seed drill fertilizer applications.

“Our R&D is continuously working towards providing more and more innovative solutions in the plant nutrient as well as the crop protection space,” Bimal Shah, SML’s managing director, told *Fertilizer International*. “Our products reduce the overall impact on the environment while providing the most efficient, efficacious and cost-effective solutions to the farming community.”

SML’s product range is now offered to farmers in over 80 countries. Advantageously, being OMRI-certified, Techno-S® and Techno-Z® are approved for organic farming too.

Having achieved rapid growth and adoption of these products in India, SML has now successfully established a firm foothold in the Turkish agricultural market. “This year we are gearing up for some mega launches in Brazil and Europe alongside our continued focus in the US,” said Bimal Shah.

Fertigation, the application of nutrients via an irrigation system, is a niche but high-value agricultural market for sulphur. Thio-sulphates, in particular, are widely-used as liquid sulphur fertilizers in the broad acre and speciality crop market in North America and Europe. Their use is also on the increase in Latin America.

**Tessenderlo Group** is a global leader in speciality liquid fertilizers and manufactures four main thiosulphate products:

- Ammonium thiosulfate, Thio-Sul (12% N + 26% S)
- Potassium thiosulphate, KTS (25% K + 17% S)
- Calcium thiosulfate, CaTs (6% Ca +10% S)
- Magnesium thiosulfate, MagThio (4% Mg + 10% S)

Thiosulphates offer sulphur in both immediately plant-available form and in slower release form available to plants over a longer time period. Thiosulfates also have a modest acidification effect, benefitting crops grown on alkaline (calcareous) soils.

According to Tessenderlo, providing sulphur to crops via thiosulphates can offer the following specific benefits:

- Enhances crop protein and chlorophyll content
- Assists the synthesis and functioning of enzymes in the plant
- Optimises fertilizer efficiency by stabilising nitrogen
- Improves availability of nutrients in the soil, particularly phosphorus and micronutrients, and their uptake by the crop
- Energy efficient assimilation in the plant
- Provides prolonged sulphur nutrition
- A controlled and localised pH adjustment effect in the soil.

Thio-Sul is suitable for a variety of application methods and, alongside nitrogen, delivers sulphur as ‘active’ thiosulphate. It also improves phosphorus uptake and can be added to urea ammonium nitrate (UAN) to improve nitrogen use efficiency.

KTS is one of the most concentrated forms of liquid potassium and sulphur available on the market. It is marketed as a fast-acting and flexible liquid potassium crop quality improver, particularly in fertigation applications. The product is suitable for booster or starter formulations and can also be applied as a foliar fertilizer when crop demand for potassium is high.

When combined with liquid ammonium polyphosphate (APP), KTS can be applied as an effective starter fertilizer early in the plant’s growth cycle. The presence of KTS improves phosphorus use efficiency by regulating the rate at which polyphosphates turn into orthophosphates and becomes plant available.

Thio-Sul has a powerful acidification effect by combining the ammonium cation with thiosulfate. Thio-Sul also provides two particular benefits when combined with UAN solutions:

- It brings sulphur as a nutrient into the mix – the correct N/S ratio being very important for most crops
- It acts as nitrogen stabiliser improving nitrogen use efficiency.

Various studies suggest that Thio-Sul and CaTs both have the ability to inhibit the urease reaction, thereby reducing nitrogen loss

via ammonia volatilisation, as well as slowing down nitrification by reducing the loss of nitrogen through nitrate leaching.

CaTs, as well as offering a nitrate- and chloride-free source of calcium, and providing thiosulfate sulphur, also acts as a soil conditioner. Being a highly-soluble liquid form of calcium – unlike gypsum – CaTs is effective at penetrating the soil profile where it acts as a flocculant, opening up soil pores and improving soil structure and drainage. It can also help displace undesirably high levels of sodium in soils.

(Note: Thio-Sul, CaTs, MagThio and KTS are registered trademarks of Tessenderlo Group NV/SA.)

### US sulphur fertilizer use increasing

The use of sulphur fertilizers is increasing in the Midwestern US, according to research published in *Communications Earth & Environment* in December. This scientific paper compared sulphur fertilizer application rates across 12 Midwestern states with the declining rates of atmospheric sulphur deposition.

The researchers from the University of Colorado and Syracuse University found that almost all the decline in atmospheric sulphur deposition was being replenished by the field application of sulphur fertilizers.

Data from the US National Atmospheric Deposition Program showed that the rate of sulphur deposition on Midwestern croplands fell from 4.7 kg/ha in 1987 to 1.1 kg/ha by 2017. This was due to the progressive removal of sulphur from vehicle fuels and the scrubbing of sulphur dioxide from power plant emissions.

In contrast, fertilizer sales data from the Association of American Plant Food Control Officials showed that sulphur application rate from the use of sulphur-containing fertilizers increased from 0.1 kg/ha in 1985 to 4.9 kg/ha in 2015. This increase almost completely replaced the loss of ‘free’ sulphur from declining atmospheric deposition.

Despite this, the researchers concluded that the need to add sulphur fertilizers to soils will continue to rise – given the competing priorities of air quality regulation and high agricultural productivity – both in the US and many other parts of the world. ■

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**phosphates  
& potash**

**INSIGHT**

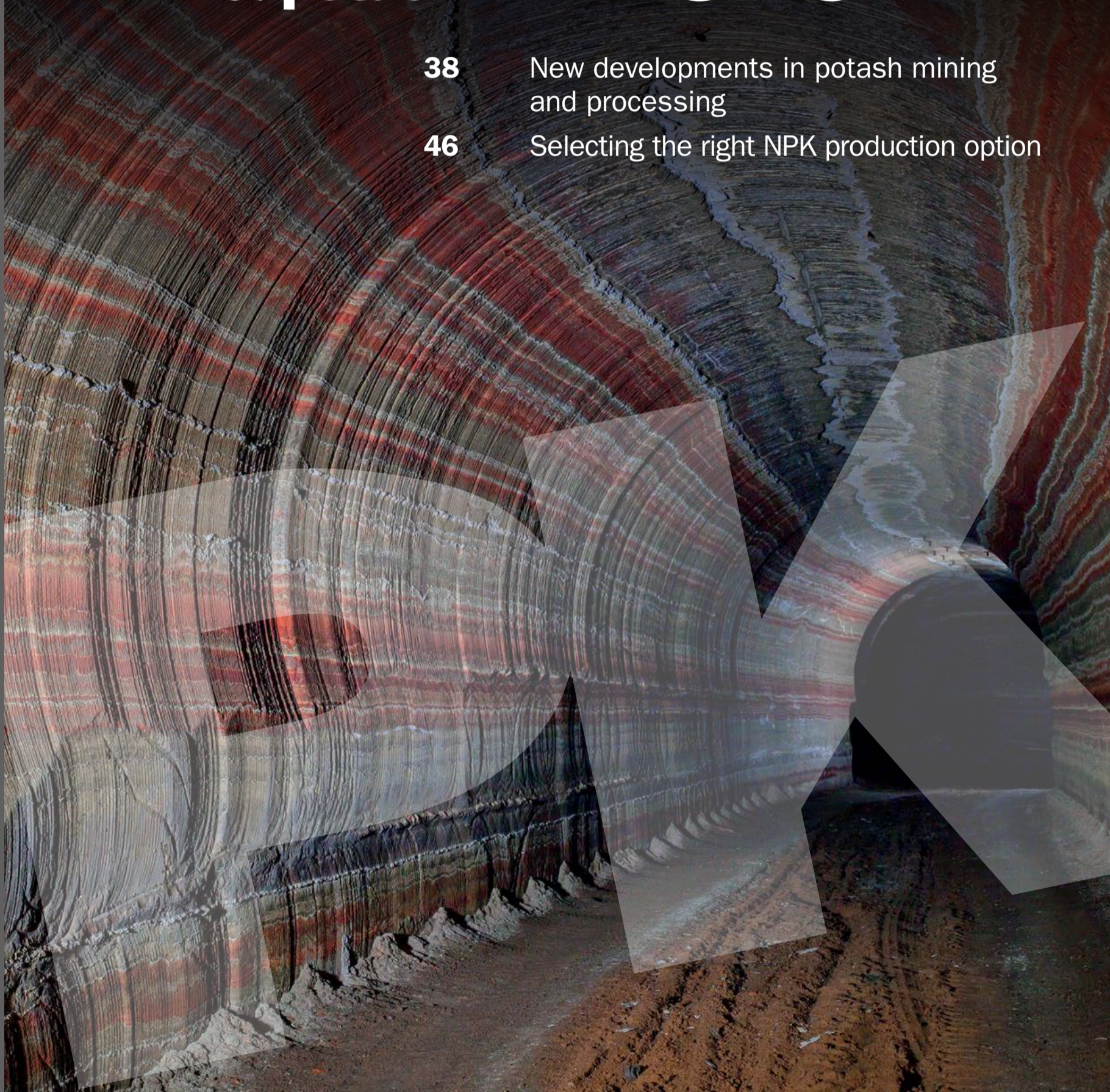
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# New developments in potash mining and processing

Potash production improvements are being made in areas such as ore extraction, cooling and froth flotation. We review technological developments from Sandvik, Eriez, Nouryon and Solex Thermal Science.

## SANDVIK

### Sandvik wins major Jansen mine orders

**S**andvik Mining and Rock Solutions has secured a major order for 10 battery-electric vehicles (BEVs) from BHP, along with one electric tethered loader, for the first phase of its Jansen potash project in Canada. These BEV loaders and other equipment are scheduled to be delivered between 2023 and 2025.

The order for battery-electric loaders, placed last June, reflects BHP's focus on both sustainability and advanced technology for the Jansen mine. Sandvik's BEV loaders are designed for minimal underground mining infrastructure – as they eliminate the need for overhead cranes and other heavy handling equipment.

“Electric mining equipment is essential to meeting our goals to reduce emissions, improve productivity and most importantly protect the health of our employees underground. Jansen will have the lowest carbon emissions per tonne of product produced compared to any potash mine operating today in Saskatchewan,” said Simon Thomas, BHP's president, potash.

“We are excited to partner with BHP and proud to contribute to the sustainability and productivity of this project. Sandvik electric loaders have been designed to best utilise innovative technology of its battery pack and electric driveline, and maximise the capabilities of our battery technology,” said Alex Willows, business line manager for Sandvik Canada.



SOURCE: SANDVIK

*Sandvik's family of battery-electric vehicles.*

**“Jansen will have the lowest carbon emissions per tonne of product compared to any Saskatchewan potash mine currently operating.”**

This latest order follows a SEK 2 billion (\$216 million) mining systems contract for the Jansen project won by Sandvik in February 2022. This commits Sandvik to supplying a fleet of electric, cable-con-

nected MF460 borer miners between the third-quarter of 2023 and 2026. These borers have been especially developed for the project following several years of Sandvik-BHP collaboration.

