

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

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Fertilizer INTERNATIONAL



CRU Phosphates 2024 conference, Warsaw
Fertilizer markets - what's in store for 2024
Magnesium removal from phosphate rock
Phosphate market review



CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets - what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
JANUARY/FEBRUARY 2024



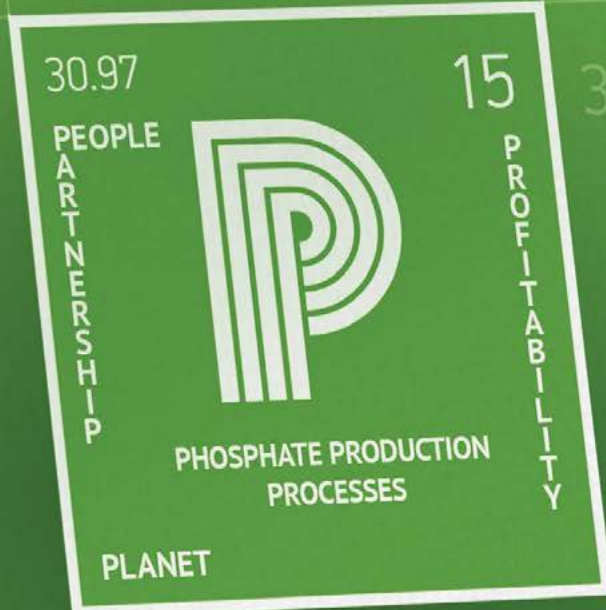
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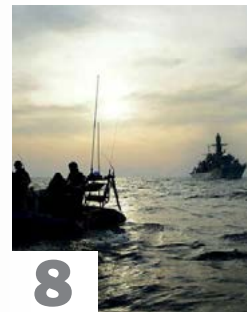
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8

The year ahead in fertilizers



20

Ridding phosphate rock of unwanted magnesium

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www.fertilizerinternational.com

NUMBER 518

JANUARY | FEBRUARY 2024

CONTENTS

- 8 The year ahead – a market exposed to global risks**
We look ahead at fertilizer industry prospects for the next 12 months, including the key economic and agricultural drivers likely to shape the market during 2024.
- 10 Argus Fertilizer Europe 2023**
More than 700 delegates from 300 companies and 55 countries gathered at the EPIC SANA Lisboa Hotel, Lisbon, Portugal, 17-19 October 2023, for the Argus Fertilizer Europe 2023 conference.
- 11 The future of fertilizer coatings**
New regulatory developments in Europe are focusing attention on eliminating microplastic residues in soils. Major companies are also developing new coating technologies for controlled-release fertilizers (CRFs).
- 14 Urea finishing technologies: selecting the optimal solution**
Stamicarbon's Dr Wilfried Dirx, Ahmed Shams and Branislav Manic explore the technology options for urea finishing.
- 17 New Kimre leadership**
In an exclusive interview, Kimre's new president Mary Gaston sets out her plans for the company.

PHOSPHATES AND POTASH INSIGHT

- 19 CRU Phosphates welcomes you to Warsaw!**
CRU Events will convene the 2024 Phosphates International Conference & Exhibition in Warsaw at the Hilton Warsaw City Hotel, 26-28 February.
- 20 Innovative magnesium removal technology**
Kevin De Bois of Prayon Technologies describes an innovative process for removing magnesium from phosphate rock.
- 22 Phosphates project listing 2024**
Fertilizer International presents a global round-up of phosphate rock, phosphoric acid and finished phosphates projects.
- 26 2023: the phosphates year in review**
CRU's Senior Analyst Logan Collins looks back at what's been a dynamic year for the global phosphate market.

REGULARS

- 3 Editorial**
Top ten fertilizer calls for 2024
- 3 Market Insight**
- 5 Industry News**
- 7 People & Calendar**
- 28 Index to advertisers**

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
JANUARY/FEBRUARY 2024



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Top ten fertilizer calls for 2024



In a recent webinar, Chris Lawson, CRU's Head of Fertilizers, gave the CRU view on what 2024 holds in store for the global fertilizer industry. Here are CRU's top 10 calls for the year ahead:

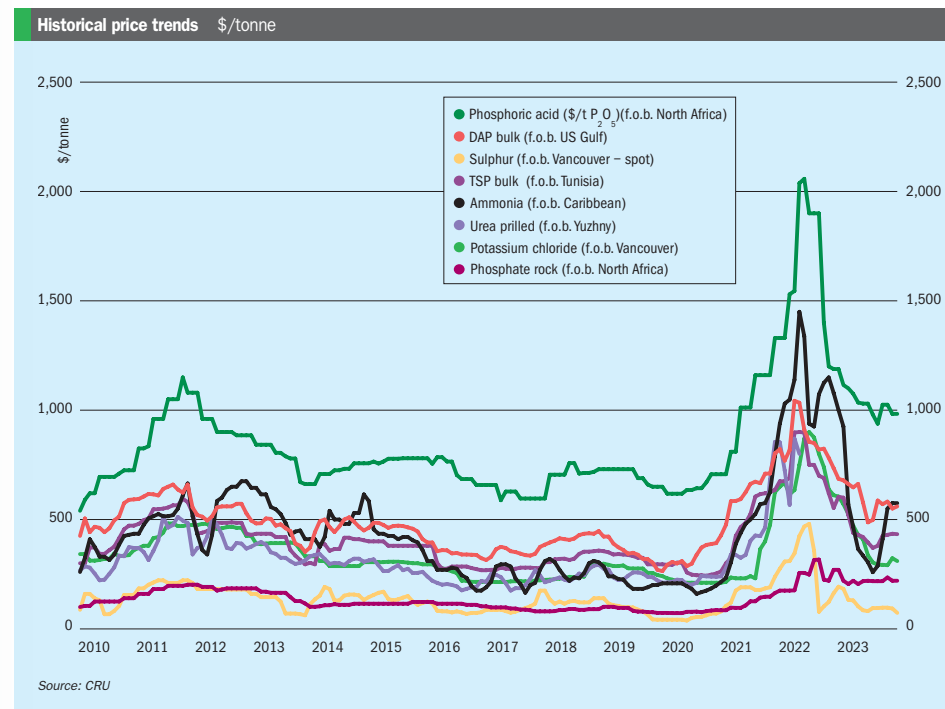
- 1. Demand will continue to recover as affordability improves.** Fertilizer demand recovered during 2023 from the price-induced destruction of the previous year. CRU's expects this trend to continue in 2024, with agricultural consumption of nitrogen up 1.5 percent, P₂O₅ up 4.8 percent and K₂O up 6.5 percent year-on-year.
- 2. European fertilizer capacity will remain constrained and is likely to shrink.** Business is tough for European fertilizer producers (*Fertilizer International* 517, p32). High gas prices and a challenging regulatory environment will continue to plague producers in 2024. CRU does not anticipate a restart of the Lifosa phosphate plant, for example. NPK plants (*Fertilizer International* 516, p16) are also being shuttered, while closed ammonia capacity is unlikely to return, and high costs will stifle any potential investments.
- 3. Europe's CBAM reporting requirements will catch importers off-guard.** Fertilizers importers are facing new EU emissions reporting requirements for certain goods imported into the bloc, as part of the carbon border adjustment mechanism (CBAM). In CRU's view, the fertilizer industry is under-prepared for new CBAM requirements. We therefore expect some fertilizer importers to be handed small fines this year as a result.
- 4. European producers to invest more in North American ammonia projects.** The United States' '45Q' tax credit has proved to be a successful incentive for US blue ammonia projects. The decision by CF Industries to cease ammonia production at its UK Billingham site (*Fertilizer International* 516, p8) and replace this with North American imports is a sign of things to come. CRU expects European companies to accelerate their investment in US blue ammonia production, driven by cost effectiveness and low carbon intensity.
- 5. Expect more delays and backtracking on ammonia investment decisions.** CRU expects only half of the two million tonnes of low-emissions ammonia capacity due in 2024 to commission, as project timelines continue to slip. While some 11.7 million tonnes of capacity in CRU's low-emissions ammonia project pipeline is scheduled for a final investment decision (FID) this year, just one million tonnes of this capacity is expected to achieve financing this year.

- 6. Purified phosphoric acid (PPA) capacity will receive further capital injections.** Battery and electric vehicle markets are growing rapidly, and lithium iron phosphate (LFP) is increasing its share in the battery chemistry mix. There is also a conscious effort to de-risk battery supply with a shift away from China (*Fertilizer International* 517, p46). This will be supportive of overall phosphate demand – although the incremental gains will be modest.
- 7. China's potash import flows will continue to favour Belarus, Russia and Laos.** China has imported a record volume of potash in 2023. Its potash import sources have also become more diverse, with both Laos (*Fertilizer International* 517, p52) and Belarus increasing their product share. CRU expects this trend to continue in 2024 – leaving Canada vying to capture more market share elsewhere.
- 8. Chinese urea and phosphate export restrictions will be tight in the first half of 2024 but loosen thereafter.** The Chinese government has injected more confusion into the urea and phosphate markets by raising its export barriers yet again – and knowingly leaving export restrictions vague – its main objective being to lower domestic prices. CRU believes export restrictions will eventually loosen in 2024's second half and, as a result, total export volumes this year will end up fractionally higher than in 2023.
- 9. More fertilizer exports from Russia and Morocco.** Russian ammonia will continue to find its way back to the traded market with exports expected to restart via Taman, Russia's Black Sea port, in the first quarter of 2024. Shipments which resumed from the Russian Baltic port of Ust-Luga in 2023 are also expected to continue. Morocco is finally expected to boost its phosphate exports – with recent data suggesting this is already occurring. Both Russia and Morocco will step into China's usual markets in the first half of 2024.
- 10. Fertilizer price moves will be muted.** Tighter markets will not translate into sharply higher prices in 2024, in CRU's view. Fertilizer prices reached stasis last year – a situation that is set to continue, as illustrated by urea. While the urea market is set to tighten on paper, with gas price volatility and Chinese export doubts still looming as huge risks, ample supply should keep a lid on prices. ■

S. Inglethorpe

Simon Inglethorpe, Editor

Market Insight



PRICE TRENDS

Urea: December began on a positive note with a flurry of Egyptian urea sales and firmer prices for delivery to Brazil. The increase in values was short lived, however, and piecemeal demand in Europe was insufficient to halt the downward trend. By mid-December, buying interest from Brazil had fizzled out, although sellers breathed a sigh of relief when India's NFL floated a new import tender on 21st December. Offers opened by NFL on 6th January revealed that Fertcom was lowest for West Coast India (WCI) at \$317/t cfr, while Agri Commodities was lowest for East Coast India (ECI) at \$329/t cfr.

Ammonia: The market started the final month of the year with a bearish tone but no clear evidence of lower prices. Tampa set the last firm benchmark with \$625/t cfr settled for December, a rollover from November. By the middle of December, a lack of availability in the Middle East was slowing

the downward trend but failed to halt it completely. After an outage at Ma'aden, there was little pressure to sell spot tonnes from the region, although pressure elsewhere resulted in a considerable drop in the price of ammonia in Southeast Asia.

Phosphates: In early January, low stocks and tight supply pushed DAP/MAP prices higher in the US and Pakistan with India at risk of a similar fate. Indian fears over DAP availability appear to be growing. The government signalled its intention to increase the fertilizer subsidy for the remainder of the Rabi season as market participants gathered in New Delhi to attend the annual FAI conference. By mid-December, India finally stepped back into the market to buy DAP, despite ongoing reports of tight supply. Phosphate fertilizer prices ended 2023 noticeably lower than at the end of 2022, but most benchmarks remained historically high heading into the New Year. Trading in the first week of January was uninspiring with prices mostly flat and relatively little

activity outside of a barrage of sales from Saudi Arabian producer Ma'aden.

Potash: MOP prices for delivery to key spot market Brazil came under more pressure than expected through December, slumping to their lowest levels since March 2021. European prices remain relatively firm among seasonally low demand. Bearish sentiment for 2024 remains strong as unfavourable weather has hampered winter crop planting. Southeast Asian prices remained firm as the market awaited Pupuk Indonesia's return in the coming weeks. Potash spot prices look set to soften further in Brazil and Europe in the New Year, as the global potash outlook remains bearish in the absence of fresh India contracts. US potash prices held relatively firm, however, with fill offers expected in January.

NPKs: While some NPK benchmarks have firmed into December, others softened amid reports of a steady supply of Russian product.

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
JANUARY/FEBRUARY 2024



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Market price summary \$/tonne – start January 2024

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	475	334**	f.o.b. E. Europe 280	f.o.b. US Gulf	560	-	-
f.o.b. Yuzhny	Port closed	Port closed	-	f.o.b. N. Africa	585	430	983
f.o.b. Middle East	435	302**	-	cfr India	593	-	985*
Potash	KCl Standard	K ₂ SO ₄	Sulphuric Acid	Sulphur			
f.o.b. Vancouver	311	-	cfr US Gulf	104	f.o.b. Vancouver	73	-
cfr India	319	-	-	-	f.o.b. Arab Gulf	77	-
f.o.b. Western Europe	-	633	-	-	cfr China	103	-
f.o.b. Baltic	258	-	-	-	cfr India	98+	-

Prices are on a bulk, spot basis, unless otherwise stated. (* = contract ** = granular). Phosphoric acid is in terms of \$/t P₂O₅ for merchantgrade (54% P₂O₅) product. Sulphur prices are for dry material. (+ Quotes for product ex-Arab Gulf). n.a. = not available.

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India's 10-26-26 prices were unchanged at \$460-470/t cfr. Some domestic producers in India are reported to have increased NPK production at the expense of DAP. This is due to more favourable margins.

Acron was reported to be selling NPK 16-16-16 to Brazil at prices as low as \$370-390/t cfr. Morocco's NPS 12-46-0-7 benchmark increased to \$535-540/t f.o.b., a result of slightly higher prices in Brazil. In China, some domestic NPK prices climbed in December with raw-material prices remaining firm, although buying activity has slowed.

Demand for NPKs in Southeast Asia was steady. Indonesia's total NPK import demand – through various formulations – was indicated at roughly 300,000 t/a by market sources. Most of this was met with 16-16-16 product sourced from Europe.

Sulphur: Price benchmarks across the globe declined further in December amid limited spot demand and ample availability. Sales into China and Brazil indicated netbacks below the official monthly contract prices posted by Middle East producers for December.

While Middle East producers lowered their monthly contract prices for January, spot price assessments were mostly stable in the New Year as activity was limited. The three main sulphur producers in the Middle East offered material in the \$74-77/t f.o.b. range for January, down from \$85-90/t f.o.b. for December, \$98-100/t f.o.b. for November.

OUTLOOK

Urea: The outlook for global urea prices is weak. But a one million tonne purchase by India could put a line under recent declines, if buyers in Europe and the US are tempted

back into the market. The US is still thought to be a million tonnes short.

In Brazil, a lack of clarity about the size of the planted Safrinha crop, and what demand for urea may be outstanding, is weighing on urea prices. Paper markets indicate modestly firmer prices through the first quarter.

Ammonia: Prices are expected to remain soft moving through January with little in the way of price support from both a supply and demand perspective. Weakened global sentiment was typified by the news that January's Tampa settlement at \$525/t cfr was \$100/t down on December, with further first quarter declines anticipated once the Gulf Coast Ammonia (GCA) project comes online.