The Jansen potash project is located around 140 kilometres east of Saskatoon in Saskatchewan, Canada. Targeting an initial capacity of 4.35 million t/a, Jansen will be world's largest-scale and most advanced potash mine when it enters production in 2027. Once commissioned, the mine is expected to operate for up to 100 years. ■

**NOURYON**

# Advances in potash mining reagents

Dr Krzysztof Kolman, scientist, Jan-Olof Gustafsson, senior scientist, and Dr Odair Lima, global strategic marketing manager

## Enhancing potash recovery

Nouryon offers innovative and individually customised flotation agents for unique ores including potash (*Fertilizer International* 506, p41). These deliver superior performance combined with a strong focus on sustainability. Such capabilities are possible thanks to decades of mineral processing expertise and the company’s track record of customer collaboration.

For Nouryon, environmental stewardship starts with the sustainable sourcing of bio-based raw materials. Nouryon has a broad portfolio of flotation agents for the potash industry. The company’s main potash processing products are listed in Table 1 together with their respective functions.

The use of selective collectors that efficiently make mineral surfaces hydrophobic – and therefore susceptible to separation – is critical for successful flotation. To this end, Nouryon has designed and developed several collectors suitable for diverse



Typical sylvite flotation test in Nouryon’s application lab.

potassium-bearing minerals and conditions. Many of these are based on fatty amine technology, one of Nouryon’s core areas of expertise.

“Our collectors can efficiently balance recovery and selectivity during the flotation of sylvite from sylvinite in MOP production across a variety of ore types, brine compositions, and process temperatures,” says Henrik Nordberg, global section manager for mining at Nouryon.

Figure 1 illustrates the performance of amine blends used in potash flotation.

## Reverse flotation for halite removal

Nouryon’s Armoflote® 619 collector is unique, as it enables the successful reverse flotation of halite (sodium chloride) from carnallite (a potassium chloride and magnesium chloride mixture) and other double salts such as schoenite (a mixture of potassium and magnesium sulphates). In reverse flotation, the unwanted gangue mineral is floated while the valuable mineral remains as the bottom product. When used as collector in carnallite flotation, Armoflote619 exhibits an impressive ability to remove halite from the valuable potash-bearing mineral (Figure 2).

Table 1: Nouryon’s mining product range for potash ores

Ore type	Ore characteristics	Product name	Function	
Sylvinite (direct flotation)	Mixture of halite and sylvite	Armeen® HT	Fatty amine collector for wintertime (cold brines)	
		Armeen® M	Fatty amine collectors for summertime (warm brines)	
		Lilafлот® FAB53		
	Various clay/slime content	Ethomeen® HT/40	Berol® range	Slime collectors
			Phospholan® PE65	Anionic clay/slime collector
		Celect® SD	Clay/slime depressants and blinding agents	
		Finnfix® 300		
Carnallite (reverse flotation)	Mixture of carnallite and halite (potassium, magnesium and sodium chlorides)	Armoflote® 619 (reverse flotation)	Selective and unique halite collector	
Schoenite (reverse or direct flotation)	Mixture of schoenite and halite (potassium/magnesium sulphate and sodium chloride)	Lilafлот® D817M (direct flotation)	Cationic schoenite collector	
Potash concentrate		Armeen® O	Anticaking	
		Armeen® HT		
		Armeen® T		
		Armeen® M		
		Armoflo® AC-59P		

Source: Nouryon

Fig. 1: Performance of Nouryon's Armeen® M/Armeen® HT collector blend in sylvite flotation: typical grade-recovery curves

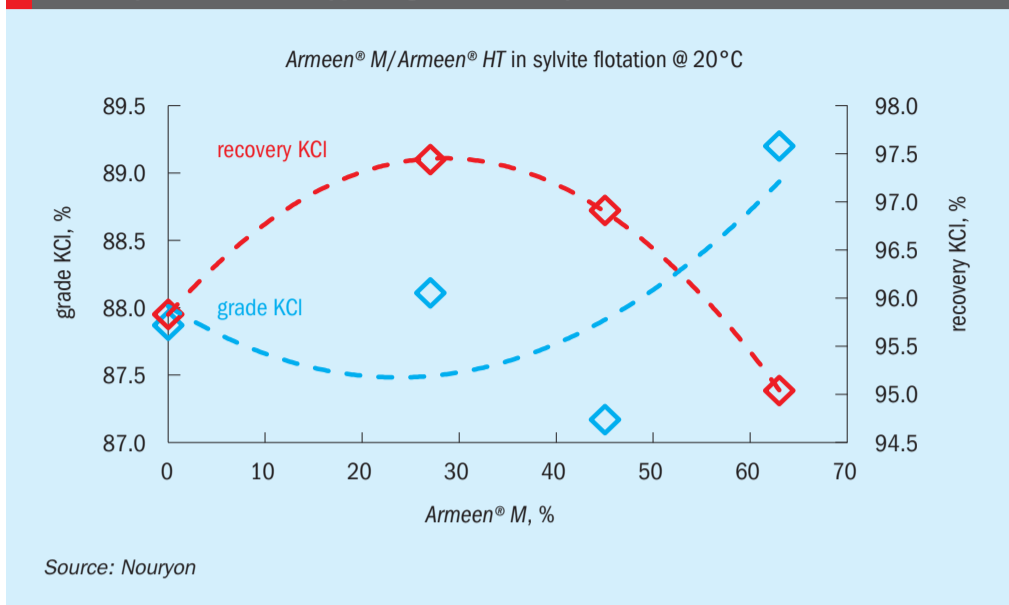


Fig. 2: Separation of carnallite from halite by reverse flotation using Nouryon's Armoflote® 619 collector

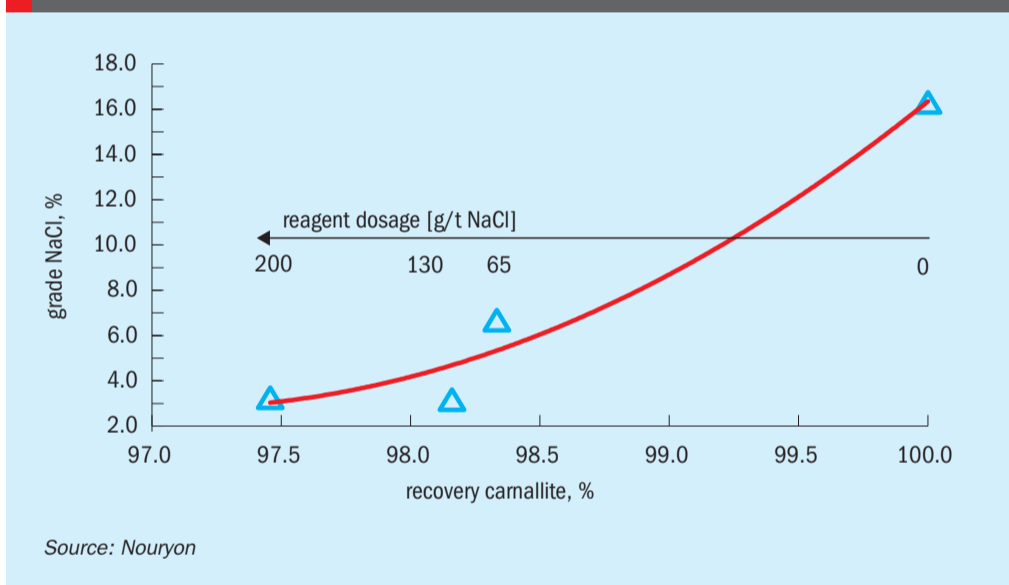
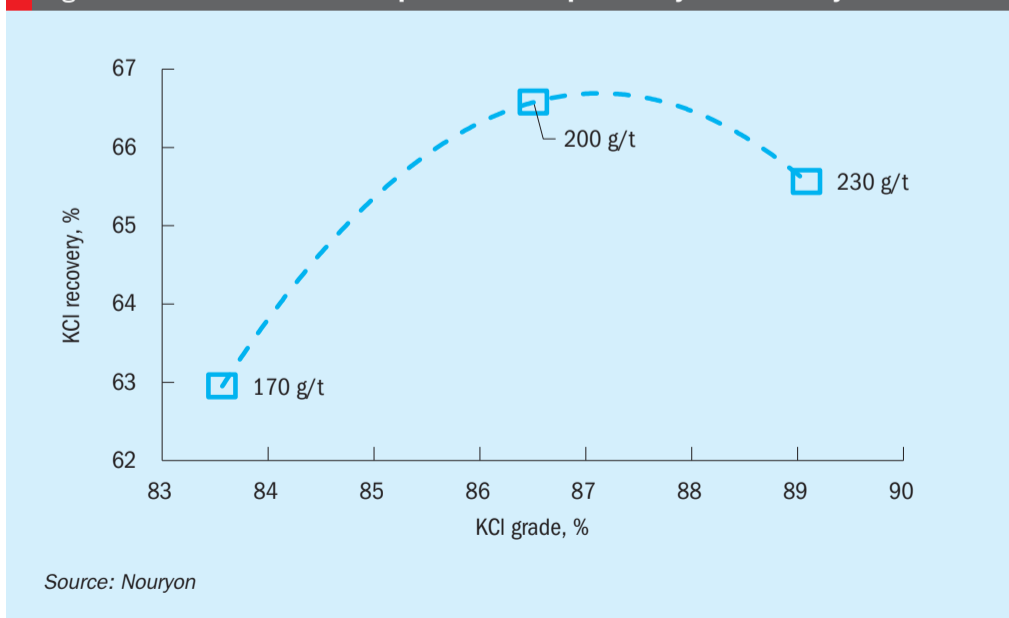


Fig. 3: Use of Celect® CMC depressants to optimise sylvite recovery



## Removal of slimes

Certain potash ores contain clay minerals in addition to the salt minerals that typically occur. These fine clay particles – also known as slimes – negatively impact potash flotation due to their high charge and high surface area. This prevents separation by depleting collector concentration. Solutions to this problem include:

- Mechanical desliming using hydro separators and cyclones
- Physico-chemical separation via slime flotation or the use of a depressant that blocks slime surfaces from interfering with sylvite flotation.

Of these two options, physico-chemical separation via flotation is usually preferred, since mechanical desliming causes the loss of fine potash particles, while total potash recovery can also be improved through selective reverse flotation of the slimes. A range of products demonstrates Nouryon's proficiency with slime collectors. These include Ethomeen® HT/40 and Berol® non-ionic collectors as well as the Phospholan® PE65 anionic collector.

Nouryon is also a leading global manufacturer of carboxymethylcellulose (CMC) depressants (Celect® and Finnfix®) for mining applications. This enables the company to maximise recovery grade profiles for its customers by offering holistic and individually tailored flotation options. CMC, a bio-based anionic polymer, functions as an efficient depressant in the flotation of a wide variety of minerals, including potash. CMC optimises sylvite recovery (Figure 3) by ensuring that flotation collectors are fully adsorbed on the surface of the target mineral by 'blinding out' the active surface area of clays.

## Potash coating

Once successfully separated via froth flotation, the high quality potash concentrates obtained need to be prepared for storage and transportation. This is usually achieved by applying a mineral coating, typically an anticaking agent, to prevent potash adsorbing water and becoming lumpy and sticky. Nouryon offers a range of anticaking agents (Armeen® HT, Armeen® T, Armeen® O, Armeen® M, and Armoflo®AC-59P) which use fatty amine technology to preserve potash concentrates in their desired form until they reach their ultimate destination. ■



**SOLEX THERMAL SCIENCE**

# Potash cooling – the decarbonisation challenge

Igor Makarenko

**R**aw bulk materials go through numerous steps while being transformed into valuable products. Yet these steps often require emissions-intensive equipment and high energy inputs – which carry considerable operational costs.

Such equipment creates a dilemma for today’s fertilizer producers who, as they seek to minimise the environmental impacts of their operations, require scalable and low-cost options for decarbonising production. These low-carbon production options also need to achieve a high return on investment while still delivering high-quality final products.

In December 2015, 196 countries famously adopted the Paris Agreement, the central aim of which was to limit global temperature rise to 1.5°C above pre-industrial levels by 2030. However, late last year, the UN Environment Programme (UNEP) reported that, to meet Paris Agreement commitments, a cut in global annual greenhouse gas (GHG) emissions of 45 percent was still necessary, compared with emissions projections under policies currently in place. These reductions also need to be accomplished in less than eight years. This represents a mammoth challenge, particularly for energy-intensive industries such as fertilizer production.

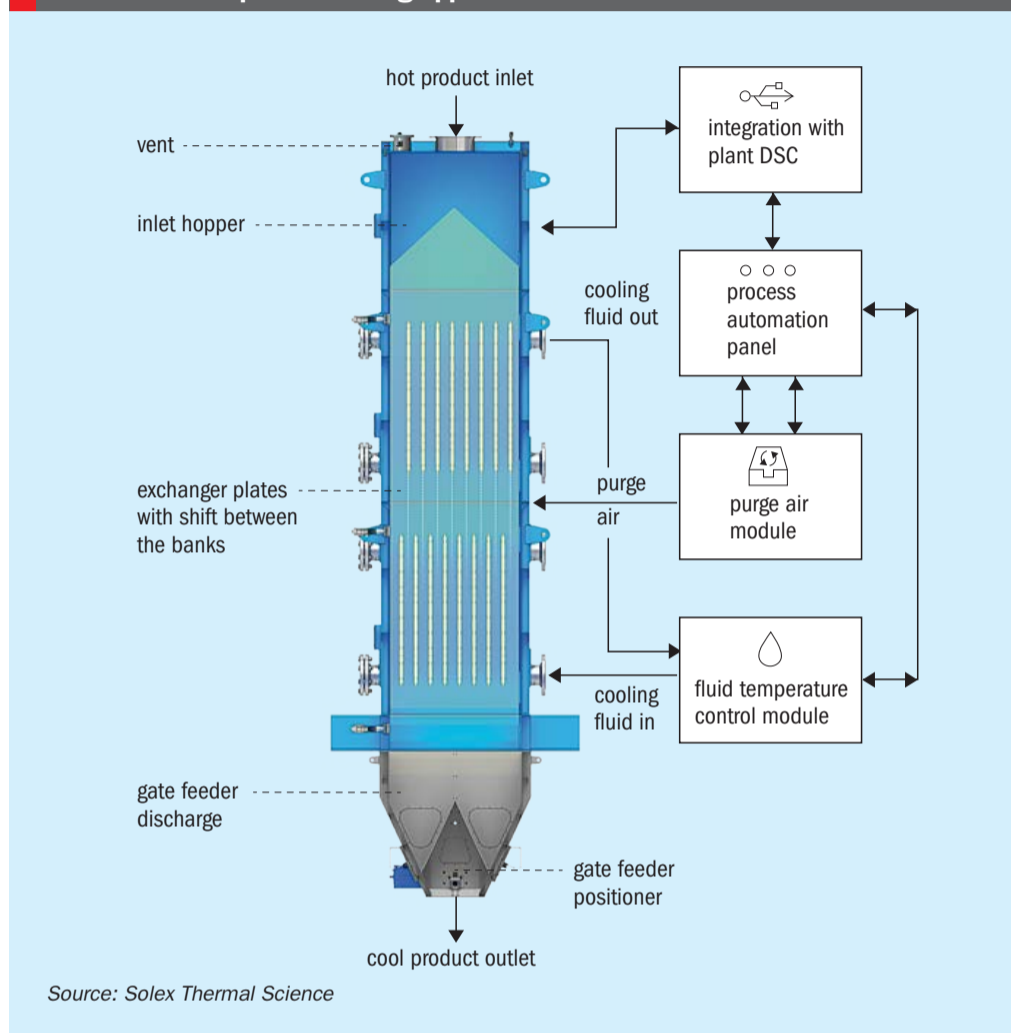
## Potash producers take action

For the potash sector, this struggle is playing out in real time. Potash producers have already acted – or are committed to firm future targets – to improve their energy efficiency, reduce their operational carbon intensity and make the transition to renewable energy. The industry is also exploring the potential for capturing production emissions using carbon capture and storage (CCS) technology.

Despite this, many common pieces of production technology that are still in place in the potash industry today are actively working against the sector’s carbon-cutting efforts. The cooling stage being one example.

During its processing, potash must be cooled to a specific temperature – typically 50°C or lower – before it can be safely stored and transported. Yet traditional direct-contact (e.g., convection) cooling

Fig. 1: Schematic of a typical plate-based moving bed heat exchange system used in a potash cooling application



Source: Solex Thermal Science

equipment, such as fluidised beds and rotary drums, require large energy inputs to get the job done and can also generate significant dust and GHG emissions.

Moving bed heat exchangers (MBHEs) based on vertical plate technology are emerging as an increasingly popular cooling equipment choice within the fertilizer industry. This is particularly true for those potash producers who are looking to improve the overall energy status of plant operations, cut dust emissions and reduce their carbon footprint, while still producing a high-quality product.

In fact, MBHEs have been proven to reduce energy demand at the cooling stage to one tenth of normal. Also, new advances in MBHE processes now provide potash producers with the ability to recover energy at the cooling stage for use elsewhere in the plant. This reduces fossil

fuel consumption further and delivers extra energy savings that translate into reduced GHG emissions.

## The advantages of MBHEs

One of the biggest differences between plate-based MBHEs and direct-contact alternatives is how heat transfer occurs. With MBHEs, potash enters through the top of unit and flows by gravity through banks of parallel vertical stainless-steel plates. At the same time, a heat transfer fluid – typically water – passes through the plates to cool the potash by conduction (Figure 1).

This passive, indirect form of heat transfer – the flow velocity of the potash is typically less than 0.3 m/min – means MBHEs do not contribute to any additional dust emissions or the degradation

of potash granules. In contrast, fluidised beds operate by forcing air through the solid material within the fluid bed. Rotary drums, meanwhile, rotate and lift the potash through a counter-current air stream.

Both these direct-contact methods involve a lot of agitation and can therefore cause abrasion, attrition and dust emissions. Critically, they also require high-horsepower blowers, ducting and associated air-handling and -cleaning equipment to circulate the air and then clean it before it can be discharged to the environment. Heat recovery from these air streams is generally not technically or economically viable, so the thermal energy is simply lost to the environment.

MBHEs, meanwhile, do not use air to get the job done, and therefore do not need these ancillary pieces of equipment. The associated savings are therefore substantial.

In a standard 75-tph cooling system, for example, a plate-based MBHE requires only 90 kW of installed power (Figure 2). By comparison, a rotary drum needs

Fig. 2: Energy consumption comparisons between fluidised beds, rotary drums and plate-based moving bed heat exchangers (MBHEs)