As Traders returned to their desks after New Year, ammonia prices extended their losses, amid a stable supply outlook and a distinct lack of downstream industrial and fertilizer demand.

Phosphates: Limited availability from some suppliers in the weeks ahead could continue to support DAP/MAP prices, particularly if India's government increases the nutrient-based subsidy (NBS) for DAP.

Most key global benchmarks are expected to firm through the first quarter before softening. Prices could move lower than expected if demand does not improve or if supply from China is higher than expected. CRU is forecasting ammonia costs to fall even further over the short term. This represents a further possible downside for DAP/MAP prices.

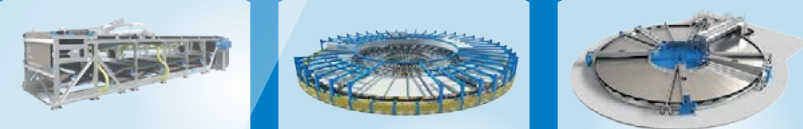
Potash: Potash spot prices are expected to remain stable in the months ahead. Delayed potash demand and improving weather conditions could, however, lead to higher than anticipated global consumption and, consequently, prices could surprise to the upside.

No major impact on potash exports from Israel and Jordan was discernible in early January despite the disruption to shipping in the Red Sea. Delivered prices to China and India could come under upwards pressure from higher freight rates.

The India contract is expected to rollover at \$319/t cfr but has yet to be agreed. China's previous contract expired in December, although buyers are likely to exercise their optional tonnage volumes. The China contract is currently expected to remain at \$307/t cfr, with fresh negotiations anticipated in May to mid-July.

NPKs: Early January indications suggest little change in NPK/NPS prices in some key global markets compared with the previous month. Demand for NPKs, while seasonally slow in some regions, is starting to improve in parts of Europe. There are few notable supply constraints and NPK/NPS shipments from Russia are likely to remain steady. Phosphate raw-material prices are expected to increase in the first quarter, potentially offering short-term support for some NPK benchmarks, before softening thereafter.

Sulphur: Sulphur prices are expected to increase during the first half of 2024, following recent declines, although good availability will limit upside in the short term. Prices could remain below expected levels, however, should fertilizer production prove weaker than expected. Nonetheless, major sulphur buyer OCP is expected to increase its fertilizer output further over the coming months, as the Moroccan phosphate giant has the potential to achieve good revenues and margins from its ample spare production capacity.



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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL ISSUE 518 JANUARY/FEBRUARY 2024



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SAUDI ARABIA

Ma'aden and partners develop unique phosphogypsum recycling process

The Saudi Arabian Mining Company (Ma'aden) has entered into a partnership with Metso and thyssenkrupp Uhde to develop and license an integrated process to reduce carbon emissions and recycle phosphogypsum in Saudi Arabia. A framework agreement between the three partners was jointly announced on 10th January.

The innovative new process, which will form the centrepiece of a new complex in Ras Al Khair, is designed to reduce CO₂ emissions across Ma'aden's phosphate business. Ma'aden has already been granted a US patent for this integrated CO₂ and phosphogypsum recycling technology.

The partners plan to incorporate the patented technology at the greenfield Ras Al Khair complex. It will capture CO₂ with lime generated from the calcination of phosphogypsum using sulphur. The new process is designed to reduce CO₂ emissions across Ma'aden's phosphate business, making it more sustainable in the long-term. It will also recycle phosphogypsum waste and transform this into a useful resource.

Ma'aden says the patented approach is dual-purpose and addresses two of the phosphate industry's most pressing environmental challenges – first, the decarbonisation of production to prevent atmospheric CO₂ pollution and, second, the effective reuse of phosphogypsum, a by-product of phosphate production that is generated in very large quantities. Overall, the new process offers global warming mitigation via sustainable carbon capture as well as providing a viable solution for phosphogypsum recycling.

Hasan Ali, executive vice president, Ma'aden Phosphate, said, "This pioneering patent, combined with our new CO₂ capturing complex, underscores Ma'aden's commitment to sustainability. We look forward to working with Metso and thyssenkrupp Uhde to develop this important project that will truly change and reduce the carbon footprint of our phosphate business. It puts

us at the forefront of innovation, turning what was once leftover material into a valuable resource, while significantly reducing CO₂ emissions. It's a giant leap towards a sustainable future."

Hannes Storch, vice president for metals and chemicals processing at Metso, added: "We are excited to see this unique project moving forward. The new concept for phosphogypsum processing will be a major step forward in the fertilizer industry, contributing to sustainability targets, such as waste recovery and limiting global warming. Metso contributes to the project with our extensive know-how and experience in the field of fluid bed, gas cleaning and sulfuric acid solutions."

"We are honored to be chosen from our esteemed customer to provide our technology and expertise," said Lucretia Löscher, COO thyssenkrupp Uhde. "We are providing the innovative process to turn the phosphate industry into a circular economy. This project will be another important milestone for thyssenkrupp Uhde in enabling the green transformation for our customers."

Ma'aden is the Middle East's largest commodity mining and metals company and one of the fastest-growing mining companies in the world, generating revenues of \$10.7 billion in 2022. The Saudi mining giant operates 17 mine and production sites in the Kingdom, has more than 6,500 direct employees, and exports products to over 30 countries.

The company has huge growth plans for phosphate, aluminium, gold and copper mining over the next 18 years, and to extract new minerals – enabling Ma'aden to capture a greater share of Saudi Arabia's \$1.3 trillion endowment in mineral resources and turn these into commercial opportunities.

Ma'aden also wants to be a role model in responsible and sustainable mining as set out in the government's Vision 2030 strategy for the Saudi economy. ■



PHOTO: ANGLO AMERICAN

The under-construction Woodsmith polyhalite mine in the UK (see news item opposite).

UNITED KINGDOM

Anglo seeks outside investors for Woodsmith mine

Mining giant Anglo American is looking to sell a minority stake of up to 49 percent in its Woodsmith polyhalite fertiliser mine project in the UK, *The Times* reported on 27th December.

The company's chief executive Duncan Wanblad told city analysts that the company is "moving at pace to find a partner" to share project costs. Anglo has already begun to identify potential investors before starting a formal sales process, *The Times* said, having itself already injected \$2.5bn into the project to date.

There is speculation that the company will target infrastructure investors and sovereign wealth funds as well as looking for further binding offtake agreements for it POLY4 product from the fertilizer industry.

Wanblad said Anglo needed "the right partner at the right price for this particular asset". It is understood that the company is looking to secure new investors for the project by early 2025, with an external stake of up to 49 percent on offer, allowing Anglo to maintain project control.

Project costs have risen rapidly since the project's inception. This is partly because Anglo has needed to redesign, over several years, what was originally a junior mining project. *The Times* reported on 9th November that project costs had tripled since 2017, describing the Woodsmith mine as a "money pit" for Anglo.

In 2017, Sirius Minerals, the project's previous owner, originally estimated that the Woodsmith mine would cost \$2.9 billion to build. But Tom McCulley, the head of Anglo American Crop Nutrients, has now confirmed that recent estimates by analysts that the Woodsmith mine could cost around \$9 billion to complete were not "too far off".

The 13 million t/a capacity project to construct Europe's deepest mine near Whitby in North Yorkshire is scheduled to enter production in 2027. Anglo announced a series of upgrades to the Woodsmith mine's core infrastructure last year as part of strategy update. These are designed to deliver a larger and more scalable polyhalite mining operation (*Fertilizer International* 514, p44).

UNITED ARAB EMIRATES

ADNOC to buy out OCI's stake in Fertiglobe

The Abu Dhabi National Oil Company (ADNOC) has entered into a binding agreement with OCI Global to acquire its entire majority shareholding in Fertiglobe for \$3.62 billion.

The agreement to purchase OCI's '50 percent plus one share' holding – announced on 15th December last year – will make ADNOC the majority shareholder in Fertiglobe, increasing its total shareholding to 86.2 percent. The transaction is expected to complete this year.

The agreement also incorporates an earn-out mechanism for the next two years, this being linked to commodity pricing and the free cash flow performance of Fertiglobe's business over this period.

Fertiglobe is the world's largest seaborne exporter of urea and ammonia. It is also the largest nitrogen fertilizer producer in the Middle East and North Africa, with production facilities in Egypt, Algeria and the UAE. The transaction supports ADNOC's chemicals strategy and its plans to establish a global growth platform for ammonia – a key low carbon fuel and hydrogen carrier that is expected to play an important role in the energy transition.

Khaled Salmeen, executive director, downstream, marketing and trading directorate at ADNOC, said: "Working in close partnership with OCI since 2018, we have successfully listed and grown Fertiglobe into the world's largest seaborne exporter of ammonia and urea fertilizers. Today's agreement reinforces ADNOC's long-term commitment to Fertiglobe and our continued focus on delivering growth and maximising value for the company's shareholders. This important transaction supports ADNOC's ambitious chemicals growth strategy and accelerates our plan to establish a global growth platform for ammonia and clean ammonia."

UNITED STATES

OCI sells Iowa Fertilizer Company to Koch

OCI Global has agreed to sell its wholly-owned US subsidiary Iowa Fertilizer Company (IFCO) to Koch Ag & Energy Solutions for \$3.6 billion. The binding agreement was announced on 18th December last year.

IFCO is located in Wever, Iowa, and produced 1.2 million t/a of urea ammonium nitrate (UAN), 700,000 t/a of anhydrous ammonia and 700,000 t/a of diesel exhaust fluid (DEF) in 2021.

The announced sale of IFCO to Koch follows a strategic review by OCI in March 2023. OCI is expected to use the proceeds from the transaction to pursue value-added opportunities in the energy transition. The company has been an early mover into lower-carbon ammonia and green methanol production and is seeking to build on this.

Nassef Sawiris, the executive chairman of OCI, said: "Today's announcement marks an evolutionary step in our journey to create value for shareholders, and to enhance our focus on efforts in lower carbon initiatives. IFCO was the first world-scale greenfield nitrogen fertilizer facility built in the United States in over 25 years. We are confident that under Koch's stewardship, IFCO will be well positioned for its next phase of growth. Our strengthened balance sheet will support the acceleration of our strategy in the field of decarbonisation projects, driving future growth and supporting the energy transition goals we share with many of our stakeholders, establishing us as a leader in the low carbon space."

The transaction is expected to close in 2024 but remains subject to US anti-trust approval and other customary closing conditions.

EGYPT

Agreement to develop green hydrogen project

ACWA Power has signed a framework agreement to develop the first phase of a green hydrogen/ammonia project in Egypt.

The agreement was signed on 7th December with the Sovereign Fund of Egypt, the Suez Canal Economic Zone, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority in the presence of Dr Moustafa Madbouly, Egypt's prime minister.

The first phase of the \$4 billion project has a green ammonia production capacity of 600,000 t/a, with the potential to scale up to two million t/a of capacity in the project's second phase. The hydrogen feedstock for the project will be generated electrolytically from wind and solar plants.

Saudi-listed ACWA Power, the world's largest private water desalination company, has been rapidly expanding its green portfolio. The company is currently developing the

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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NEOM Green Hydrogen Project, the world's first utility-scale green hydrogen plant, in the northwest of Saudi Arabia, as part of a joint venture with Air Products and NEOM. The project will have the capacity to produce 1.2 million t/a of green ammonia.

The company also broke ground on its second green hydrogen project in Uzbekistan on 27th November. The first phase of this project will produce 3,000 t/a of green hydrogen, with a second phase expansion to 500,000 t/a of green ammonia also planned. This will be powered by 2.4 GW of wind energy.

Marco Arcelli, the CEO of ACWA Power, said: "As a first mover in green hydrogen, ACWA Power is proud to bring its expertise in this new and exciting market to Egypt. We commend our partners for their bold step into producing the fuel for the future, for which there will be great demand in Europe and the rest of the world. Egypt is well-positioned to become one of the world's top producers of green hydrogen and we are elated to be a part of the country's energy transition."

ACWA signed new agreements for green hydrogen projects in Jordan and Indonesia during the recent COP28 conference.

AUSTRALIA

Uhde to license Karratha project granulation unit

thyssenkrupp Fertilizer Technology has signed a contract with Saipem to license a urea granulation unit for the Karratha project in Western Australia.

The Karratha project is being constructed by a 50:50 joint venture (50/50) between Saipem and Australian company Clough on behalf of its developer Perdaman Chemicals and Fertilisers. The project reached financial close in April last year.

The 6,200 t/d capacity urea granulation unit at Karratha – made up of two identical trains of 3,100 t/d – will use thyssenkrupp's proprietary UFT® fluid bed urea granulation process. This technology is responsible for more than 70 percent of the urea granules produced worldwide.

thyssenkrupp Fertilizer Technology will be responsible for the licensing and process design package for the granulation plant and supplying the main equipment. This includes the supply of two granulators and two exhaust air scrubbers.

Dr Cord Landsmann, thyssenkrupp Uhde's CEO, said: "This project for Perdaman marks an important milestone that will further consolidate our position as a technology supplier in the fertilizer industry. We are proud to have been selected as the partner to supply our highly efficient urea granulation technology. With our proven UFT® fluid-bed urea granulation technology, we guarantee the production of a consistent top-quality product and, at the same time, strict compliance with environmental standards. We are pleased to be supplying the market with advanced technologies for fertilizer production and furnishing our global customers with the best solutions."

Perdaman's chairman, Vikas Rambal, added: "We are pleased to be building Australia's biggest downstream project,

which represents a major investment in the Australian production sector. This state-of-the-art plant will contribute to Australia having a safe and reliable source of high-quality urea, thus supporting the farmers and food producers. The decision in favour of thyssenkrupp Fertilizer Technology as the technology supplier and licensor for this urea project not only speaks for the competence of thyssenkrupp Fertilizer Technology, but also for confidence in the ability of the company to supply reliable solutions for the fertilizer industry."

EUROPE

Europe's fertilizer industry commits to decarbonisation

Trade body Fertilizers Europe has unveiled a decarbonisation roadmap for the European fertilizer industry.

The document, published on 14th November last year, commits Europe's nitrogen producers to climate-neutral production of ammonia by 2050. It also sets out steps required to achieve two intermediate targets by 2030:

1. Reduce ammonia production greenhouse gas (GHG) emissions by 31 percent (trajectory 1)
2. Produce 50 percent of ammonia production via water-electrolysis (trajectory 2).

"With the appropriate legislative framework, investment landscape, and collaborative efforts we will ensure Europe's food security and strategic autonomy for generations to come," Fertilizers Europe said in a statement.

"Our European fertilizer industry supports the EU Green Deal and is committed to play its part in Europe's climate objectives. By 2050, at the latest, every kilogram of fertilizer produced in Europe could be climate neutral. The real challenge is how to successfully transition to low-carbon production while remaining globally competitive," said Antoine Hoxha, Director General of Fertilizers Europe.

The Roadmap, developed with consultancy Guidehouse, explores two main pathways on how Europe's fertilizer industry can decarbonise, as Antoine Hoxha explains:

"From 2005 to 2020, our sector has already reduced its scope 1 and 2 emissions

by 49 percent, placing European fertilizer industry as best in class globally. Going beyond this level of ambition, a drastic change in the production process is required. Such massive change can only materialise with the deployment of a technology-neutral approach, substantial and targeted support and access to affordable, low-carbon and renewable energy".