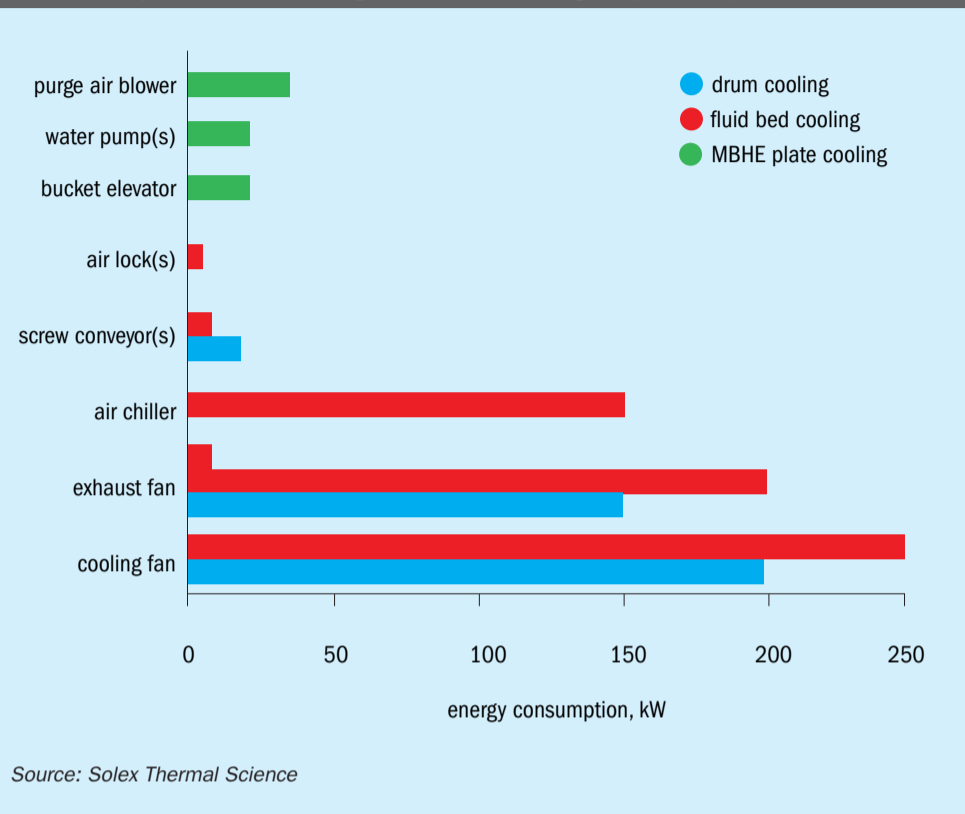
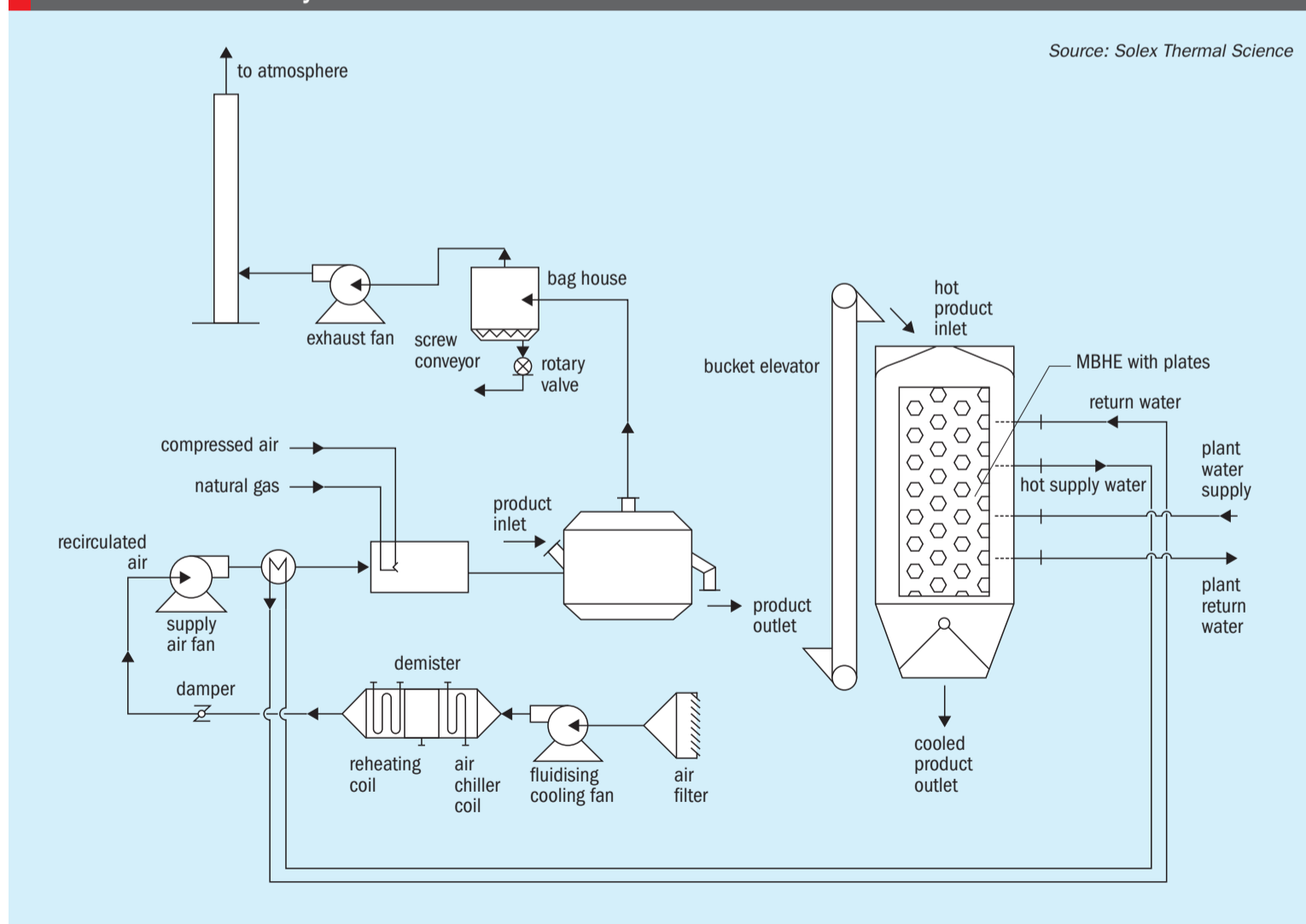


Fig. 3: Recovered low-grade thermal energy from a plate-based MBHE can be used upstream to pre-heat the combustion air for a fluid bed dryer



365 kW and a fluidised bed 612.5 kW. Annually, based on 8,000 operating hours and \$0.17/kW, it costs just \$122,400 to operate a plate-based MBHE, compared with \$496,400 and \$833,000 for a rotary drum and fluidised bed, respectively.

By cutting energy consumption, potash producers also have an opportunity to reduce CO<sub>2</sub> emissions. Based on 0.19 kg of CO<sub>2</sub>e per kW, the carbon footprint of a plate-based MBHE is 138,960 kg – compared with 563,560 kg for a rotary drum and 945,700 kg for a fluidised bed.

### Capture of low-grade thermal energy

Furthermore, during cooling, MBHEs produce a hot transfer fluid that can provide low-grade thermal energy for use elsewhere in the plant. This can be converted to hot air using a finned-tube heat exchanger and then ducted to various points for end-use.

One upstream use for this recovered low-grade thermal energy is the pre-heating of combustion air, via an air-to-fluid preheater, for equipment such as a fluid bed dryer (Figure 3) or rotary drum dryer. This, in turn, can

**“During cooling, MBHEs produce a hot transfer fluid that can provide low-grade thermal energy for use elsewhere in the plant.”**

significantly cut natural gas consumption, further reducing both energy costs and the plant’s carbon footprint.

The cooling of the transfer fluid, via the finned-tube heat exchanger, also reduces the load on the plant’s cooling water system. This working fluid requires only minimal cooling as it is returned to the water module at a temperature well below 70°C.

### Conclusion

In its report last year, the UNEP notes that many industrial sectors already have the necessary technology to hit their GHG emissions reduction targets. What’s needed instead is a more robust audit to identify whether all the equipment still in place can deliver on these targets. If not,

a rapid transition to equipment that that can deliver on energy and climate targets will be necessary.

In the case of potash cooling, moving bed heat exchangers (MBHEs) based on vertical plate technology are providing potash producers with the necessary means to reduce their emissions. By design, MBHEs are a near-zero-emissions, low-energy cooling option – one that has been proven to reduce the carbon footprint of operations around the world. What’s even more exciting is how recent improvements in MBHE technology are helping to further decarbonise operations – by using a new waste heat recovery process that can cut natural gas consumption.

Fertilizer production technology will undoubtedly need to improve and do more in future – to align with companies’ ESG commitments and allow plant operators to make changes that positively affect the world around us. By moving to near-zero-emissions equipment and recovering waste heat, potash producers now have a real opportunity to move closer to achieving their shared climate ambitions. ■

## ERIEZ FLOTATION

# Flotation innovations unlock value at potash mines

Erich Dohm, senior manager, USA operations and product development, and Drew Hobert, global business development manager

**A**s global demand for fertilizers continues to grow and geopolitical events disrupt supply from Russia and Belarus, operators are focused on finding innovative ways to improve efficiencies for new and existing potash mines. Flotation is a critical step in the potash production process as it removes impurities from the ore to achieve commercial concentrate grades required for fertilizer production.

Historically, most potash mines employ conventional mechanical flotation technology with several stages of cleaning and scavenging to achieve acceptable product grades and recoveries. In some cases, where potash can be liberated from gangue minerals at coarse sizes (i.e., +3-mm), separate coarse and fine flotation circuits have been designed to improve flotation performance. Nonetheless, legacy technologies for particle classification and flotation present inherent challenges to efficient and low-cost production of potash.



The generation of a deep froth by an Eriez® CavTube® column flotation cell helps to improve the flotation of fine potash.

Fig. 1: Classification: Flotation performance improvement for a more efficient Eriez CrossFlow separator (blue) versus the use of conventional vibrating screens (red)

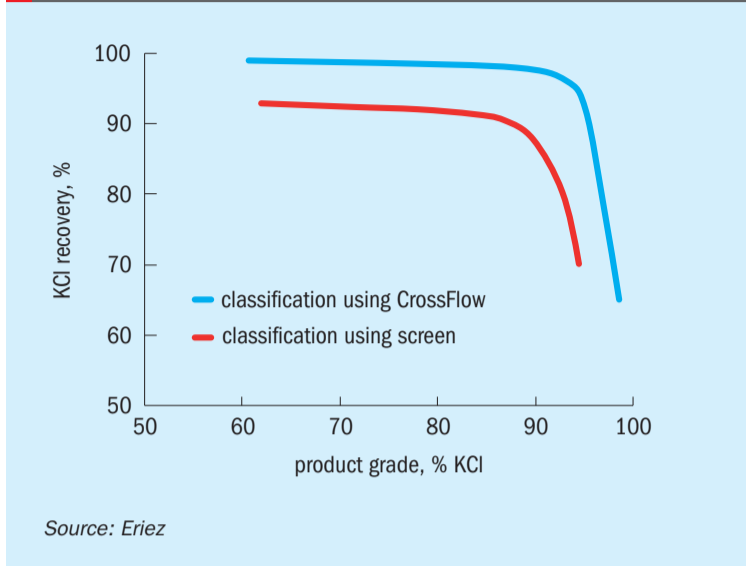
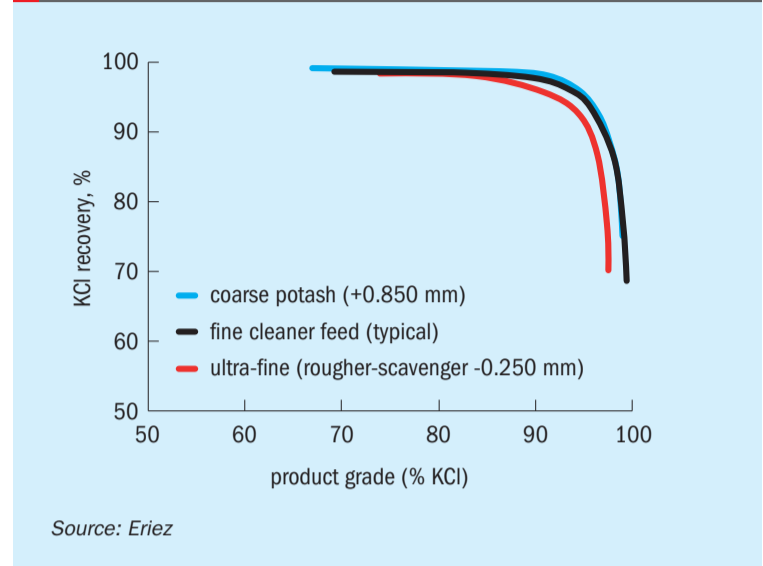


Fig. 2: Eriez CavTube column flotation: Example potash grade/recovery curves for coarse potash (blue), fine cleaner feed (black) and ultra fines (red)



### Eriez CrossFlow separator

The CrossFlow® is a teeter-bed classification technology that replaces vibrating screens and cyclones in potash processing to:

- Enhance sizing efficiency
- Prevent fines bypass
- Reduce the plant's footprint.

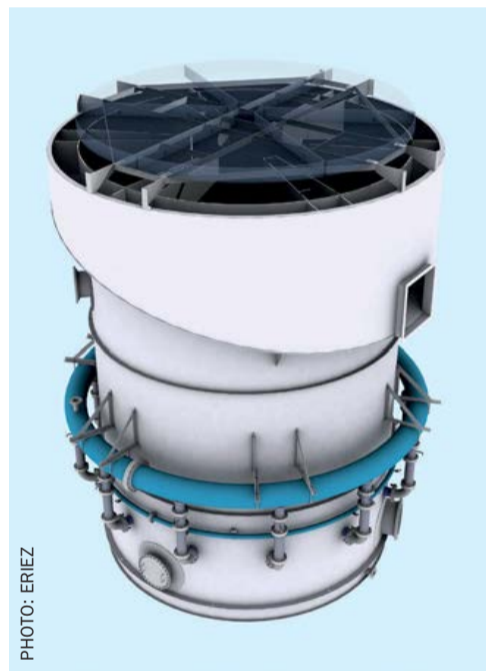
Due to its inherent water split, the CrossFlow separator minimises misplaced material that occurs in screens and cyclones due to inefficient washing or overloaded conditions and underflow bypass. Misplaced material can significantly impact the flotation process, negatively affecting final product grades and recoveries. The CrossFlow separator's high efficiency mitigates this issue, resulting in minimal or no misplaced material, within coarse or fine flotation feedstocks (Figure 1).

### Eriez CavTube column flotation

CavTube® column flotation cells have been successfully implemented to improve the flotation of fine potash by:

- Increasing bubble surface area flux
- Developing a deep froth phase
- Enabling the use of counter-current wash brine to remove impurities from the froth concentrate.

The high air rates and stable froth phase formed using these cells ensures both high recovery and also a high-grade product that can exceed 95 percent KCl (Figure 2). Fine effluent streams are also best treated using the CavTube system. Accept-



Eriez CavTube column flotation cell.

able recovery (95%) and grade have (+90% KCl) been obtained in either a rougher-only or rougher-scavenger configuration.

### Eriez HydroFloat separator

The HydroFloat® is an air-assisted teeter-bed separator used in potash processing to enhance the selective recovery of coarse particles up to 4-mm in size. In conventional mechanical flotation cells, flooding the cells to improve coarse particle recovery results in poor product grade as gangue minerals unselectively report to the concentrate. Whereas the HydroFloat's fluidised bed decreases turbulence and detachment, while improving the flotation rate of the coarsest material. As a result,



Eriez HydroFloat separator.

the HydroFloat achieves over 95 percent KCl recoveries during coarse particle flotation while maintaining concentrate grade targets of more than 90 percent KCl.

### Project experience

The success of the CrossFlow, CavTube Column, and HydroFloat in retrofit and expansion projects has led to the implementation of these innovative technologies at the largest greenfield potash project in the world. As operators seek innovative methods to maximise the use of natural resources, optimise costs, and reduce environmental impacts of their operations, Eriez serves as a partner to unlock existing value through process optimisation. ■

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## CUTTING EDGE INNOVATION IN FERTILIZERS AND PLANT NUTRITION

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# Selecting the right NPK production option

Blended and compound NPK fertilizers are a mainstay of many markets globally. We review the main production technology options.

## JESA TECHNOLOGIES

### NPK production: the fundamentals

Dave Ivell, president, Ivell Fertilizer Consulting, and Chris Dennis, phosphate fertilizer specialist, JESA Technologies

**N**PK is a broad term covering a multitude of different nutrient formulations, each having their own process characteristics. Indeed, the term 'NPK' itself is a catch-all phrase given to any fertilizer that contains the primary plant nutrients nitrogen, phosphorus and potassium. Similarly, 'NPS' is a generic term for fertilizers that contain significant quantities of sulphur alongside nitrogen and phosphorus. They are also referred to as ammonium phosphate sulphate (APS) products.

NPK/NPS fertilizers can be produced from various raw materials via different manufacturing routes – to generate granular products containing N, P, K and S in a wide range of ratios. There are several production methods for NPKs, the main manufacturing routes being:

- Steam granulation
- Chemical granulation
- Bulk blending.

A summary of the main merits and demerits of the three NPK process routes is provided in Table 1.

#### Steam granulation

In this granulation route, solid raw materials are mixed and granulated using steam and/or water. The process generates granular products through agglomeration. The addition of steam/water causes part of the solid raw materials to go into solution. This promotes the agglomeration of solids by forming crystal bridges that bind particles together.

Table 1: Summary of the advantages and disadvantages of steam granulation, chemical granulation and bulk blending

	Bulk Blending	Steam Granulation	Chemical Granulation
Raw Material Cost	High	Medium	Low
Utilities Cost	Low	Medium	High
Fixed Cost	Low	Medium	High
Capex	Low	Medium	High
Overall Production Cost	Lowest	Higher	Higher
Multiple Grade Flexibility	High	Low	Low
Product Quality	Low	Medium	High

Source: JESA Technologies

In granulation, it is generally desirable to create end-products of between 2-4 mm in size. How efficiently these product-sized granules are formed determines the recycle ratio of the process – a ratio of 2/1 or less being usual. Product granules formed by steam granulation typically have the following characteristics:

- Fairly uniform chemical composition
- Low strength
- Poor shape
- Wider particle-size distribution.

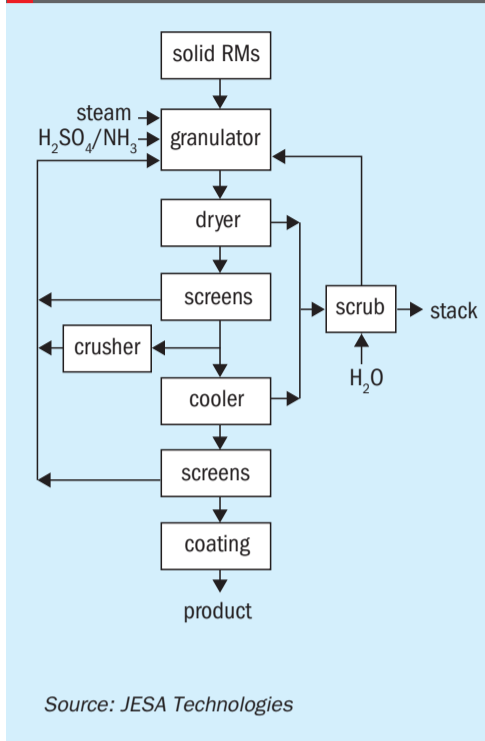
In steam granulation, a relatively long dryer residence time is also required (typically 20 minutes). This is because, when they leave the granulator, most of the moisture is present within the interior of the granules and needs time to diffuse to the surface before it can evaporate.

Changing NPK grade at the end of a steam granulation production run can be

time consuming – given that the entire plant is left full of fertilizer of the previous composition. 'Change-over' formulations are therefore used to speed up the switch in production from one grade to another. These exaggerate the normal feed rates required for the new grade during the changeover period. This technique can be applied when different grades of the same type of NP or NPK product are being produced. But if the production change is from an NPK product to an NP product then the only real choice is to empty the plant beforehand.

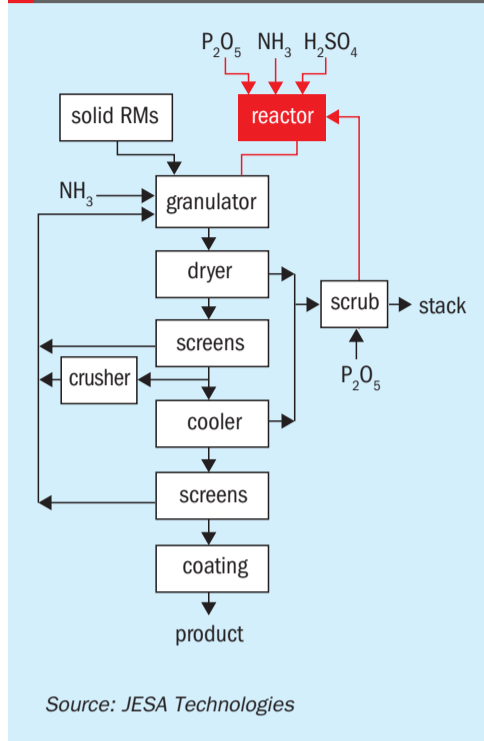
A typical steam granulation flowsheet is shown in Figure 1. This flowsheet can vary slightly, depending on the grades produced. The main variations include where to place the screening and crushing operations – either before or after the cooler – and whether to pass some of the process gases through baghouses rather than wet scrubbing.

**Fig. 1: Typical steam granulation flowsheet**



Source: JESA Technologies

**Fig. 2: Typical chemical granulation flowsheet**



Source: JESA Technologies



PHOTO: JESA TECHNOLOGIES

Typical bulk blended product.

mechanism and the higher recycle ratio – the granules formed are harder, more spherical and typically have a narrower particle-size distribution. The required dryer residence time is also shorter (typically 7–12 minutes depending on grade) as the moisture is mostly on the surface of the granules leaving the granulator.

A typical chemical granulation flowsheet is shown in Figure 2. This is similar to the steam granulation flowsheet except for the added reaction stage and the use of phosphoric acid rather than water as the scrubbing medium.

Chemical granulation also faces exactly the same production challenges as steam granulation when changing between NPK and NP product grades.

### Bulk blending

Bulk blending requires the mixing of dry, granular raw materials. This physical blending process is very simple and low-cost, in capex and opex terms, in comparison to the other two granulation routes.

The chemical composition of individual granules will vary according to the raw material type and their source. Granules present in bulk blends are also of different sizes, shapes and densities (see photo). Because of this, segregation can be an issue and result in the uneven field spreading of nutrients. The incorporation of micronutrients may also present a problem, although these can now be applied as a liquid coating on the surface of granules.

### Raw material needs

Each NPK process route has different raw material requirements. Bulk blending, for example, requires the purchase

**Table 2: Raw material requirements for production of 15-15-15 NPK: steam granulation, chemical granulation and bulk blending**

Raw material, kg/t	Bulk Blending	Steam Granulation	Chemical Granulation
Granular urea	24	-	-
Prilled urea	-	58	36
Granular ammonium sulphate	400	-	-
Standard ammonium sulphate	-	360	-
Granular DAP	329	-	-
Powder MAP	-	292	-
Granular potash	253	-	-
Standard potash	-	253	253
Ammonia	-	22	165
Phosphoric acid (P <sub>2</sub> O <sub>5</sub> )	-	-	154
Sulfuric acid	-	31	295
Coating oil	4	4	4

Source: JESA Technologies

### Chemical Granulation

The chemical granulation route manufactures granular products by reacting phosphoric acid and sulphuric acid with ammonia. This produces a slurry which is sprayed onto recycle material in the granulator. Solid raw materials – such as potash if NPKs are being produced – are also fed to the granulator along with the recycle. Granulation occurs partly through agglomeration but mainly by layering.