The roadmap includes cost estimates for this transition. If all the hydrogen used in low-carbon ammonia production was produced with offshore wind-driven electrolyzers, for example, this would require investments of:

- €64 billion only for the wind parks
- €17 billion for the electrolyzers
- €3 billion for a hydrogen pipeline network.

"Decarbonising domestic production is of strategic importance for Europe to ensure its long-term food security and autonomy. We are looking forward to working with the European Commission, the European Parliament, Member States governments and wider stakeholders to ensure that we all contribute in a timely manner to drive this change forward," concluded Antoine Hoxha. ■



Perdaman's Karratha project in Western Australia.

PHOTO: PERDAMAN

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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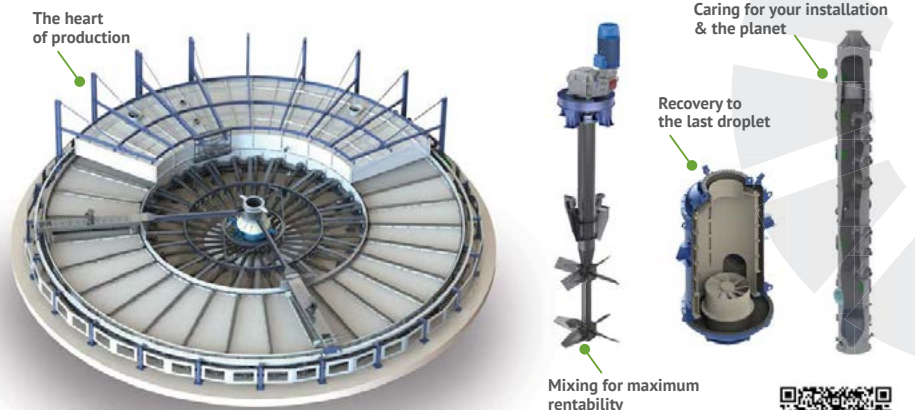
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People

CRU acquires BCInsight's industry publications

The ownership of *Fertilizer International* magazine transferred from BCInsight Ltd to CRU, the global commodities experts, at the start of the year.

CRU confirmed the purchase of BCInsight's leading fertilizer and chemical industry publications on 4th January. The strategic acquisition will reunite the magazines *Fertilizer International*, *Nitrogen+Syngas* and *Sulphur* with their sister conferences owned by CRU.

As a result of the acquisition, BCInsight's publications are combining with CRU Events to form CRU Fertilizer Communities. This new integrated business unit will improve engagement, knowledge-sharing and networking across the fertilizer and wider chemicals industries.

All of BCInsight's employees have also transferred across to CRU, namely **Lisa Connock** (Managing Editor), **Richard Hands** (Editor of *Nitrogen+Syngas* and *Sulphur* magazines), **Simon Inglethorpe** (Editor of *Fertilizer International*), **Marlene Vaz** (Subscriptions and Advertisement Manager) and **Tim Stephens** (Design and Production).

Fertilizer International will continue as the official magazine of the long-standing CRU Phosphates and Fertilizer Latino Americano conferences. The title has a long association with CRU dating back to a lengthy period of ownership between 1986 and 2007. The magazine has been published continuously for nearly 55 years, having been founded in July 1969 by The British Sulphur Corporation (*Fertilizer International* 490, p20).

Nicola Coslett, CEO of CRU Communities at CRU, said: "I am delighted to bring these publications back into the CRU family and to welcome Lisa Connock and her BCInsight team to CRU. This acquisition aligns perfectly with our mission to provide comprehensive and valuable resources to the global fertilizer community. We have worked as partners for many years, and I am confident that, together, we will create an even more vibrant and dynamic community that fosters innovation and collaboration opportunities to our clients who are

at the centre of our fertilizer and chemicals communities."

Chris Lawson, Head of Fertilizers at CRU, said: "Expanding technical expertise alongside our unrivalled team of dedicated and highly experienced analysts will enhance CRU's ability to deliver even more comprehensive and insightful information to our clients. With so many new entrants into the ammonia, phosphate and fertilizer industries, the need for technical knowledge and insights has never been more important."

Lisa Connock, Director and Technical Editor at BCInsight, said: "After working closely with Nicola for so many years, it was clear CRU Communities would be a great home for our publications. CRU's fertilizer and related conferences have long been recognised as premier events in the fertilizer sector, attracting industry leaders, experts, and key stakeholders from around the world. I am incredibly proud of the community we have built together, and I look forward to serving our customers with an even stronger offering as we embark on a new phase of growth together."

BCInsight is an independent private publishing company providing market leading publications online and in print. These provide analysis, technical articles, comment and statistics on the world-wide production, trade, transportation, handling and consumption of fertilizers, fertilizer raw materials, sulphur and other basic chemicals.

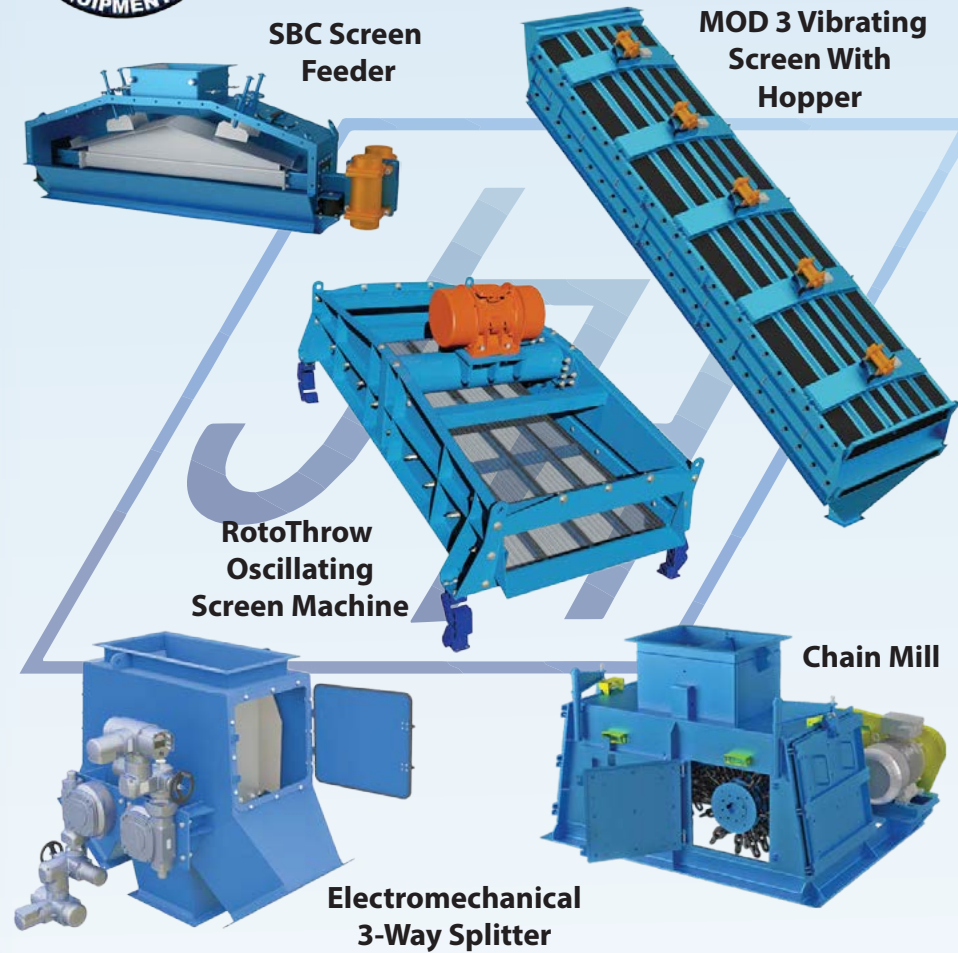
The company publishes three bimonthly titles, two annual directories and an online buyer's guide, namely: *Sulphur*, *Nitrogen+Syngas*, *Fertilizer International*, *Sulphur Industry Directory*, *Fertilizer Industry Directory* and *BCInsightsearch.com*. These are all transferring to CRU ownership.

The three magazines will continue to operate under their existing names – and maintain their commitment to delivering high-quality technical content and meaningful market insights to readers. CRU says the acquisition will allow the magazines to leverage its extensive data and thought leadership to further enhance their reach and influence across the whole fertilizer industry. ■



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26-28 CRU Phosphates 2024 Conference & Exhibition, WARSAW, Poland Contact: Michelle Bingham, CRU Tel: +44 (0)20 7903 2159 Email: michelle.bingham@crugroup.com	6-8 IFA Global Sustainability Conference, Amsterdam, The Netherlands Contact: IFA Conference Service Tel: +33 1 53 93 05 00 Email: ifa@fertilizer.org	20-22 IFA Annual Conference, SINGAPORE Contact: IFA Conference Service Tel: +33 1 53 93 05 00 Email: ifa@fertilizer.org

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

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The year ahead – a market exposed to global risks



PHOTO: UK MINISTRY OF DEFENCE

We look ahead at fertilizer industry prospects for the next 12 months, including the key economic and agricultural drivers likely to shape the market during 2024.

Growth slows, inflation falls and risks abound

Global growth has been uneven and continues to remain below trend, according to the IMF, with the “global economy limping along, not sprinting”, in its view.

The IMF expects world economic growth to slow from 3.5 percent in 2022 to 3.0 percent in 2023 and 2.9 percent in 2024, well below the 2000–2019 average of 3.8 percent. The outlook for inflation is improving, though, with rates declining after the inflationary shock of 2022. The IMF expects global inflation to fall back this year – as tighter monetary policy and lower international commodity prices take effect – with rates slowing from 8.7 percent in 2022 to 6.9 percent in 2023 and 5.8 percent in 2024.

“The global economy continues to recover slowly from the blows of the pandemic, Russia’s invasion of Ukraine, and the cost-of-living crisis. In retrospect, the resilience has been remarkable. Despite the disruption in energy

and food markets caused by the war, and the unprecedented tightening of global monetary conditions to combat decades-high inflation, the global economy has slowed, but not stalled. Yet growth remains slow and uneven, with growing global divergences. The global economy is limping along, not sprinting,” comments Pierre-Olivier Gourinchas, The IMF’s economic counsellor.

His observations are echoed by International Fertilizer Association (IFA) in its latest market outlook¹:

“Fertilizers remain at the intersection of unsettled food and energy markets, and are increasingly exposed to global risks spanning geopolitics, conflict, economics and climate. Supply has been resilient despite existing and fresh local disruptions in 2023, while macroeconomic drivers have grown in influence. Economic pressures stemming from inflation and recession risks have led to rising interest rates globally, which raises the cost of borrowing for governments, companies and consumers.”

Politics to the fore in '24?

Mehreen Khan, *The Times*’ economics editor, singles out politics as the biggest downside risk to the global economy in 2024. Political upheavals, alongside three other major risks, are, she says, “filling many with dread” about economic prospects for the next 12 months².

“The first [risk] is politics. A record number of voters in more than 70 countries will go to the polls in what is shaping up to be a landmark global election year. National votes will be held in the US, UK and India; there will be elections for the European parliament, and a trio of regional votes in Germany, to name a few.”

The three other major key economic concerns highlighted by Khan are:

- The US presidential election in November – this being the most significant global political flashpoint of the year.
- A sense of foreboding that something could still break the fragile world economy – with one contender being the recent Houthi rebel attacks on Red Sea

cargoes, and their potential spillover for commodity prices, freight rates and global inflation, if they were to close the Suez Canal as a shipping route.

- The final source of trepidation for the year ahead is self-inflicted damage from the over-zealous monetary policy of central banks – a factor that has already brought the Eurozone to the edge of recession, according to *The Times*.

There are signs that the Suez Canal is already becoming an untenable route. Maersk, for example, suspended shipping through the canal on 3rd January, until further notice, following a Houthi attack on one of its vessels. Other major shipping firms, including Hapag-Lloyd, Evergreen Line and MSC, have also stopped using this critical shipping route due to similar Red Sea attacks by Houthi rebels.

Political risks to the fertilizer market are also singled out by IFA in its short-term outlook³:

“Politics will play a significant role in 2024, with almost two billion people in more than 70 countries due to vote in national elections. [Several] topics ... on the table in these elections ... will have implications for fertilizers. Positions on foreign policy, food security, agricultural subsidies and decarbonisation could spell change for fertilizers in these countries and the global market as a result.”

IFA also highlights the impact of “the higher cost of borrowing, access to credit and depreciating currencies” on affordability “in many importing and fragile markets”⁴.

Food prices continue to slide

After near record food prices in 2022 (*Fertilizer International* 512, p13), the FAO Food Price Index (FFPI) stood at 118.5 points in December 2023, 10 percent (13.3 points) below the level of a year ago. The index averaged 124.0 points last year, some 14 percent lower than the 2022 average.

The FAO’s cereal price index averaged 130.9 points in 2023, down 15 percent (23.8 points) from its record annual average in 2022 - a reflection of well supplied global markets. After falling for four consecutive months in the second half of 2023, wheat export prices rallied in December, supported by tensions in the Black Sea and the weather-related disruptions affecting major exporters. International rice prices, meanwhile, registered a 21 percent annual increase in 2023, largely due to concerns

What drives fertilizer demand?

Fertilizer demand is influenced by the complex interplay of many factors – some of which are harder to predict than others. In the short-term, the main drivers of demand include:

- Farm economics, the macroeconomic outlook and currency exchange rates
- Crop prices and fertilizer-to-crop price ratios
- Crop mix, growing areas and crop yields
- Soil nutrient levels and nutrient replenishment
- Policy, regulation and fertilizer subsidies
- Sustainability, nutrient management and nutrient recycling

Many of these factors vary from country-to-country and region-to-region. Adding to the complexity, these primary drivers are in turn influenced by a host of secondary considerations.

Macroeconomic conditions, by triggering slowdowns or expansions in global, regional and national growth, control overall economic demand and affect the health of agricultural markets. **Farm economics** and attendant issues such as credit availability and barter ratios have a more direct impact on the ability of farmers to purchase fertilizers.

Crop prices and fertilizer-to-crop price ratios act as key controls on crop nutrient demand as they play a critical role in determining farm buying power and (alongside exchange rates) fertilizer affordability. Crop prices in turn are driven by the **harvest size** annually, **stock levels** and **demand** for agricultural commodities. Fertilizer industry analysts pay particularly close attention to the prices of cereals, oilseeds, cotton, sugar and palm oil, the main fertilizer-consuming crop types globally.

The **biofuels market** is also an important driver of fertilizer demand due to large-scale cultivation of maize and sugarcane for ethanol and oilseed rape (canola) for biodiesel (*Fertilizer International* 474, p22). Crop failures due to extreme weather events such as the **El Niño** (*Fertilizer International* 475, p38) and **La Niña** can also affect fertilizer demand in the short-term. ■

about El Niño’s impact on production and the aftermath of the rice export restrictions imposed by India.

Amid improved global supplies, the vegetable oil price index averaged 126.3 points last year, a sharp 33 percent (61.5 points) fall on the 2022 average and marking a three-year low.

Sugar prices bucked the annual price declines seen for other food commodities, being driven upwards in 2023 by concerns over the tight global sugar balance. The average sugar price index in 2023 averaged 145 points, its highest annual value since 2011 and up 27 percent (30.6 points) on 2022.

Ag commodities – prices to fall and supplies to improve?

Global food commodity prices are set to fall in 2024, predicts Rabobank in its annual outlook. This should help to ease food price inflation in many parts of the world after three years of record highs caused by war, adverse weather and rising energy and input costs.

Rabobank expects across-the-board falls in the global prices of key agricultural commodities including sugar, coffee, corn and soybeans. This should be good news and welcomed by buyers and food consumers. Ag commodity demand is, however, likely to remain weak this year due to slowing economic growth, high inflation and elevated interest rates – despite improving prices and rising supply availability.

Carlos Mera, head of agri commodities at Rabobank, said: “Describing the last three years of global agricultural commodity prices as volatile is an understatement. Producers are still grappling with the after effects of war, adverse weather, high farm input inflation and weak consumer demand, but eyeing 2024 as the return to a semblance of normality.”

He continued: “It won’t be plain sailing but the more positive outlook for the majority of agri commodities should lead to relief for buyers around the world. Governments, businesses, farmers and consumers will all feel beleaguered after a volatile few years”.

Uncertainty will persist for wheat, though – a vital food commodity in developing countries – due to the potential for weather-related disruptions and restrictions on Black Sea exports. Indeed, Rabobank expects, for the fifth year in a row, another deficit in the global wheat market in 2024.

While Russia's 2024 wheat harvest is likely to stay high (above 87 million tonnes), this expectation remains subject to weather uncertainties and export restrictions. In Ukraine, meanwhile, the continuing effects of the war on wheat production are expected to result in a shrinking exportable surplus.

Southern hemisphere wheat growers are unlikely to provide much relief in the coming months either, with Argentina underperforming and Australia falling well behind its good harvests of the past three years.

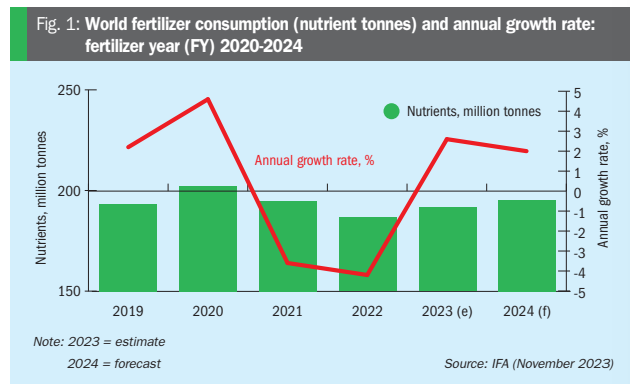
The South American agricultural production should return to a healthier position this year and bolster global supplies, forecasts Rabobank. Brazilian farmers, for example, are expected to deliver a 163 million tonne soybean crop in 2024, as La Niña weather conditions gives way to El Niño. Rabobank also expects Argentina, the biggest exporter of soy products, to recover after last year's crop failure.

Rabobank's 2024 outlook is also forecasting:

- Global supplies of canola (rapeseed) to recover due to strong Ukrainian plantings and an end to the dry spell in Canada, the world's largest canola producer
- El Niño to push palm oil supplies short of expectations and support prices
- Vegetable oil demand to continue to grow exponentially driven by ever higher US biofuel sector consumption
- More favourable 2024/25 growing conditions in Thailand to bring down sugar prices from the 12-year high seen in 2023.
- The coffee market to hit a 6.8 million bag surplus in 2024/25, spurred by a recovery in the Brazilian and Colombian arabica crop, although farmers will continue to be squeezed by high input costs, labour shortages and weak consumer demand.

Fertilizer demand

In a welcome respite for farmers, the International Fertilizer Association (IFA) has highlighted the improvement to fertilizer affordability since mid-2022 in its latest



demand outlook¹. IFA advises that true farm costs will, however, vary from country-to-country, due to currency depreciation and the effects of higher interest rates on access to credit.

IFA is estimating a modest 2.6 percent rebound in global fertilizer consumption in 2023 to 191.5 million tonnes of nutrients (N + K₂O + P₂O₅), this being only a part reversal of the sharp 7.6 percent demand contraction seen in the preceding two years (Figure 1).

While world nitrogen consumption in 2023 (109.7 million tonnes N) is expected to exceed pre-pandemic levels, a more muted recovery in phosphorus and potassium demand is likely, according to IFA's latest outlook. Indeed, global consumption of both these nutrients in 2023 – 46.2 million tonnes P₂O₅ and 35.6 million tonnes K₂O – looks set to remain below 2019 levels.

IFA expects the following usage pattern in four key regions to drive up year-on-year (y-o-y) global growth in fertilizer consumption in 2023:

- Increasing N use (43 percent y-o-y) in both East Asia and Eastern Europe & Central Asia
- Increasing P₂O₅ use (36 percent y-o-y) in South Asia
- Increasing K₂O use (44 percent y-o-y) in Latin America.

Looking ahead, IFA expects the modest growth in global fertilizer use to continue this year and is forecasting a 2.0 percent y-o-y rise in nutrient use in 2024. A rise by this amount (+3.9 million tonnes to 195.4 million tonnes of nutrients) would, however, finally return global fertilizer consumption to above 2019 levels (Figure 1).

On an individual nutrient basis, nitrogen consumption is expected to grow by 1.7 percent in 2024, while P₂O₅ and K₂O consumption look set to grow by 2.0 percent and 3.1 percent, respectively, suggests IFA¹.

While forecasting overall growth in consumption, IFA highlights a number of overarching risks to global fertilizer demand during 2024, particularly:

- Crop economics and fertilizer affordability
- El Niño and unforeseen weather events
- Politics, the economy and government policies
- Conflicts in agricultural centres.

Regionally, the main factors to watch over the next 12 months include:

- The continuing war in Ukraine
- The agricultural impact of El Niño in Latin America, southern Africa and Australasia
- Chinese government monitoring and restriction of fertilizer exports
- Election outcomes and the strength of monsoon rains in India
- The regulation of nitrogen consumption in Europe.

Summing up, IFA's main conclusions in its short-term outlook are that ¹:

- Although fertilizer availability and affordability are much improved, the potential for market disruption remains
- Macroeconomics (and risks) remain the foremost driver of demand
- Agricultural N and P consumption are expected to recover more strongly than K consumption in the short term
- Weather is a big short-term risk as we move from La Niña to El Niño conditions

- Policies on food security and nutrient use efficiency (NUE) are becoming increasingly important drivers of fertilizer use.

Fertilizer supply

IFA currently uses a supply metric known as 'capability'. This estimates actual fertilizer supply by combining announced production capacity developments with a set of assumptions for disruptions to production output in affected countries¹. Supply capability factors in the impact of the following world events on the global fertilizer market:

- The evolution of Russia's war in Ukraine
- Sanctions placed on Russia and Belarus
- The logistical ability of both Russia and Belarus to export fertilizers
- The introduction of protectionist policies curbing exports from key fertilizer exporting countries such as China.

IFA is currently forecasting the following fertilizer supply changes for the two years 2023-2024 ²:

- A four percent increase in nitrogen capability from 156.5 million tonnes to 162.1 million tonnes N – driven by low-cost projects in Russia and the US, the displacement of imports from the ramp up of new plants in India, and a return to production growth in China.
- A 12 percent increase in phosphate capability from 51.1 million tonnes to 53.4 million tonnes P₂O₅ – mainly driven by a return to pre-pandemic production in North Africa and the ramp up of recently commissioned production capacity in West Asia.

- A 10 percent increase in potash capability from 46.2 million tonnes to 50.8 million tonnes K₂O – based on production capacity additions in Laos and Russia, continued Belarussian export recovery via alternative routes, and higher operating rates in Russia in response to higher demand.

In terms of individual commodities, IFA makes the following global supply projections for 2023 versus 2022:

- **Urea:** Increased production (+3.6%) to 190 million tonnes and falling trade (-4.3%) to 51 million tonnes.
- **Monoammonium phosphate and diammonium phosphate (DAP/MAP):** Falls in both production (-0.7%) to 63 million tonnes and trade (-3.2%) to 26 million tonnes.
- **Muriate of potash (MOP):** Higher production (+5.1%) to 65 million tonnes and an increase in trade (+9.0%) to 50 million tonnes.

Fertilizer purchasing boost in 2024?

Rabobank is forecasting annual rises in fertilizers purchases – of around three percent in 2023 and five percent in 2024 – in its latest global fertilizer market outlook. This follows a seven percent contraction in global purchases in 2022³.

"These figures align with our affordability index, which shows much better conditions for purchasing fertilizers than a year ago," says Bruno Fonseca, senior analyst for farm inputs at Rabobank. "The index's movements confirm our expectation of usage growth in 2023, with nitrogen grow-

ing two percent phosphate 3.9 percent, and potash five percent."

The outlook for potash and phosphate is positive, according to Rabobank, while the nitrogen market, in contrast, is facing challenges due to lower fertilizer demand from corn and wheat growers and production uncertainties.

"As winter approaches in Europe, there is more uncertainty in the natural gas market and related uncertainty in the production cost of nitrogen fertilizers," comments Fonseca.

The arrival of El Niño is expected to disrupt grain and oilseed markets, following the good Brazilian and the US harvests of recent years.

Potash, meanwhile, is going through a period of ample supply, while the phosphate market is also on the rise, suggests Rabobank, due to the return of Chinese MAP/DAP exports.

Finally, the Israel-Hamas war could widen to negatively affect global fertilizer markets this year, warns Rabobank. Israel is a sizable supplier of phosphate and potash, accounting for around three percent of phosphate exports and eight percent of potash exports globally. The impact of the conflict is, however, only marginal currently. ■

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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Argus Fertilizer Europe 2023

More than 700 delegates from 300 companies and 55 countries gathered at the EPIC SANA Lisboa Hotel, Lisbon, Portugal, 17-19 October 2023, for the Argus Fertilizer Europe 2023 conference.

The exhibition and networking area was a big hit with delegates at the latest Argus Europe event in Lisbon.

We report on keynote presentations and roundtable discussions at last October's Argus Fertilizer Europe conference in Lisbon.

Soil and water - precious agricultural resources

In his opening keynote address, Gonçalo Rodrigues, Portugal's Secretary of State for Agriculture, set out the challenge for the conference in terms of more effective fertilizer use.

The UN's Global Campaign on Sustainable Nitrogen Management, for example, has set the goal of reducing global nitrogen pollution by 50 percent by the end of this decade – a non-binding target that, as Mr Rodrigues pointed out, is now only six years away.

Portugal's commitment to agricultural sustainability was also highlighted by Mr Rodrigues:

"The challenge I give you for these three days is to discuss how we can do better and improve, focusing on our natural resources, especially soil and water, because [their] contamination is a big issue in Europe. So we need to find a better way to cope with this.

"It's essential to remember that soil is a vital and limited, non-renewable and irreversibly precious resource. We can try to grow maize, fruits vegetables, whatever, but without soil we cannot do that. We cannot keep on improving our [growing] techniques, we cannot strive to feed our population, we can do nothing without soil.

"[We] have more or less 700 people in Lisbon for the next three days to discuss the best techniques possible, to improve what we are doing today, and look to the future path we need to take. We can navigate the complexities and opportunities that lie ahead, ensuring that we are resilient, efficient, sustainable – because we need to focus on [both] the present and the future generations to come.

"It's a big honour to have you in Lisbon. Thank you for your dedication as we try to shape the future together."

European gas market briefing

Lawrence Templeton, VP for European natural gas and electricity at Argus, briefed delegates on Europe's natural gas market. The market was at the crossroads currently in Templeton's view.

"Why a crossroads? Simply put, the future increasingly in the European natural gas market does not look like the past," Templeton said. "We've entered an era of increased uncertainty both in terms of supply and in terms of demand for natural gas in Europe."

In terms of market fundamentals, there's been a reconfiguration in Europe's natural gas supply following the slowdown in Russian deliveries that began in the second half of 2021. These had accounted for 40-45 percent of European supply historically.

The key supply development in the European market over the last 2-3 years, suggested Templeton, has been the

pivot away from a reliance on Russian supply towards liquid natural gas (LNG) instead.

"The big story is LNG – natural gas on water, on boats – it's now a global market to which Europe is exposed," said Templeton. "The increase in European reception capacity has increased Europe's ability to absorb [LNG] supply in the global economy, and we expect the build out [of this capacity] in Europe to continue over the coming years."

Europe's gas market looked well supplied last October ahead of winter in the northern hemisphere. "Over the summer of 2023, we've seen the highest stock build and levels of stock since we've been tracking this data, much higher than the 2015-2019 average," commented Templeton.

European gas demand in winter has also reconfigured, with household consumption, in particular, partly decoupling from outside temperature, as Templeton explained:

"[Last winter] We saw significantly reduced demand from the household sector as well as from industrial clients and manufacturers. So we've got a double change here – and this is why we say the future looks increasingly less like the past.

"Not only do we have a reconfiguration on the supply side we have a reconfiguration of demand too. And it remains to be seen if we'll return to historical behaviour when it comes to how people consume gas in households."

PHOTO: ARGUS



The panel in this keynote discussion asked if Europe can successfully decarbonise its fertilizer industry without damaging output. From left to right: Argus moderator Oliver Hatfield, IFA's Laura Cross, Maen Nsour and Bart Pescio of OCI

Europe's nitrogen market

Following the extreme price volatility of last few years – and corresponding swings in the fertilizer affordability index – a softening in fertilizer prices during 2023 has seen a turnaround in affordability, according to **Oliver Hatfield**, VP for fertilizers at Argus.

"High prices have cured themselves in the sense that we've seen farmers reducing applications – not just in Europe – with prices effectively rationing demand to the extent that prices have bottomed out," Hatfield said. "The nature of the market has also changed. There's now much more caution around purchasing, much more hand to mouth buying.

"This means that the market in general is a lot more precarious. Stock levels in relative terms are a lot lower than they would otherwise be, but we have moved through a transition from a situation where supply was short and prices were high to more or less the reverse of that."

Natural gas price volatility has affected EU nitrogen production costs, resulting in the idling and closure of capacity and boosting imports from outside the region (*Fertilizer International* 517, p32). Consequently, European supply has been similarly precarious.

"We could see [European ammonia] capacity start to turn down again. We have seen capacity come back over the last six to 12 months because gas prices and market conditions have allowed it," said Hatfield. "But we're getting close, based on the [gas price] spike of the last few weeks, to a situation where production costs could challenge those economics."

European farmers have a preference for nitrate fertilizers such as calcium ammonium nitrate (CAN) over urea and, in general, are prepared to pay a premium for this.

"That preference is not completely inelastic," commented Hatfield. "Substitution [of urea for CAN] will take place if the premium for nitrates exceeds a certain threshold, which is what has happened over the last couple of years, with nitrate production costs in Europe driving up prices and making it unaffordable.

"This has drawn in large volumes of urea imports, not only from traditional but also from non-traditional sources. There are substantial alternative sources of [low cost] supply for urea all primed and ready to ship urea to the European market."