The recycle ratio in this process route is usually higher than in steam granulation – a typical value being 4/1 – and is determined by the granulator’s heat and water balance. Keeping to this higher ratio often requires the recycling of product-sized material to the granulator to maintain the correct heat and moisture conditions.

The resulting granules, as with steam granulation, are uniform in chemical composition. However – due to the layering

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of premium granular products. Steam granulation, in contrast, consumes predominantly non-granular solid raw materials. This route also often consumes by-products, off-specification materials, or even 'spoiled' substances available from nearby industries. Chemical granulation, meanwhile, uses the cheapest possible liquid chemicals as feed. These are typically generated on-site. This keeps costs low by avoiding the need to pay third parties to convert these liquid feeds into solid raw materials. The typical raw material requirements of the three differ-

ent process routes in the production of 15-15-15 NPK are shown in Table 2.

### Chemical granulation: product categories

Chemical granulation produces the best quality products out of all the three process routes and can manufacture these in a range of NPK and NPS grades. These include:

- Ammonium phosphate/potash mixtures
- High sulphate NP grades

- High sulphate NPK grades
- High urea content NP grades
- High urea content NPK grades.

The granulation of high and low mole ratio NPK and NP product types has been described in a previous article. (*Fertilizer International* 492, p57). Mole ratio measures the relative proportion of phosphoric acid and ammonia in the feed. This is an important parameter for adjusting and 'fine tuning' the granulation process to ensure it delivers the highest quality products at the greatest output. ■

## EIRICH

# Simple and cost-effective fertilizer granulation

Thomas Lansdorf, sales manager, fertilizer process technology

Even the best fertilizers have little worth if nutrients cannot be applied to crops in the correct quantities at the right rate. This simple fact is what continues to keep the demand for granulated fertilizers high. Especially as stable, round and free-flowing granules are needed when applying fertilizers with a centrifugal broadcaster. Granules with these characteristics can be applied optimally across the field to deliver an even distribution of nutrients over the soil.

### SmartMixer - an ideal granulator

The Eirich SmartMixer is capable of mixing, granulating and coating raw materials within one single item of equipment. It

operates rapidly and can granulate powdered materials in a matter of minutes (Figure 1). Chemical reactions can also be carried out within the mixer quickly and completely. In many applications, the SmartMixer combines individual processes together – enabling, for example, a homogeneous mixture to be produced from filter cake, dusts and slurries etc.

Within the mixer, water is firstly added to uniformly moisten the powder mixture. Forces of adhesion then act between the particle leading to the formation of granules. It is also possible to add binding agents or other additives to the granulating fluid – typically water – as required. The addition of a binding agent increases the

strength of granules to ensure that these will not disintegrate under mechanical stress. When required, larger pellets (5-10 mm size) can also be produced using a disk pelletizer unit.

The SmartMixer combines fully-automated mixing and granulation processes in a single system. By combining individual processes in this way, Eirich can create a complete fertilizer production plant – one that is capable of continuously manufacturing fertilizers to consistently high-quality standards around the clock (Figure 2). Many straight fertilizers are used as important constituents of compound fertilizer mixes. They can also be granulated individually to improve field distribution and

Fig. 1: The Eirich SmartMixer



Source: Eirich

Fig. 2: EIRICH SmartMixer within a fully automated mixing and granulation plant



Source: Eirich



reduce dust formation. Examples of popular straight fertilizers include:

- Potassium sulphate (sulphate of potash, SOP,  $K_2SO_4$ )
- Potassium chloride (muriate of potash, MOP, KCl)
- Ammonium sulphate (AS,  $(NH_4)_2SO_4$ )
- Diammonium phosphate (DAP,  $(NH_4)_2HPO_4$ )
- Polyhalite ( $K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$ ) etc.

The goal of granulation is to produce uniform and round granules with a target size of 2-4 mm. High throughput rates of several tonnes per hour are required for the main straight fertilizers listed above. High capacity R28 and R33 type Eirich Mixers are therefore used for this purpose. Eirich can offer a range of customised granulation processes capable of manufacturing large amounts of granular fertilizers to very high quality standards.

### Dissolving minerals with acids

Phosphate rock can be dissolved in sulphuric acid at industrial scale to manufacture superphosphate. This process can be carried out particularly quickly and efficiently in an Eirich mixer. Dissolution in acid transforms the insoluble apatite

(calcium phosphate) present into a soluble and plant available form of phosphorus. Similarly, the valuable nutrients present in other insoluble minerals can also be made more available to plants by treatment with sulphuric acid or phosphoric acid. Serpentinite, which contains magnesium silicate, is one example.

Eirich has installed a modern production plant in Paraguay which uses serpentinite to manufacture fertilizer. This plant combines a RV19 Eirich mixer with a TR36 disk pelletizer. The serpentinite rock is crushed, ground and then dissolved with sulphuric acid in the mixer. This generates a moist reaction product which readily forms granules in the disk pelletizer. The soluble end-product obtained via this process is applied as fertilizer to soils to improve the growth and yield of maize and grain crops.

### Recovering valuable resources

Because they are finite, it is becoming ever more important to use all natural resources both sparingly and sustainably. For example, phosphorus – which is in high demand as a fertilizer – is contained in large quantities in sewage sludge ash. This can be concentrated and recovered by the precipi-

tation of struvite (magnesium ammonium phosphate). This can then be dried and granulated using an Eirich mixer which is capable of handling all the required process steps in a single unit.

The recovery and reuse of secondary raw materials is requiring new types of preparation processes and technologies. This is being done, for example, in Duisburg, Germany with an Eirich RV24 mixer and TR36 disk pelletizer. These produce nutrient-rich microgranules for agriculture from gypsum filter cake and other compounds such as kieserite and iron salts.

### Conclusions

Energy prices and the costs of raw materials look set to rise in the future. This means that the sustainable use of finite resources will become increasingly important. Cost-effective fertilizer finishing techniques such as granulation – by ensuring that fertilizers are used efficiently – can contribute to more eco-friendly agriculture. Granulation helps ensure that plants receive the nutrients they require in the correct amounts during the growing season. At the same time, granulation also prevents fertilizer losses due to disintegration and wash-out from soils. ■

## LANCASTER PRODUCTS

# Enhanced mix-granulation in a single machine

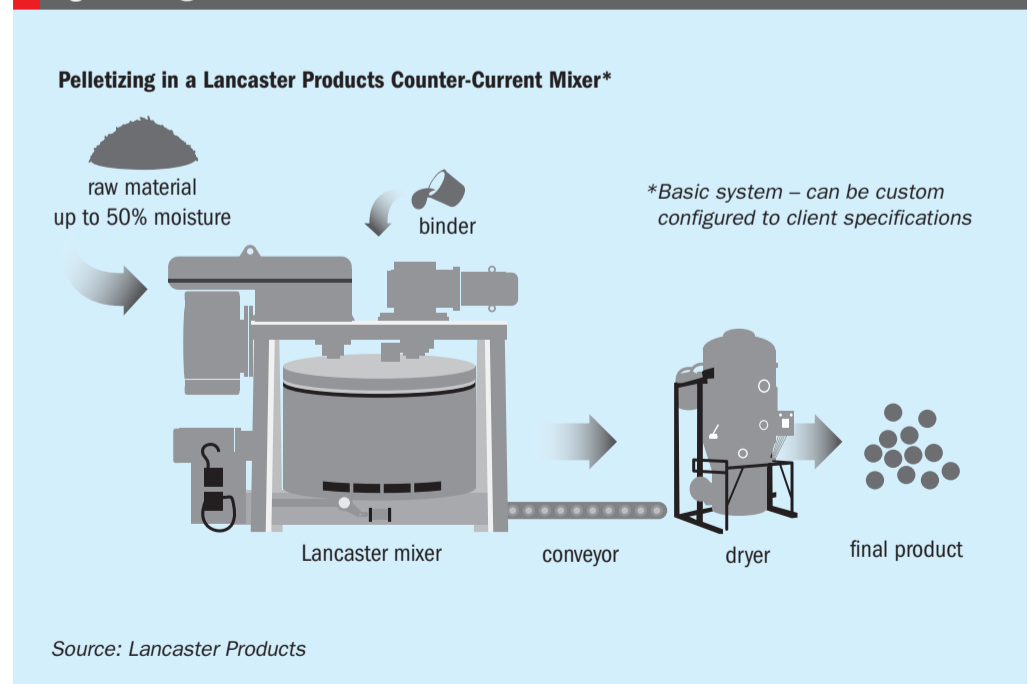
Cayden Miller, applications lab manager

The ability to mix and granulate in a single machine offers fertilizer manufacturers both operational and product quality advantages over traditional granulation methods.

High shear, counter-current mixers – unlike most granulation options – can rapidly mix and granulate materials in the same machine as a single-stage process. In mix-granulation equipment, such as those offered by Lancaster Products, the pan rotates in a clockwise direction, while the mixing tools rotate counter-clockwise. This design results in efficient counter-current mixing by creating the necessary shearing action within the mixing cavity.

The mixing tool's variable speed capability achieves the desired output by enabling different sized granules and densities to be created. A wide spectrum of granule sizes – from the micron range to as large

Fig. 1: Mix-granulation in a counter-current mixer



as 8-10 millimetres – are possible depending on the feed materials. Mix-granulation is completed in batches and excels at producing highly repeatable homogeneous mixes and granules (Figure 1).

Mixing and granulating in the same step in a high shear, counter-current mixer is advantageous (Table 1) as it reduces system complexity in the following ways:

- **Reduced physical footprint.** The continuous batch process offered by Lancaster Products requires very little square footage due to its vertical design which employs gravity for material transport.
- **Operates with high moisture materials.** Initial drying and subsequent milling in the manufacturing process can also be eliminated or greatly reduced as the mix-granulation process handles raw materials with up to 50 percent moisture.
- **Less maintenance and energy use.** The replacement of multiple machines typically found in traditional pelletising process lines with a single high shear, counter-current mixer translates into less maintenance, fewer points of failure and reduced energy usage.
- **Optimised ingredients and lower operating costs.** Precise batch recipes eliminate the ingredient waste that results from uneven mix distribution. Instead, much less binder and water is required because counter-current mixing technology is highly effective at thoroughly dispersing such additives throughout the main ingredients.

Because the pan, high speed rotor and plow are individually controlled, the mixer can create exact and repeatable conditions within the mixing cavity to produce specific

products – e.g., granules of a specific size within a tight tolerance. Valuably, even slight adjustments to tooling speeds can produce different sized granules, shapes, densities, and yields. Mix-granulation also offers the following product quality advantages:

- Homogeneous pellets with improved ingredient distributions
- High yields of on-size pellets with substantially less need to reprocess off-size product
- Versatility to control pellet size and characteristics on a batch-by-batch basis.

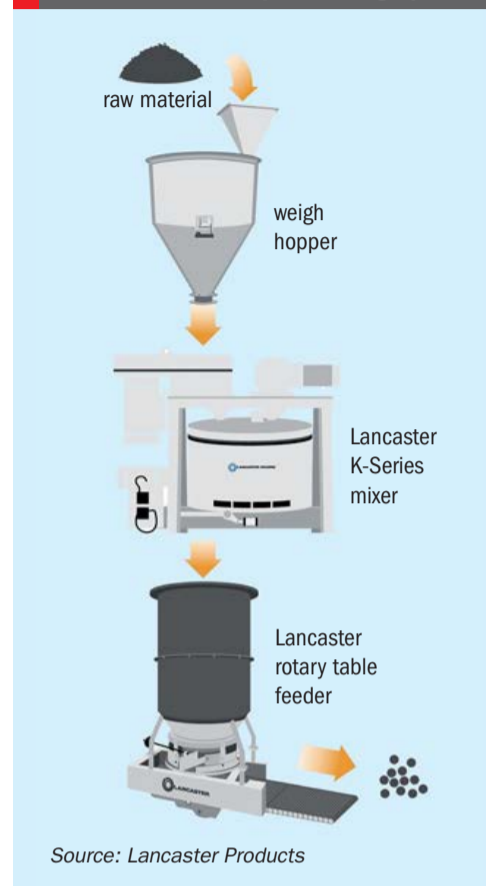
### Increased throughput

Batch processing of complex fertilizers offers both greater product accuracy and high outputs. The other key advantages of a batch process are recipe optimisation and mix homogeneity. These important benefits can be realised simultaneously with the consistent throughput and high production rates of a continuous production line.

A continuous batch processing system (Figure 2) is configured sequentially as follows:

- The process begins with pre-weighed raw materials and binders
- These are delivered to the mixer via a weigh hopper
- The high shear mixer runs through a dry mix, a wet mix and then continues to a granulation cycle
- The material is then discharged from the mixer to a conveyor or table feeder – this converting the batch process into a continuous flow of materials
- Parallel lines for redundancy, or systems with multiple mixers, can also be utilised to increase output capacities.

Fig. 2: Lancaster Products continuous batch processing system



Source: Lancaster Products

### Conclusions

Simplifying the fertilizer granulation process, while simultaneously increasing throughput and lowering costs, all contribute to delivering high value fertilizer products to customers at increased profitability. Advanced technologies such as mix-granulation offer fertilizer manufacturers opportunities to achieve these objectives – by combining high shear, counter-current mixing with continuous batch processing. ■

Table 1: Operational advantages of mix-granulation

Continuous process	Continuous process	Batch process	Lancaster Products continuous batch process
Continuous operation	✓	–	✓
High production rates	✓	–	✓
Multiple lines	✓	–	✓
Recipe optimisation	–	✓	✓
Multiple operations	–	✓	✓
High yield outputs	–	✓	✓
Higher product accuracy	–	✓	✓
Reduced mix times	–	✓	✓
Minimised additives	–	✓	✓
Mix homogeneity	–	✓	✓
Reduced expenses	–	–	✓
Reduced maintenance	–	–	✓
Equipment consolidation	–	–	✓

Source: Lancaster Products

**CASALE**

# Steam vs chemical granulation: picking the best NPK technology

Gabriele Marcon, solid fertilizer technology manager

## Advantages of chemical granulation

**C**hemical granulation, using both solid and liquid raw materials, is generally recognized as the most complete NPK production method. This reflects both the nature of the chemical reactions involved and its use of liquid and solid raw materials. These process characteristics deliver excellent agglomeration by ensuring strong bonds form between components inside the granule.

The chemical granulation of NPK fertilizers uses a standard granulation loop (granulator, dryer, screen, crusher) and, unlike steam granulation, consumes liquid raw materials alongside solid feed materials. The properties of the fertilizers granules obtained are greatly improved by the chemical reaction(s) between the liquid acid (H<sub>3</sub>PO<sub>4</sub> and/or H<sub>2</sub>SO<sub>4</sub>) and ammonia.

Chemical granulation, because it offers numerous options for selecting different raw materials, can produce a very wide range of



PHOTO: CASALE

Casale dual pipe reactor granulation plant.

different NPK grades (Table 1). Experience has shown that more than 200 NPK grades can be manufactured at a single plant using different liquid and solid raw materials. This is a priceless advantage as it allows NPK plant operators to respond to market demands, such as the availability of raw materials and customer requests for specific NPK grades.

The NPK granules generated also have the best possible chemical and mechanical characteristics. The level of aggregation inside each granule, for example, is excellent due to the strong links between individual components. At the same time, the granules produced have a homogeneous chemical composition, good roundness and high crushing strength. These characteristics are ideal as they ensure the field spreading of NPK fertilizers delivers the desired mix of nutrients to the soil in a homogeneous and controlled manner.

## Dual pipe reactor technology

Casale offers dual pipe reactor technology as a chemical granulation process for NPK production (Figure 1). Casale recommends this advanced granulation technology, which is based on conventional drum granulation, even when other NPK production methods such as bulk blending and steam granulation are available.

The dual pipe reactor has distinct advantages over other types of chemical granulation by providing two separate locations for reactions between H<sub>2</sub>SO<sub>4</sub>/H<sub>3</sub>PO<sub>4</sub> and NH<sub>3</sub> to take place:

- The granulator pipe reactor (GPR)
- The dryer pipe reactor (DPR).

The GPR is located inside the granulator drum. This is supplied with a feed of H<sub>3</sub>PO<sub>4</sub> and/or H<sub>2</sub>SO<sub>4</sub> together with NH<sub>3</sub> and recycled scrubbing liquor. The DPR is located inside the dryer drum and is supplied with an H<sub>3</sub>PO<sub>4</sub> and NH<sub>3</sub> feed. Acid(s) can also be supplied to the scrubbing system to properly control atmospheric NH<sub>3</sub> emissions.

This design configuration makes it possible to further widen the range of raw material choices and, consequently, increase the number of NPK grades that can be produced. It also guarantees the lowest possible production cost by adjusting the solid-liquid ratio to lower the recycle rate.

The production of any NPK grade can be targeted by selecting different raw materials such as:

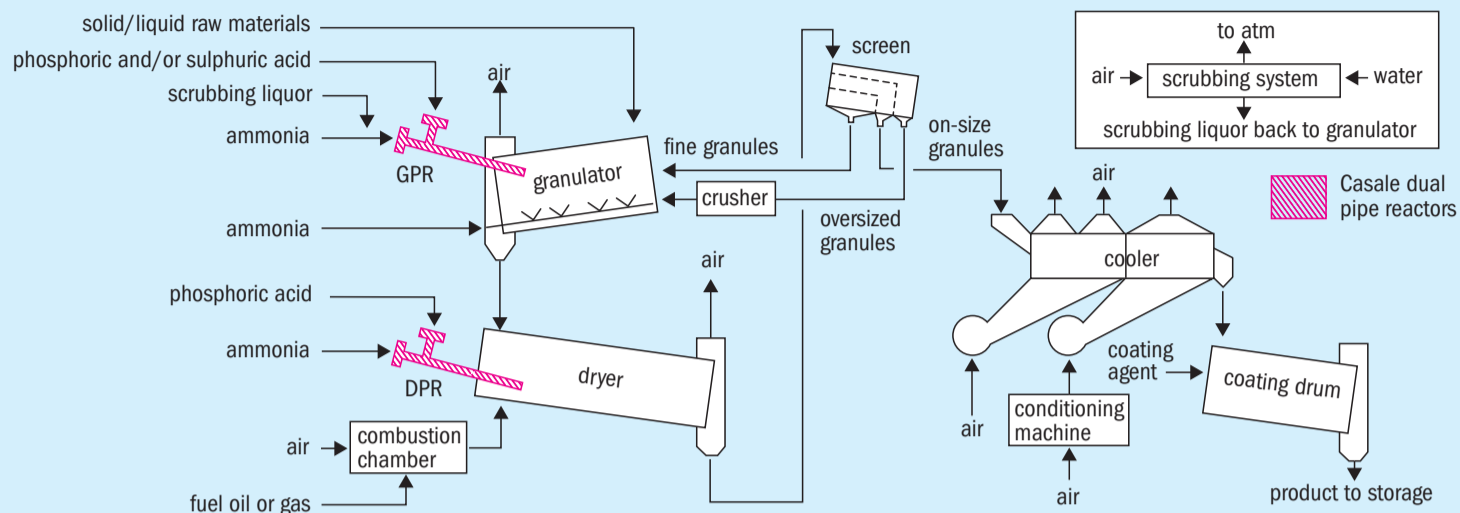
- Solid and liquid ammonium nitrate (AN) and urea
- Liquid (phosphoric acid) or solid (MAP, DAP, SSP, TSP, etc.) phosphorus sources

**Table 1: Example of NPK grades produced at a Casale dual pipe reactor granulation plant**

Name	Type	N	P	K	S	Trace elements
General fertilizer	MOP	15	15	15	8	5
General fertilizer	SOP	15	15	15	18	5
General fertilizer	MOP	16	16	8	8	5
General fertilizer	SOP	16	16	8	12	5
General fertilizer	MOP	16	8	16	8	5
General fertilizer	SOP	16	8	16	18	5
Potato fertilizer	Special	12	8	20	12	5
Potato fertilizer	Special	9	8	18	8	5
Corn compound fertilizer	Special	20	10	10	8	5
Corn compound fertilizer	Special	16	12	12	8	5
Wheat compound fertilizer	Special	18	16	6	8	5
Vegetable compound fertilizer	Special	16	6	18	18	5
Asparagus compound fertilizer	Special	18	8	14	8	5
Soybean compound fertilizer	Special	12	16	12	8	5
Grape compound fertilizer	Special	16	8	16	12	5
Watermelon compound fertilizer	Special	12	12	16	12	2
Cotton compound fertilizer	Special	18	10	12	8	5
Peanut compound fertilizer	Special	14	12	14	12	5
Rice compound fertilizer	Special	16	12	12	8	5
Rice compound fertilizer	Special	16	10	14	8	5
Tobacco compound fertilizer	Special	10	10	20	18	5
Compound fertilizer for fruit trees	Special	10	12	18	18	5
Compound fertilizer for peppery	Special	16	8	16	12	5