Over the last year, European urea supply sources have included Algeria, Russia, Nigeria, Egypt, Iran and central Asian countries. This shift in supply has also resulted

in greater European dependence on the urea spot market. The upshot has been much greater price volatility, said Hatfield, with dramatic urea price swings as high as \$100/t in a single week.

Can Europe decarbonise?

In this moderated session, Oliver Hatfield sat down to discuss progress on fertilizer industry decarbonisation with **Laura Cross**, director of market intelligence at the International Fertilizer Association (IFA), **Bart Pescio**, OCI's head of commercial strategy, and **Maen Nsour**, the CEO of the Arab Potash Company (APC).

He asked the panel if they thought that decarbonisation was progressing fast enough – and, if not, why?

Laura Cross agreed that the fertilizer industry could definitely move faster, and suggested that two drivers were delaying decarbonisation efforts and the shift to green and blue ammonia:

"The first is broadly the macroeconomic climate," said Cross. "It's easy to underestimate how much capex inflation – and the change in lending environment – we've seen in last two years.

"There was a period when we were tracking green and blue ammonia project announcements almost daily. [Now] when you look at projects that have slowed down or been indefinitely delayed, the two main drivers factors being cited are, one, it's now much more expensive to build these projects – because there's increased demand for capex – and, two, it's much more expensive to borrow the money to invest.

"The second driver is really about two parallel needs we're seeing playing out. So, on the one hand, we recognise the importance of decarbonising fertilizer production, but you also have the [emerging]

PHOTO: ARGUS



Oliver Hatfield, Argus VP for fertilizers, provided a typically thorough and insightful European nitrogen market briefing.



role of ammonia as an energy carrier. That makes it more complex to forecast – as a lot of these new uses of ammonia don't really exist today.

"In the not-too-distant future, there are projections of ammonia consumption reaching the triple digit millions of tonnes, based on the use of ammonia in the marine sector as an energy carrier, for power generation etc. But that's not the same investment case as for an established market."

Currently, there are established nitrogen fertilizer producers wishing to decarbonise their production, alongside new large-scale green and blue ammonia project developers entering the market with different aims and objectives. Nitrogen producers are also pivoting away from fertilizers towards the energy market. This means that the future pathway to decarbonisation is not entirely clear or straightforward, as Cross explained.

"We have companies, who were not present in the fertilizer and ammonia space a few years ago, investing billions of dollars into ammonia capacity," said Cross. "Then, at the same time, we have established fertilizer producers who are really interested in re-marketing themselves as energy companies."

"There is a space for both. But, personally, I believe this is what's slowing the pace – the chain of events and/or drivers leading to decarbonisation are not straightforward."

Bart Pescio agreed with Laura's assessment:

"OCI is building the first world-scale blue ammonia plant [at Beaumont in Texas]. It's happening. We are going at the speed at which the market develops – we believe in this transition and we will be part of it."

"While I cannot speak for others, OCI believes there is a market appetite [for low carbon ammonia] – as the carbon intensity of goods will become part of commercial transactions when CBAM [the EU's carbon border adjustment mechanism] is introduced. [But] it's going to be a difficult road given that, unfortunately, not everything is subject to the same taxation."

Arab Fertilizer Association (AFA) countries in the Middle East and North Africa (MENA) region, which are responsible for around 33 percent of global fertilizer exports, need to be included more in the dialogue and action on decarbonisation, suggested Maen Nsour. These countries have different economic incentives as they fall outside the policies which are driving decarbonisation in Europe and North America.

"I have to be extremely candid. The movement [towards decarbonisation] is not going to continue at the speed everyone wishes," Nsour said. "You [Europe] will be flying in one direction at a certain speed and hoping that everybody will act like flying geese in formation. This is not happening and will not happen."

"You have to understand the priorities of other countries and ... how we can come up with conduits [on decarbonisation] that will be needed very soon to make a big difference [globally]. It's crucial that we [Europe] understand what's happening on the other side of the Mediterranean and try very hard to build channels of communication – so we [act] in the best interests of everybody and not only those [countries] in the north."

Fertilizers and sustainable food

In this session, **Ruben Eussen**, OCI's global head of product manufacturing and development, and **Dennis Bakx**, global sustainability manager for raw materials at European drinks giant Heineken, discussed the fertilizer industry's contribution to the decarbonisation of agriculture and the switch to low carbon farming. Oliver Hatfield was on hand to moderate.

OCI is pursuing two low carbon ammonia projects currently:

- The under-construction 1.1 million t/a capacity Beaumont blue ammonia project in Texas. The project, which will sequester 1.7 million t/a of carbon dioxide and reduce production CO₂ emissions by 70 percent, is on track for completion in 2025.
- OCI subsidiary Fertigllobe also launched the Egypt Green Hydrogen project in 2022, as part of a consortium with Scatec, Orascom Construction (OC) and The Sovereign Fund of Egypt (TSFE). These partners have committed to building a green hydrogen plant with a 15MW polymer electrolyte membrane (PEM) unit in Ain Sokhna, Egypt, in the project's first phase. This plant will produce 8,000 t/a of green ammonia initially, with plans to ultimately scale up production to 90,000 t/a.

OCI is also driving down the carbon footprint of the Nutramon calcium ammonium nitrate (CAN) fertilizer it produces in the Netherlands. This already has a 40-50 percent lower carbon footprint than conventional CAN thanks to the use of biomethane feedstocks.

The use of blue ammonia in the manufacture of Nutramon will reduce its carbon footprint by 50-55 percent, and the switch to a green ammonia feedstock, when this becomes available from 2024, will ultimately reduce its footprint by 70-75 percent.

Ruben Eussen, in his presentation, highlighted two pioneering food projects using low carbon Nutramon fertilizer:

- OCI, German agricultural trading company AGRAVIS Raiffeisen AG and Dossche Mills are collaborating on a project to manufacture low carbon wheat flour for use in bread making and other food staples. The wheat, which was harvested from fields in Germany in summer 2023, is currently being milled and distributed as lower carbon flour to food manufacturers.
- OCI also delivered its first UK shipment of Nutramon to Simpsons Malt Limited in March 2023 as part of a new project to reduce the carbon footprint of malting barley and distilling wheat.

Heineken, as Dennis Bakx explained, is also driving down agriculture emissions by rolling out a low carbon farming programme (LCFP) for its barley growers. The company is committed to reducing its 'Scope 3' agricultural emissions by 30 percent by 2030. This is part of a concerted drive by Heineken to grow sustainable barley and make low-carbon beer. This is being increasingly demanded by the retailers Heineken supplies.

The LCFP incorporates precision farming and regenerative agriculture and actions such as:

- The use of cover crops and crop residues
- No tillage or reduced tillage practices
- Reduced fertilizer usage
- Use of nitrogen inhibitors to prevent environmental losses from fertilizers.

The programme was expanded from 200 farming pilots in 2022 to 300 pilots in 2023 and is on track to expand to 500 pilots by 2025. Heineken's ultimate aim is to massively scale-up the LCFP to more than 10,000 farmers by 2030.

Argus Fertilizer Europe 2024

Building on the success of Lisbon's 2023 event, Argus Fertilizer Europe will be returning to Athens, Greece, in October 2024 – a date to keep for your diary! ■

PHOTO: SIMON INGLETHORPE/CRU

The future of fertilizer coatings

CONTROLLED-RELEASE FERTILIZERS

New coating technologies should make the adoption of controlled-release fertilizers in broad acre agriculture more competitive.

New regulatory developments in Europe are focusing attention on eliminating microplastic residues in soils by adopting biodegradable fertilizer coatings. Major technology licensors and engineering companies are also developing new coating technologies for controlled-release fertilizers (CRFs).

MILLIKEN & COMPANY

The EU finally adopts its microplastics regulation: now what?

Wade Holcombe, TS&D Team Lead for agriculture

The arrival of new EU regulation

The European Union (EU) formally adopted a restriction on the use of microplastics in products sold within the region on 25th September 2023, following the recommendation of the European Chemicals Agency (ECHA). This new regulatory action seeks to avoid or reduce the release of microplastics into the environment, regardless of product type. It comes at a time when more businesses and communities are working to increase the 'circularity' of plastics consumption and production.

Microplastics can be particularly difficult to dispose of – as, by definition, they are less than 5 millimetres in size and most consumers, therefore, are not even aware they exist. This general lack of awareness means that microplastics could end up in the environment, degrading into smaller and smaller pieces for centuries, if not disposed of or recycled properly.

With the restrictions on microplastics introduced by REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) regulation 2023/2055 in September, EU companies will have to adhere to industry-specific guidance on how to avoid, remediate or reformulate their products. For the fertilizer industry, this regulation specifically affects fertilizer products that:

- Incorporate microplastics as defined below; and
- Are not currently governed under REACH EU 2019/1009.

Introduction

The sustainability of fertilizer coatings, and their sourcing from bio-based natural sources such as vegetable oils, have become priorities for key suppliers such as Arkema (*Fertilizer International* 500, p24), NAQ Global (*Fertilizer International* 500, p22) and Novochem (*Fertilizer International* 516, p40). The industry's major technology licensors and engineering companies, notably thyssenkrupp and Stamicarbon, have also developed new coating technologies for controlled-release fertilizers (CRFs).

Regulatory developments in Europe, meanwhile, are focusing attention on eliminating plastic residues in soils by adopting biodegradable fertilizer coatings. Leading CRF manufacturer ICL, for example, has recently introduced biodegradable coatings into its controlled-release portfolio (*Fertilizer International* 510, p24).

A selection of the latest regulatory, technological and product developments in the coated fertilizer market are reviewed.

How will this affect fertilizers?

Fertilizers often incorporate microplastics to control the release of their highly water-soluble active ingredients. Microplastics help impart 'staying power' and limit the water solubility of fertilizer products by applying a cross-linked polymer – often polyurethane – to their nutrient components. Liquid fertilizer formulations, for example, can incorporate a polymer-based acrylic thickener to enhance their staying power on the ground, while encapsulating solid fertilizer granules within a plastic coating can impart controlled-release characteristics.

A difficult balancing act

Microplastics therefore play an essential role in precision agriculture by helping limit the downstream release of chemicals that could taint the environment. Less desirably, however, the remnants of plastics coating, having partly deteriorated over time to slowly release fertilizer ingredients, are left in the ground and water bodies. The presence of these residual microplastic fragments in the environment can affect animals and humans, as well as countless other organisms that draw nutrients from soil and water.

Striking the right balance between nutrient losses to the environment and microplastic contamination of soil and water is difficult, especially given that controlled-release fertilizer (CRF) technol-

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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ogy has not changed much in 50 years. Nonetheless, the introduction of REACH regulation is now providing added urgency and prompting an industry shift. That's because fertilizer manufacturers, under EU 2023/2055, will have until 2028 to achieve compliance with this microplastic-free regulation. From this date, all products placed on the market will need to adhere to specific requirement. The key takeaways from this regulation are as follows:

- It covers synthetic polymer microparticles. These being defined as: not an unmodified, naturally-occurring polymer; not water-soluble (greater than 2g/L); or not biodegradable.
- Although fertilizer products must be compliant by 17th October 2028, the supplier ingredients that go into these fertilizers will need to be compliant almost a year ahead of the 2028 deadline.
- An interim period is expected, during which end-users may incur increased costs and experience performance gaps, until product innovation catches up with the regulation.
- In certain instances, REACH regulation EU 2019/1009 on fertilizer standards can take precedence over the new EU 2023/2055 regulation. Where this is the case, the guidance is to continue to follow REACH EU 2019/1009 as the appropriate standard.

Not just a European challenge

For European players, 2028 is not that far away, especially considering that products will need to be market-ready by 2027. While expectations of change may appear to be on the far horizon for companies not invested in EU markets, it is worth noting that the Canadian and Australian parliaments are expected to enact similar legislation within a few years, with more countries potentially following suit within the decade. At the same time, products sold into a microplastic-regulated market such as the EU must follow regional guidelines, regardless of where the fertilizer manufacturer is based.

Practically, this means that if you are not formulating compliant fertilizer products, or actively investigating microplastic-free or reformulated products, now is the time to do so. It can be daunting to know where to start, but here are three things to consider:

1. Adhering to REACH regulation EU 2023/2055 doesn't necessarily mean developing polymer-free fertilizer, as the regulation does outline exemptions. This means your product could still contain polymer coating elements if they are: naturally occurring, water-soluble (greater than 2g/L), or biodegradable under an accepted test method.
2. Regulation EU 2023/2055, by governing the use of microplastics, will have an impact on how manufacturers develop inert or inactive components like coatings or colorants. This change does not, however, generally affect the active ingredients of fertilizers, as these are governed by REACH EU 2019/1009 in many cases.
3. The difficulty with this regulation is that it directly impacts the controlled-release fertilizer technology currently used in the global marketplace. As things stand today, existing CRF technology cannot meet REACH EU 2023/2055 while still matching prevailing performance expectations and current market costs. This regulation will therefore force a major shift in the fertilizer industry – one that will be accompanied by interim performance shortcomings and,

potentially, increased costs. Change is, however, part of the very nature of business. So breakthroughs in collaborative innovation are expected to solve these issues eventually.

Summing up

The move away from microplastics will, ultimately, deliver significant sustainability advantages. The ECHA estimates that, of the 145,000 tonnes of microplastics used across all EU industries, nearly 42,000 tonnes end up in the environment. Fertilizer companies should therefore have a vested and growing interest in embracing new and novel approaches that will enhance the economy.

Whatever the underlying motives, this new EU microplastic regulation should encourage the fertilizer industry to rise to the challenge and harness the innovation that will ensure compliance and bring about a more sustainable future.

About the author

Wade Holcombe is TS&D Team Lead for agriculture within Milliken's Chemical Business. He and his team develop and refine Milliken solutions for seed treatments, crop protection and fertilizers.

THYSSENKRUPP

Sustainable and future-proof coating technologies

Bernd Peuckmann and Rolf Weiss of thyssenkrupp Fertilizer Technology (tkFT) and Yevgeny Makhynya, Marc Wieschalla and Tobias Birwe of thyssenkrupp Uhde

Introduction

Increasingly, the fertilizer industry needs to meet new, more stringent environmental obligations and respond to calls from society for greater sustainability. In Europe, these demands are exemplified by the EU's Green Deal – although similar pressures apply in other regions.

To prepare the fertilizer industry for these future needs, thyssenkrupp Fertilizer Technology (tkFT) and thyssenkrupp Uhde have developed controlled-release fertilizers to meet upcoming European and worldwide demand for products with better nitrogen use efficiency.

Controlled-release fertilizers (CRFs)

The conventional application of commodity fertilizers to crops typically results in big nutrient losses. These can reach 70 percent or more for some nitrogen fertilizers such as urea. Such losses are directly responsible for the nitrate pollution of groundwater and soils in countries where intensive agriculture and fertilization is practiced, such as those in Western Europe.