Source: Casale

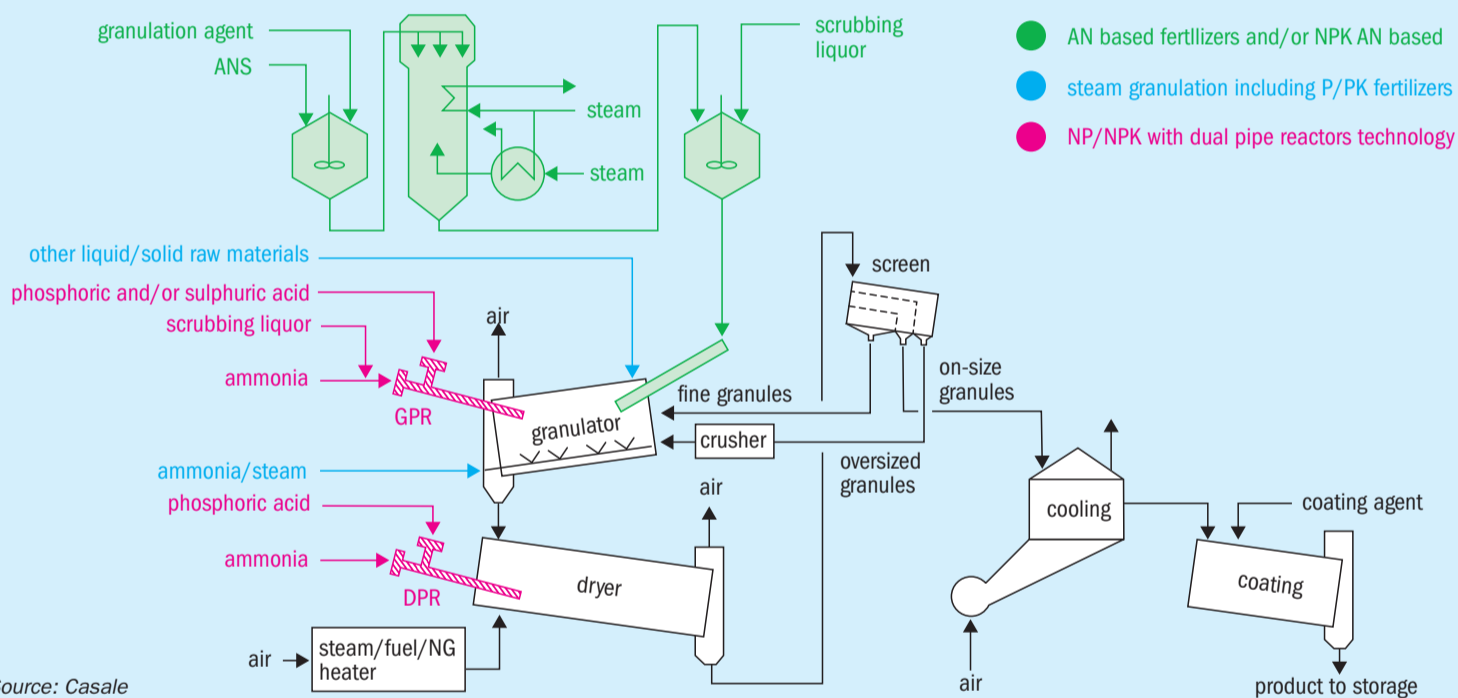
Fig. 1: Casale's dual pipe reactor NPK process\*



Source: Casale

\* This process incorporates an additional dryer pipe reactor (DPR) in the dryer in addition to the granulator pipe reactor (GPR).

Fig. 2: An integrated granulation plant incorporating three different Casale processes, including dual pipe reactor technology



Source: Casale

- Liquid or gaseous ammonia
- Sulphuric acid
- Nitric acid
- Solid ammonium sulphate (AS)
- Elemental sulphur
- Micronutrients.

NPK or NP grades can be produced by either selecting or omitting a potassium source (KCl or  $K_2SO_4$ ), respectively. NP and NPK grades using different nitrogen sources, such as ammonium nitrate, urea or ammonium sulphate, can also be manufactured.

For each NPK grade, raw materials are generally selected according to market

availability and cost. Operating costs (particularly recycle rate) also have an impact on raw material selection. Plant flexibility, in terms of raw materials, is therefore a key factor when it comes to the competitive production of NPK grades in response to changing market conditions.

### Investment and production costs

Chemical granulation is undoubtedly the best production choice for NPK product quality and offers the maximum flexibility for both raw material use and NPK product options. The selection of chemical and

steam granulation should however, involve an evaluation of their respective investment and production costs.

Chemical granulation is not much different from steam granulation in terms of investment cost. Both require a complete drums granulation loop (granulator, dryer, screens, crushers). Additionally, chemical granulation requires extra feeding systems and reaction point equipment (GPR, DPR) for liquid raw materials.

The main difference in the production costs of chemical and steam granulation, however, reflect their different raw material costs. Chemical granulation requires an

available supply of phosphoric acid and/or sulphuric acid plus ammonia. Nevertheless, the consumption of acid and ammonia can be minimised for each NPK grade by adjusting the raw material selection and mix. Phosphoric acid can be used as the sole phosphorus source, for example, or in combination with other solid sources (MAP, DAP, SSP, TSP), according to availability and what is most economically advantageous.

### Revamping

Because they are configured with essentially the same equipment, a steam granulation plant – if based on conventional drum granulation – can be upgraded to

chemical NPK granulation by revamping with Casale’s dual pipe reactor technology.

Casale has successfully revamped several granulation plants. These have either:

- Changed production from NPKs to ammonium nitrate (AN) fertilizer manufacture
- Or upgraded steam granulation plants (e.g., from TSP granulation) to NPK production.

### The integrated granulation plant

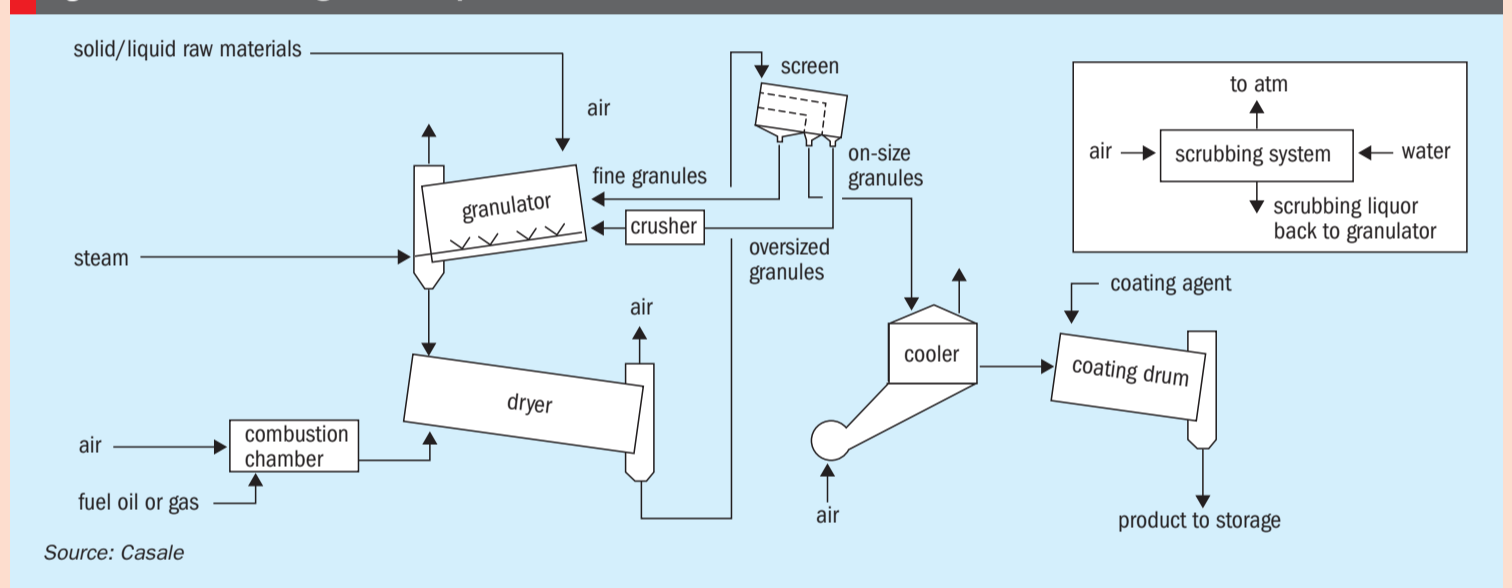
Casale is a comprehensive licensor of fertilizer production technologies with wide-ranging expertise and long-standing experience in plant design, start-up and operations. By integrating Casale process technologies (Figure 2), it is possible to

design a new granulation plant, or revamp an existing plant, to produce the following wide range of fertilizers:

- AN-based fertilizers via chemical granulation
- AN-based NPKs via chemical granulation
- NP/NPKs via chemical granulation with dual pipe reactor technology
- P/PK fertilizers via steam granulation.

The production of AN-based fertilizers, such as ammonium nitrate (AN), calcium ammonium nitrate (CAN) ammonium sulphate nitrate (ASN), requires a dedicated AN solution concentration section together with a granulation agent dosing and mixing system (Figure 2, green). This is necessary to ensure proper control of ASN concentration. ■

Fig. 3: Casale’s steam granulation process



Source: Casale

## STEAM GRANULATION

This NPK production method (Figure 3) achieves a specific NPK grade by granulating a ground mixture of solid raw materials in the presence of steam. Unlike bulk blending, steam granulation generates individual granules with the desired NPK composition. In this NPK production route, the addition of steam is used as a ‘glue’ to stick together the different raw material particles. Raw materials need to be pre-ground prior to steam granulation to achieve effective mixing and agglomeration.

The steam production method, to enable granules to form via the agglomeration mechanism, must include a full granulation loop (granulator, dryer, screen, crusher etc). The product granules obtained, although homogeneous in composition, have poor mechanical properties (crushing strength and roundness) because their different components are only held together weakly.

Not all fertilizer raw materials can be mixed and granulated using steam either, superphosphate and urea being two examples. This limits the flexibility of steam granulation by restricting both the range of acceptable raw materials and the method’s

ability to produce different NPK grades.

Despite this, steam granulation still has a deserved place in Casale’s technological portfolio especially because of its ability to produce certain valuable fertilizers, particularly granular phosphates or PK grades, using only solid raw materials. Notable examples include the steam granulation of single superphosphate (SSP) and triple superphosphate (TSP).

In these fertilizer types, the only nutrients present are phosphorus or phosphorus plus potassium, while nitrogen (in the form of ammonia, for example) is specifically avoided. This means that phosphoric acid or sulphuric acid cannot be used as the ammonia necessary for their neutralisation is absent.

Casale therefore offers steam granulation as a process step in SSP/TSP powder production as follows:

- In the first step, SSP/TSP powder is initially produced in a Casale run-of-pile SSP/TSP plant by acidulating rock phosphate with sulphuric or phosphoric acid.
- In the second step, the SSP/TSP powder, with or without addition of solid K source such as potassium chloride, is granulated in a steam granulation plant. ■

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