Consequently, legislators in some regions have reacted by introducing restrictions that limit both the amount of applied fertilizers and the number of applications

SOURCE: THYSSENKRUPP

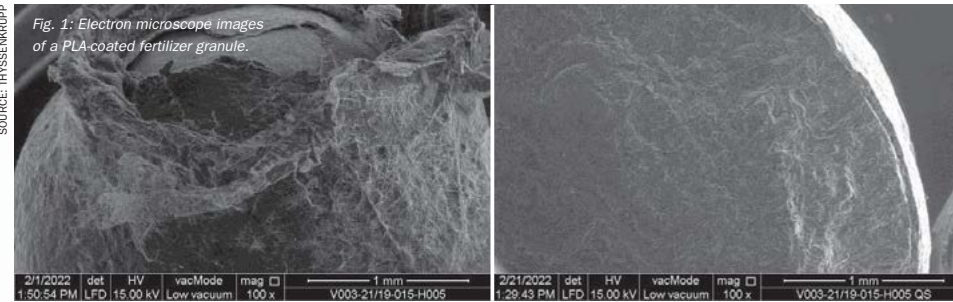


Fig. 1: Electron microscope images of a PLA-coated fertilizer granule.

allowed during the growing period. Additionally, the use of so-called stabilised fertilizers (SFs) is also being mandated to cut nutrient losses.

Having recognised this trend, thyssenkrupp Uhde, as a leading engineering, procurement and construction (EPC) contractor for ammonia and urea plants, has been working to develop SFs and controlled-release fertilizers (CRFs) together with their associated production processes. One successful outcome has been the development of innovative polymer coated urea (PCU) products (*Fertilizer International* 503, p26). These special

types of CRF use biologically degradable polymers such as polylactic acid (PLA) to coat urea granules (Figure 1).

These polymers decompose in soil without producing environmentally harmful substances and can be produced from renewable resources. This ensures that the whole production and crop application process is sustainable.

These types of CRFs make nutrients available over the entire growing period. They are also more efficient as they supply nutrients in the exact quantities required by crops. This provides the option to:

- Either increase crop yields by up to 10 percent for the same amount of fertilizer
- Apply less fertilizer to achieve the same yield.

The production of CRFs can be integrated within an existing ammonia-urea production complex, or set up as a standalone plant, and can be realised for a wide range of production capacities. To minimise nutrient losses and increase nutrient use efficiency, the same coating technology can also be successfully applied to other fertilizer types, including potash-, phosphate- and sulphur-containing fertilizers.

STAMICARBON

Coated fertilizers get smart

Nikolay Ketov, public relations officer

Introduction

With fertilizers playing an increasing role in food production, the application of urea remains essential if crop yields are to increase. Yet urea typically has a low nutrient use efficiency due to the loss of nitrogen, which is either volatilised into air as ammonia and N₂O, or lost to surface and ground water as nitrates. These environmental losses have adverse effects, ranging from air pollution and fine dust, to elevated levels of nitrates in drinking water, and the eutrophication of surface water bodies.

The switch to smart fertilizers

Fertilizers are traditionally applied several times during the growing season to ensure that plant nutrient needs of



Opening of the Purcell Agri-Tech controlled-release fertilizer (CRF) plant in Sylacauga, Alabama, USA.

PHOTO: STAMICARBON

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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crops are continuously met from planting through to harvest. It is common practice in Europe, for example, to apply fertilizers in three split applications. The first application fulfils between 40-50 percent of total crop demand. The second, applied several weeks later, meets 20-30 percent of demand, while a third and final application, several weeks before harvest, boosts the nutritional value of the crop.

However, the need to keep sufficient nutrients available throughout the growing season can mean these are quickly lost to the environment, as farmers tend to oversupply fertilizers to maximise their yields. The losses associated with this excessive fertilizer use often result in poor overall nutrient use efficiency.

Smart fertilizers, in contrast, behave very differently. These products are able to unlock and release nutrients to closely match the nutrient demands of the crop. In this way, nutrient release is attuned to crop needs, creating a perfect balance between nutrient supply and plant uptake, so preventing nutrient losses to the environment. Ideally, nutrient use efficiency is optimised by adjusting the nutrient release curve of the fertilizer so it corresponds exactly with the nutrient demand curve of the crop.

The smart solution: polymer coated urea

Controlled-release urea can be classed as a true 'smart fertilizer'. It is produced by encasing the urea granule within a polymer coating. This acts like a membrane, sealing the urea from the surrounding soil environment. Over time, urea's hygroscopic nature naturally attracts and draws in water through this membrane, where it dissolves part of the urea. A driving force then develops due to the high nitrogen concentration inside the membrane relative to the low concentration outside. As a consequence, nitrogen dissolved in water permeates outwards through the membrane into the soil, ready to be absorbed through the root system of the plant in an efficient and controlled manner (Figure 1).

This creates an almost perfect balance between crop needs and fertilizer supply, as nutrient release through the membrane is temperature dependent, and also depends on water availability. As a result, losses to the environment, whether to air or water, are prevented and maximum nutrient use efficiency is achieved.

PurActive™ technology

US-based Pursell Agri-Tech has developed a novel technology, registered as PurActive™, for the production of polymer coated controlled-release fertilizers (CRFs). This new approach, by combining a novel polymer type with innovative coating technology, provides an economic solution to smart fertilizer production.

Stamicarbon, the nitrogen technology licensor of Maire engineering group, has taken a 20 percent stake in Pursell Agri-Tech. The mutually beneficial collaboration joins up Stamicarbon's global network and technological capability with Pursell Agri-Tech's leading expertise in coated fertilizers. This will enable both companies to pursue promising CRF market opportunities worldwide. Stamicarbon's technology package called Controlled-Release Fertilizer Design™ is being offered to the market as a full 'lump sum turn key' project option.

At the heart of the Controlled-Release Fertilizer Design™ package is a modular coating plant. Its relatively low investment cost and a compact layout allows these coating plants to be easily constructed near to end-user markets.

Currently, the first commercial Controlled-Release Fertilizer Design™ reference plant operates on a 24 hours, five days a week basis in Sylacauga, Alabama. This first-of-its-kind US plant has the capacity to produce up to 100,000 t/a of controlled-release fertilizer and is operated by Stamicarbon's partner Pursell Agri-Tech.

Previously, smaller scale coating plants capable of economically producing smart fertilizers for broad acre agriculture have simply not been available. However, the introduction of the Controlled-Release Fertilizer Design™ concept provides fertilizer producers and distributors with the ability to bring a new range of 'smart' products that improve crop fertilization to market. These act in one of two ways: either increasing crop yields at the same fertilizer application rate or achieving the same yields at a reduced rate. More generally, the wider adoption of CRFs helps reduce negative pressures on the environment by cutting nutrient losses to air and water.

Positive field trial results

Field trials conducted with polymer coated controlled-release urea (PCU 2.0) in different cropping systems, such as field corn, sweet corn and potatoes, have all shown that significant increases in nutrient use efficiency are achievable. A single application of controlled-release urea provides 5-10 percent higher yields, against a split application of conventional fertilizers, when applied at the same overall application rate. Alternatively, controlled-release urea provides similar crop yields when applied at 75-85 percent of the total application rate of conventional fertilizers.

Financial analysis also shows that targeting a higher yield at the same application rate permits a price premium of \$150-800/t (depending on crop) for

controlled-release urea, versus standard urea, whereas targeting a lower application rate for the same yield permits a premium of \$60-110/t. These calculations exclude the additional labour and fuel savings provided by the single application of CRFs.

Overall, crop fertilization with CRFs offers the following benefits:

- Both ammonia volatilisation and nitrate leaching losses are negligible
- Steadily releases nutrients over the whole 3-4 month growing season
- Makes nearly all of the nutrients supplied available to the crop
- Reduces costs through a single application in the spring that eliminates the need for a summer side dress.

Stamicarbon's Vision 2030

By improving the nutrient use efficiency (NUE) of fertilizers, Stamicarbon's Controlled-Release Fertilizer Design™ package will help deliver one of the two goals set out in its 'Vision 2030' innovation agenda. The agenda's other goal is to reduce the emissions and energy consumption of fertilizer plants. Stamicarbon is aiming to achieve both goals by focusing on three specific areas:

- Making fertilizers more effective and efficient by increasing their NUE
- Shift to the sustainable production of nitrogen-based fertilizers from renewable feedstocks using renewable energy
- Rolling out the digitalisation of fertilizer plants to improve their energy consumption and reduce emissions.

ICL New biodegradable coating technology

Ronald Clemens, Global Marketing & Portfolio Manager CRF

ICL has developed a new generation of biodegradable coatings for its controlled-release fertilizer (CRF) portfolio (*Fertilizer International* 510, p24). The new coating technology is designed to meet the requirements of the new EU fertilising products regulation (2019/1009) and reduce the environmental footprint of CRFs. It will also help Europe's farmers comply with the EU's Green Deal policy.

This patented innovation, named eqo.x, coats nitrogen fertilizer granules applied to field grown crops. The technology has already been fully tested in the field – and shown excellent results in terms of ease of production, nutrient use efficiency, and reducing volatilisation and leaching losses.

According to ICL, eqo.x is one of the most important innovations and technological launches since CRFs were first introduced to the market decades ago.

"We see this as a huge step forward in the use of enhanced efficiency fertilizers for the agricultural market," comments Ronald Clemens, ICL's Global Marketing & Portfolio Manager CRF. "The biodegradable release technology will be able to reduce all kinds of nutrient losses, and combines this with all the known advantages of CRFs, such as reduced application frequency and application rates."

Clemens explains how the new biodegradable coating functions (Figure 1):

"Eqo.x works similar to our existing coatings. The soil temperature affects the speed of release in a similar way to E-Max coatings. That makes it easy for the farmer to use the new product, as neither the application or the performance will change.

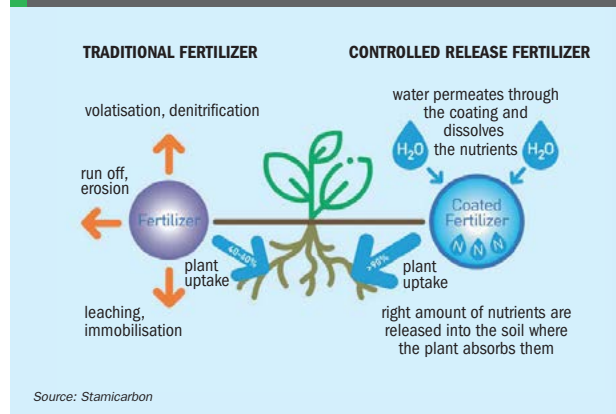
"The new technology offers an improvement in release patterns, making CRFs with eqo.x technology even more reliable and predictable than before. And after the longevity ends, the coating shells will degrade even faster to CO₂ and water, leaving no trace behind."

Wide ranging trials with eqo.x technology have all shown an increase in nutrient use efficiency, says Clemens:

"We have tested the release specifications in the lab under various temperature regimes, in water and in soil as well as under practical circumstances. In all those conditions, the nutrient use efficiency was significantly increased, giving better results than growers practice – in terms of yield, number of applications or application rates."

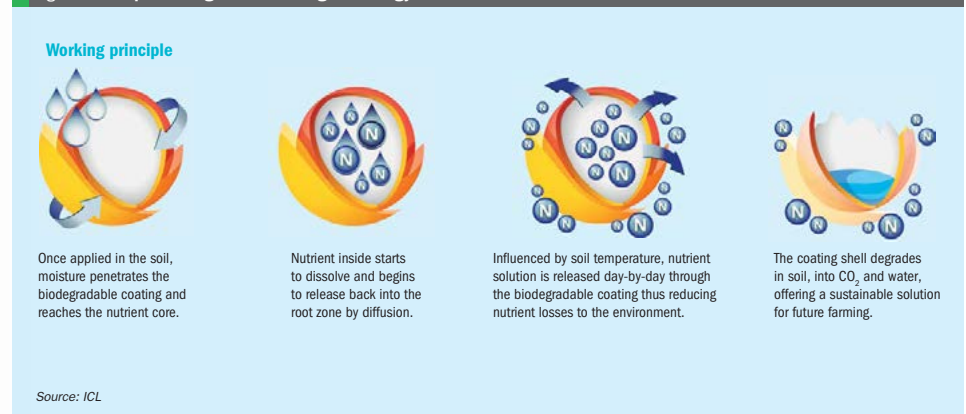
ICL has already introduced eqo.x technology to the market in its Agrocote and Agromaster CRF formulations.

Fig. 1: Uncontrolled nitrogen release from standard urea (left) versus controlled nitrogen release from polymer coated urea (right)



Source: Stamicarbon

Fig. 1: How eqo.x biodegradable coating technology works



Source: ICL

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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The Pardis III granulation plant.

Urea production continues to grow globally in response to rising fertilizer demand. At the same time, urea finishing plants are becoming more technologically advanced and their capacities are expanding to keep up with this ever-increasing demand.

Selecting the most suitable finishing technology, from the various options available, should depend on the specific configuration of each plant, its scale, and market requirements.

Fluid bed granulation, for example, is often the preferred choice for most large-scale plants, especially when urea is produced for export and/or transported over long distances. This preference is due to the superior strength, handling, and shipping behaviour of the granules generated by fluid bed granulation.

Large-scale urea plants located in countries with abundant, low-cost feedstocks benefit from competitive production economics that enable them to manufacture urea for the export market at a low cost and high margin. The use of large capacity granulation plants, which can reach up to 5,000 t/d, also enables these urea producers to enjoy the economies of scale.

Prilling technology, in contrast, offers specific advantages – including capex savings, energy efficiency and operational simplicity – for smaller-scale urea plants targeting local markets.

Stamicarbon, the nitrogen technology licensor of the Maire engineering group, has extensive experience in licensing urea granulation and prilling plants for various markets. The company, by offering continuous innovation and a wide choice of

Granulation technology generates a premium urea end-product in large volumes capable of withstanding lengthy storage and extreme shipping conditions. Prilling technology, meanwhile, given its typically lower investment cost, can be an attractive option for smaller-scale urea producers supplying local markets. Stamicarbon's **Dr Wilfried Dirx, Ahmed Shams and Branislav Manic** explore the technology options for urea finishing.

technologies, can provide its customers with an optimal fertilizer finishing solution, one that is tailored to meet their specific needs, production objectives and market demands.

Scaling up granulation technology

In Stamicarbon's fluid bed granulation process, concentrated urea melt (98.5 wt%) is introduced to the granulator unit via specially designed spray nozzles (see photo). These proprietary nozzles coat each seed granule with a thin film of urea melt, layer upon layer, until granules grow to reach the required product diameter.

Stamicarbon's fluidised bed design delivers considerable opex savings, compared to other granulation processes, as it reduces the formaldehyde content of the final product and generates less dust. This allows the granulation plant to continuously operate for 2-3 months without a shutdown for cleaning. Stamicarbon's MicroMist™ Venturi (MMV) Scrubber can also be installed to meet the latest environmental regulations, being capable of bringing down urea dust emissions to below 10 mg/Nm³.

Stamicarbon began developing fluid bed technology for urea granulation plants in the 1970s. This eventually resulted in the commissioning of the company's first pilot granulation plant for Grodno Azot in Belarus in 1998. This project involved the



PHOTO: STAMICARBON

conversion of an existing small granulation unit (280 t/d) to Stamicarbon's new Granulation Design.

Stamicarbon later scaled up its fluid bed technology during a revamp of a Canadian urea plant in 2003. Two existing granulation lines (625 t/d each), originally designed by another licensor and supplying the local market, were converted to Stamicarbon's Granulation Design as part of this revamp project.

Subsequently, Stamicarbon's first grassroots urea granulation plant entered production in Egypt in 2006. This plant, initially designed with a capacity of 2,000 t/d, was later revamped to run at a capacity above 2,500 t/d.

In recent times, more than 20 granulation plants based on Stamicarbon's Granulation Design have been licensed and put into operation as part of the company's LAUNCH FINISH™ series. These plants have

all met strict performance guarantees, despite having different configurations, capacities, ambient conditions, emissions and product requirements.

Currently, the Pardis III plant in Iran (see first page photo) is the largest operational granulation plant based on Stamicarbon's standard Granulation Design. This started up in 2018 and can operate at 110 percent of its nameplate capacity of 3,250 t/d with a turndown ratio of 60 percent.

Stamicarbon originally secured the contract for the Pardis III project in 2011. The granulation unit is connected to a fertilizer-grade urea plant. This uses Stamicarbon's Pool Condenser Design and operates under difficult ambient conditions. The plant's performance has met customer expectations, due to the reliability of this design, and achieves an on-stream time of more than two months during extreme heat conditions in summer.

Constant improvement

Stamicarbon first introduced its Optimized Granulation Design in 2008 (Figure 1). This new design has reduced the capex and opex of urea granulation plants, as it requires fewer equipment items while maintaining reliable performance and high on-stream times.

In particular, the elimination of the two main fluidisation fans delivers significant cost savings by cutting power

consumption. Increasing the length of the granulator's cooling zone, compared to the standard design, also allows three other major equipment changes:

- Firstly, the elimination of the fluid-bed granulator cooler
- Secondly, the replacement of the fluid-bed product cooler with a solids bulk flow cooler
- Finally, the elimination of the granulator cooler scrubber and its accompanying pumps and fans.

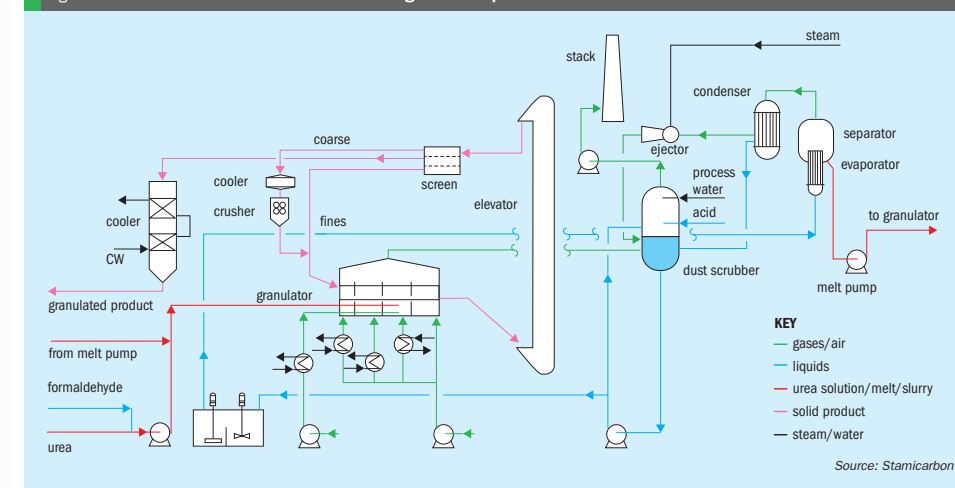
Instead, product granules are cooled further in the fourth compartment of the granulator. Only a small crusher feed cooler is necessary, separate to the fluid bed cooler.

The Optimized Granulator Design is characterised by:

- The use of film spraying nozzles
- Low urea dust formation during granulation
- Reduced formaldehyde content in the final product
- High product quality.

The fewer equipment items necessary significantly lowers the plant's footprint and reduces the overall investment cost. Cumulative savings from lower transportation and insurance costs, together with the reduced footprint and construction costs, all contribute to a lower total capex. Less operational equipment also delivers a maintenance cost saving and lower opex.

Fig. 1: Flowsheet for Stamicarbon's fluidised bed granulation process



Source: Stamicarbon

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
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ISG Pit to Ship Solutions™

CAPEX or OPEX Logistic, Storage and Ship Loading System

ISG, helping you on your way to your Environmental, Social and Corporate Governance journey (SCG).

Introduction: Intermodal Solutions Group (ISG) supply a logistical, storage and ship loading system to the fertiliser bulk industry.



ISG is Benchmarking their successful minerals system which has been implemented around the world using bulk containers and their patented lid lifting system on the tippler, to the fertilizer industry.



The system: The bulk containers are loaded at the production facility either by loading chutes or conveyor belts into the container roof hatches.

Once loaded the containers are sealed and the lid is not removed again until the bulk product is ready to be emptied.

The containers are transported by road or rail to the loading port. **Container ports** are employed for international export. **River ports** are utilised for river distribution.

Storage: The containers are used as storage sheds eliminating the usage of conventional dust and labour-intensive sheds. **No double handling.**



At the river ports some customers have bagging facilities so the bulk product is unloaded using the container tippler into the bagging shed through a chute arrangement which then delivers the product into bags for river distribution.



At the ocean ports some customers use the current port facilities with the addition of the container tippler. When the ship arrives, the containers are moved around to the quay side and lifted into the ships hold.

The lid is automatically lifted off the container and then the tippler rotates the container 360degrees emptying the fertilizer into the ships hold.



The lid is then replaced and the containers are taken back to the processing plant to start the loop again.



Fertilizer Grade Container



Tippler Loading

Visit us at Booth 1 at the Argus Fertilizer Europe Conference in Lisbon

Urea Logistic, Storage and Ship Loading Flow Chart

Case Study Number 01: Urea transport in Bolivia Brunei Urea loading

1

The urea is loaded into the patented ISG containers at the processing plant and the containers are sealed. Each container holds around 30 tons of urea.



2

The containers are fitted with RFID tags so they can be tracked on their way to the ocean or river port.



4

From the database a report can be generated using the RFID information so you can manage the amount of product being shipped.



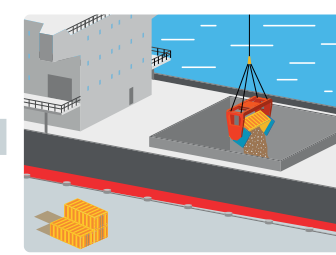
3

The containers are transported via road or rail and then stored at the port.



6

When the ship arrives the product is tipped into the bulk ships hold using a tippler. Some customers have a bagging facility at river ports. They use this system to move the bulk product to the river bagging plant.



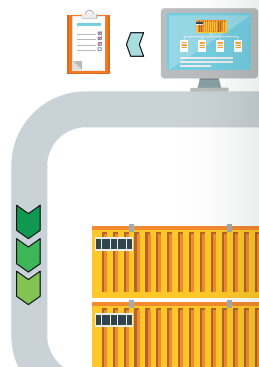
7

The bulk ship departs with your product on board. The containers are returned to the processing plant, for the cycle to start over again.



5

At the port the containers are block stacked awaiting the bulk ship to arrive.



See live videos on our website of ships being loaded at: www.pittoship.com



"The environment matters"

Green and Clean ISG, helping you on your way to your Environmental, Social and Corporate Governance journey (SCG).

Sealed from the processing plant to the ships hold

At ISG we always seek to provide sustainable and efficient solution for our customers

ISG Pit to Ship Solutions™

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets - what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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The first plant based on the Optimized Granulation Design was commissioned in 2015 for Shahjalal in Bangladesh. This 1,760 t/d capacity plant operates reliably with low maintenance costs and has met expectations on reduced power consumption. The quality of the granulated urea produced also exceeds standard commercial requirements, despite a formaldehyde content of less than 0.3 percent in humid ambient conditions.

Acidic scrubbing

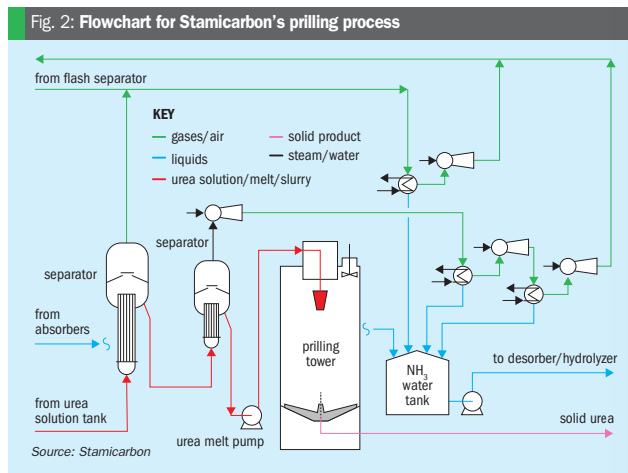
Any ammonia present in the urea melt is released during the crystallisation process in the granulator. Acidic scrubbing is therefore required to efficiently capture this ammonia and prevent its release into the atmosphere.

Acid scrubbing is achieved, after the initial dust scrubbing stage, by bringing ammonia-laden air into contact with sulphuric or nitric acid injected into a circulating aqueous solution. The circulated acid reacts with ammonia, effectively reducing its concentration in the exhaust air, to generate an ammonium salt. This can be sent outside battery limits (OSBL) or, by applying sulphuric acid, incorporated into the urea end product. Valuably, this eliminates waste streams and avoids their disposal at the plant's battery limit.

The salt generated by the scrubbing system – for example, liquid urea ammonium sulphate (UAS) – is in the form of a solution containing about 55 weight-percent (wt-%) water. This cannot be directly mixed with the main urea melt feed entering the granulator (via nozzles) as this only contains 1.5 wt-% water.

Instead, the water content of the UAS solution needs to be controlled and reduced using a dedicated evaporation step (as shown in Figure 1). This allows the recycled UAS solution to be introduced into the granulator together with urea melt. The resulting granules can be sold as standard urea as the sulphur content of the final product is minimal (typically about 0.05-0.1 wt-% sulphur).

This scrubbing configuration can address the increased need for sulphur as a plant nutrient by concentrating and recycling liquid UAS so it leaves the granulation plant in a solid form by combining with molten urea. Additionally, Stamicarbon has developed a unique UAS process that allows urea to be granulated with much higher concentrations of ammonium sulphate. This adds solid ammonium sulphate



to molten urea using a flexible modular process. Existing granulation plants can be adapted to this new design configuration via relatively minor modifications, upgrades to construction materials and the addition of some extra equipment.

Granulation capacities of up to 5,000 t/d

In recent decades, there has been a rapid increase in projects which increase the maximum capacity of operational plants. Stamicarbon's practical experiences with large capacity urea granulation plants (above 3,000 t/d) have been positive to date, these having met the overall on-stream requirements of customers.

Stamicarbon has also investigated how to design even larger capacity granulation plants – without compromising its proven design philosophy and product quality. Results suggest that scaling up the Optimized Granulation Design to 5,000 t/d now look feasible, as the main operational and manufacturing challenges have been overcome and suitable supporting measures have also been identified.

Based on the outcome of these investigations, Stamicarbon has determined that a single-train 5,000 t/d configuration is preferable, versus a dual-train configuration of 2500 t/d each, as this should deliver a capex saving on the total investment of around 30 percent. Currently, Stamicarbon is looking forward to developing this large-scale granulation concept further.

In 2019, Stamicarbon licensed its first single-line 4,000 t/d urea granulation plant. This project has entered construction, having completed its design phase, and is equipped with the MMV Scrubber to comply with environmental regulations. In 2022 and 2023, Stamicarbon also secured licensing contracts for two more 4,000 t/d urea granulation plants for a customer in Africa.

Cost-effective prilling for local markets

Prilling stands out as the most cost-effective finishing method and is a particularly attractive option for producers wishing to supply high-quality fertilizers for their local market. Several considerations do, however, need to be taken in to account before selecting conventional prilling technology, including product specifications and process challenges.

While their nutrient value is identical, prills are weaker than granules, with a crushing strength below 1.5 kg, and are therefore more vulnerable to breakage during handling and storage. The lower strength of prills, by contributing to moisture absorption and caking during storage, and potentially segregation during handling, can lead to product losses prior to application. Furthermore, the prilling process itself can generate considerable amounts of dust, sometimes exceeding one percent of production output. All of these challenges therefore need to be addressed for prilling technology to be successfully adopted.

Addressing prilling challenges

Stamicarbon, as a leading urea finishing technology provider, has developed a prilling technology that overcomes most of these challenges. This generates prills of the highest quality for urea producers while ensuring that the capex and opex of the finishing process remain highly competitive.

The rotating prilling buckets used in Stamicarbon's prilling process (Figure 2) are designed to evenly distribute liquid urea droplets in the prilling tower. These droplets crystallise into prills as they fall through a prevailing airflow moving in counter-current. Stamicarbon's process design offers several advantages, including:

- A sharp size distribution
- Uniform prill distribution across the entire prilling tower area
- Improved heat transfer between falling prills and the airflow
- Lower prill temperatures
- Suitability for larger plant capacities.

Prilling machines built to Stamicarbon's design are effective over a wide operating

range and help to reduce the particulate emissions from prilling towers. Indeed, their dust generation, being significantly lower than granulation units, contributes to plant efficiency.

Overall, Stamicarbon's 'next-generation' prilling tower design, when used in combination with Jet Venturi™ scrubbing technology, can produce high-quality, large-diameter urea prills while substantially reducing particulate matter emissions, plume opacity and ammonia emissions.

Operational experience with urea plants in China has shown that Stamicarbon's prilling process works excellently in combination with its Ultra Low Energy melt technology, thereby helping to achieve the lowest overall plant energy consumption. The latest contract for a Stamicarbon Ultra-Low Energy urea plant in China, announced in October 2023, will incorporate the company's prilling design. The plant, located in Shouguang city in Shandong province, is the company's eighth urea licensing and equipment supply contract in China.

Conclusion

The choice between granulation and prilling for urea finishing typically depends on the plant's specific requirements, budget and market needs. Granulation technology provides a premium end-product in large volumes that can withstand lengthy storage and extreme shipping conditions. This makes granulation technology more attractive for urea producers located in low-cost, feedstock-rich regions who are aiming to export high-value commodity products.

In contrast, installing a prilling plant, given its typically lower investment cost, can be an attractive option for smaller-scale producers in other locations supplying specific markets. Despite its technological challenges, prilling can be a viable option for many urea producers and, with the right technology in place, offers benefits in terms of cost, energy efficiency and operational simplicity.

For each and every individual situation, Stamicarbon can identify a tailored finishing process and find the right solution – by offering hands-on expertise in granulation and prilling technologies that caters to all the diverse segments of the urea market. ■

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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Kimre executives (left to right) Mark Zbikowski, Mary Gaston and Frank Power with Salome Perrin (second from right) of Socrematic, a key partner, in Paris.

New Kimre leadership!

For 50 years, Kimre engineers and application specialists have been solving process and gas stream emission problems in chemical and fertilizer plants around the globe. In an exclusive interview, Kimre's new president **Mary Gaston** sets out her plans for the company, building on its invaluable understanding of gas and vapour stream separation and mass heat transfer.

PHOTO: KIMRE

Introduction

The main office and manufacturing site of Kimre™ Clean Air Technology is located in Homestead, Florida. Global operations are also supported by an additional US manufacturing site in Pennsylvania, a Chinese manufacturing partnership, and a worldwide network of distributors and representatives.

Kimre's range of services include top-of-the line filtration to customised turnkey air pollution control systems. The company notably designs, engineers and manufactures its own monofilament filters – with an in-house fibre bed filter division that custom designs and fabricates each filter to meet the specific performance requirements of each customer. Kimre's highly qualified engineers also provide expertise in various applications, including ammonium nitrate, chrome, nitric acid, phosphates, sulphuric acid, urea granulation and oil mist.



Mary Gaston, Kimre's new president.

New leadership

Mary Gaston became the new president of Kimre in May 2023. She was previously a partner at leading US law firm Perkins Coie. Mary's legal background, which included representing Fortune 100 companies in high-stakes claims, makes her well qualified for the challenges of her new role.

1970s

- 1973 ● Kimre was founded by George C Pedersen, a Florida native and MIT graduate.
- 1974 ● First commercial sale of a product.
- 1979 ● Kimre successfully retrofitted Borden Chemical Company phosphate operations at Piney Point, avoiding a plant shutdown due to excess emissions.

1980s

- 1983 ● Established LIQUI-NOMIX™ Technology for oil/water separation systems installed in a majority of OWS applications.
- 1985 ● Kimre is recognised as the first nitrobenzene retrofit for equipment.
 - First major AEROSEP® Multistage Aerosol Separation System operating, GK Mannheim, Germany.
- 1989 ● Cooling tower installation at SASOL LTD, Secunda, South Africa: a 100 metre diameter Drift Eliminator installation.

1990s

- 1995 ● Kimre's Europe office opens.
 - Kimre technology identified as MACT by the EPA for chrome plating operations.

2000s

- 2008 ● Designed and supplied first full-scale scrubber for phosphate fertilizer plants.

2010s

- 2012 ● Fibre Bed Filters added to product line.
- 2014 ● Kimre designed and supplied four turnkey urea granulation plants in 2014.
- 2016 ● Opened Kimre China offices.
 - Opened Kimre Philadelphia office.
- 2017 ● Kimre achieved the lowest dust and ammonia emissions of any urea granulation facility in the world.

2020s

- 2020 ● Kimre acquires 50,000 square foot mfg facility in South Florida.
- 2020 ● Committed to its customers, Kimre remains fully operational throughout pandemic.
- 2023 ● Celebrates 50th year in business.
- 2023 ● Earns prestigious manufacturer of the year award.

In particular, she spent decades working hand-in-hand with experts in dozens of technical and scientific disciplines, including materials science and mechanical engineering. Mary is now combining these technical skills with her proven business and finance acumen to lead Kimre, a company that has spent the last fifty years cleaning the air on every continent (see timeline).

In an exclusive interview with *Fertilizer International*, Ms Gaston sets out her plans to build on and develop Kimre's mission: "to design and innovate technologies, which clean and protect our environment to create a better world for future generations."

Your background is very unusual, Mary, in that your skills set combines business leadership and financial acumen with an in-depth understanding of science, engineering and technology. How important is this mix of skills for a manufacturing company like Kimre and its business ethos – given that it was founded and previously led by George C Pedersen, an MIT graduate?

Make no mistake Simon, while I believe those skills are critical, I believe the most important thing I bring to Kimre is that I share the founder's deep commitment to the company's mission. With that in mind, there are two key points to emphasise.

First, Kimre manufactures a technically sophisticated product, which in many markets has no equal in terms of performance due to its unique physical structure. Second, we have fifty-years of experience designing custom solutions – ranging from the most straightforward to the most complex – in a wide range of industries. Because of that, when designing a solution, only rarely do our engineers discover that Kimre hasn't already successfully addressed this problem previously.

I therefore firmly believe that Kimre will, by combining its inimitable product with its depth of engineering and design expertise, significantly increase its global impact and do more to deliver its long-standing mission – that is to clean and protect our environment to create a better world for future generations.

Yes, as President, it is vitally important to have a thorough understanding of the technical and financial side of the business. Those skills will ensure that the company continues to be successful in an

increasingly nuanced global marketplace.

But to do more – to truly fulfil Kimre's mission and improve our reach – I believe an unwavering commitment to increasing our positive impact on the global environment will drive the business forward. Achieving that will require laser focus on three business areas: strategic internal growth, unrivalled technological innovation, and careful expansion of our global network.

If the past is a reliable indicator, the strength of my convictions about Kimre's potential, as a business and for environmental improvement, is what will drive me to excel in this role.

Kimre celebrated its 50th anniversary in 2023. But the company has consciously chosen to look forward, not back, and has marked this landmark birthday by investing in and expanding its engineering and technical sales teams. What organisational changes have been made, what was the thinking behind these, and how will customers benefit?

To its credit, the company has never sat on its laurels. Kimre has, in fact, always prided itself on providing rewarding careers to employees who have dedicated their working life to the business. Some of our current team members have been here more than 30 years, while others who started with the company have retired from it.

Improvements to Kimre's technology have helped scrubber manufacturers across the world achieve the lowest emissions for some of the most hazardous air pollutants

Frank Power recently became our chief technology officer (CTO), joining Kimre's executive leadership team and our board of directors. That's definitely been a significant milestone in 2023. Frank is a chemical engineer with 27 years of experience in air pollution control and process improvement at Kimre.

He's also a recognised authority on mist, aerosol and particulate elimination and scrubbing solutions, with expertise across many industries.

One of Frank's prime responsibilities in his new role is mentoring the next generation of Kimre engineers, equipping them with the necessary expertise and experience so they can support our customers with the same rigour and dedication that Frank and our founder have provided for decades. A daunting task, for sure, but one that I know Frank

will undertake with his usual skill and determination.

To fulfil its growth ambitions, Kimre needs to go beyond investing in and expanding our engineering group – we also need to ensure the company has the necessary technical infrastructure in place to support and sustain that growth. This makes the addition of **Mark Zbikowski** to the executive and engineering team another big win this year. Formerly a director who sat on our board, Mark has now joined Kimre as VP and chief information officer.

His name is actually a very familiar one and renowned by tech industry insiders, as, remarkably, only Bill Gates and Steve Balmer reached 25 years at Microsoft prior to Mark! That's a testament to the calibre of expertise he brings to Kimre. Mark, by harnessing his years of managing global product launches and software engineering teams, will ensure that we deploy cutting-edge technologies and systems to provide the most efficient and economical solutions to our world-wide customers.

Do you have any immediate priorities for the business – and do these have to be balanced with listening and learning?

Simon, you will not be surprised to hear that my priorities are both numerous and diverse. Some I've implemented immediately, others undoubtedly will take more time. The quick wins have included moving to a more customer-centric approach, encouraging an inclusive and collaborative company culture, and improving our social commitment to our community.

We have put in place processes, for example, that ensure we fully engage with and listen to our customers every step of the way. Whether it's customer service, troubleshooting, or timeliness, we now actively seek out and listen to customer feedback and then act on this by making changes. Likewise, to achieve Kimre's growth goals, we have taken new steps to empower and cross-train our workforce, and to instill and maintain a culture of innovation and pride.

Last, social commitment is important to me, for many reasons, and I believe it should also be important to Kimre and its employees. The South Florida community has supported Kimre for many years and, in my view, it is the responsibility of those who have benefited from their community to give back to it – particularly in this day and age. I'm therefore proud to say that, while we're still in the beginning stages, Kimre's employees have embraced this

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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new commitment to our local community. Everyone at the company was also honoured to have been named the 2023 Manufacturer of the Year recently by the South Florida Manufacturers Association.

To successfully achieve other priorities – I’m including the expansion of Kimre’s geographical and product reach here – I will need to take the necessary time to educate both myself and my team on many matters, some quite complex and some difficult to discern. That requires us all – me and the business – to embrace evolving customer priorities, changing emission standards, and the synergies to be gained with potential partners.

Fortunately, I have an excellent and dedicated group of colleagues and advisors assisting me, both inside and out. I’m therefore confident that time spent on learning upfront will result in my making better decisions in the not-too-distant future!

Although US-headquartered with manufacturing facilities in Homestead, Florida, Kimre operates as truly global business. As it has expanded, how has the company managed to keep serving its customers, both domestically and internationally?

Well, the fact that Kimre, a company in Homestead, Florida, has a global reach is always a surprise to our local community! But, to answer the question, our global success is built on multiple pillars.

First, we have dedicated employees and a company culture where everyone is committed to exceeding customer expectations. Second, we are focused on being a long-term, loyal partner to our amazing worldwide customers – many of whom have been with us since the company was founded and many of whom enjoy telling the stories of when Kimre went ‘above and beyond’.

Third, we also have a wide network throughout the United States, starting with a facility in Pennsylvania and reps across the nation, together with an extensive international network. That includes not just Kimre China but also reps and distributors in Europe, Morocco, Brazil, Korea, and India – to name but a few!

Last but not least, we truly value the importance of facetime with our customers and never hesitate to hop on a plane when our customers need support. Developing and maintaining strong customer relationships is essential. That’s why we always make the most of important industry tradeshows, keep in touch using technologies such as video conferencing, and take advantage

of business travel to visit engineers at the facilities that house our installations.

Kimre engineers and application specialists have been solving process and gas stream emissions problems in chemical and fertilizer plants around the globe. How important is human capital to the business?

I cannot overemphasise the value of Kimre’s engineering knowledge – gained from its fifty-year history of designing customised solutions to air pollution and gas cleaning problems. With 40,000 plus successful installations worldwide, our expertise in many markets is unparalleled.

But that wealth of knowledge and expertise would be virtually worthless without the skill of our dedicated world-class engineers and application specialists: they are the backbone of our company. These outstanding employees, when designing a system today, have the advantage of being able to draw on Kimre’s decades of successful design and engineering solutions.

It would be remiss, though, not to recognise our equally invaluable manufacturing and production employees. They’re at the heart of the business, being responsible for ensuring that the design goes from paper to end product, quickly and precisely, whatever it takes.

I am very fortunate to have a team of this calibre as Kimre embarks on its second half-century.

Kimre has a reputation as being both a market leader and an innovator. Is product development and R&D still central for your current and future success?

While Kimre’s success is based upon the technology patented by our founder, we’re constantly looking for innovative ways to build on that technology and on our decades of experience. That has helped us to successfully identify new applications and environmental protection markets that can benefit from our engineering and design services. Successful innovations include the development of semi-crossflow scrubbing systems that, in fertilizer production, have achieved the lowest pollutant emissions in the world.

Improvements to our technology have helped scrubber manufacturers in the US, and across the world, achieve the lowest emissions for some of the most hazardous air pollutants identified by the US Environmental Protection Agency, including hexavalent chromic acid. We are currently working with industry partners to design

new technologies and systems for reducing heavy metals – including mercury, lead and chrome – from flue gas emissions.

Are there regulatory and/or fertilizer industry trends that are shaping the market for clean air installations – and what is the balance currently between retrofits and new projects?

The fertilizer industry is continually developing new products and production processes, as well as tightening air pollution standards worldwide. Today’s scrubbing systems therefore need to balance low emission standards with customer and regulatory requirements, while at the same time minimising waste effluents and maximising on-line reliability. Thankfully, Kimre’s technology can deliver systems that meet all these targets, whether designing new equipment or working on retrofit installations.

We’re often approached to adapt our technology to existing scrubbing systems that don’t meet current performance requirements or have other related issues. Delivering solutions that can meet new requirements, especially for systems that were not originally designed for our products, is extremely rewarding – and illustrates the special capabilities of Kimre’s technologies and its employees.

I understand that you spend valuable free time on pro bono legal work to protect the rights of society’s most vulnerable. This must be something you’re very passionate about.

You have clearly done your homework, Simon! For me, there is nothing more rewarding than knowing you were able to positively change the trajectory of a person’s life, particularly a child or someone who is severely disadvantaged through no fault of their own.

Requiring the state of Washington to comply with federal law and dramatically increase the direct funding provided to the thousands of foster parents raising children in their care remains the highpoint of my legal career. While it took several years, I was able to drastically improve the benefits to which these children are entitled.

In some ways Simon, our conversation has gone full circle. Because the passion that drives my pro bono work is the same passion that drives my desire to expand the global reach of Kimre and its technology: a devotion to leaving the world a better place for future generations. ■

phosphates & potash INSIGHT

19

CRU Phosphates welcomes you to Warsaw!

20

Innovative magnesium removal technology

22

Phosphates project listing 2024

26

2023: the phosphates year in review

CONTENTS

What’s in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what’s in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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CRU Phosphates welcomes you to Warsaw!

CRU Events will convene the 2024 Phosphates International Conference & Exhibition in Warsaw at the Hilton Warsaw City Hotel, 26-28 February.

The 16th CRU Phosphates Conference returns this year as a live, in-person event in Warsaw, Poland. Located in central Europe, where east meets west, Warsaw makes the ideal location for the global phosphates industry to meet up, network and access crucial market intelligence and technical updates.

This timely conference will inform and spur discussions on key issues such as sustainability, trade, supply chain challenges and technical advances – all of which are occurring against a tumultuous market backdrop of volatile fertilizer prices and supply constraints.

What to expect – the 2024 agenda

Uniquely, CRU Phosphates combines a commercial agenda with a technical agenda in one single event. This enables the conference to cover the entire value chain of the phosphate industry – including the fertilizer, feed and industrial segments – from both an operational and market perspective.

CRU's principal phosphate analyst, Humphrey Knight, will provide a top-level global outlook in the opening plenary presentation. He will be asking, "Is a recovery in global phosphate fertilizer demand still on the cards for 2024?"

A panel of industry leaders from The Mosaic Company, ICL Growing Solutions and Norge Mining will then debate the role of the phosphate industry in delivering food security and the energy transition. Throughout the event, additional industry perspectives will be offered by executives from other major producers, including Deepak

Fertilisers, Ma'den and Nutrien.

Reflecting the global nature of the industry and its audience, the conference agenda will provide insights and outlooks from key supply and demand markets, including India, North America and Saudi Arabia. Major production investments and emerging junior mining projects will also be featured.

New themes for 2024 include:

- **How can the phosphate industry deliver global food security:** Is enough collective action being taken to produce and ensure sufficient food for all whilst reducing costly environmental damage?
- **Towards sustainable fertilizers:** What actions can the value chain take to produce and deliver sustainable phosphate?
- **The future of farming – emerging trends:** Will the adoption of technology and agronomic advances in precision farming, biostimulants, and regenerative agriculture reduce demand for synthetic fertilizer?

Sustainability continues to be a driving force throughout the industry, as phosphate producers balance the dual requirements of food security with their environmental, social, and governance (ESG) targets. The conference agenda will also focus on the latest technological advances and operational strategies – spanning the whole of the value chain from mine to market.

The conference's commercial and market track will cover:

- Key phosphate growth markets
- Agronomy and the future of farming

- Regional phosphate production
- Shifting towards sustainable fertilizers
- Supply chain and trade dynamics
- Project updates and project financing
- Regulatory developments
- The LFP battery market
- Environmental challenges and solutions
- Specialty fertilizer market update.

While the technical innovation track will cover:

- Phosphate rock – quality and grinding
- Advances in the phosphoric acid process, technology and equipment
- Enhanced phosphate beneficiation
- Generating value from phosphogypsum
- Fertilizer production innovations.

The tailor-made technical innovation track is designed to cater to the needs of production personnel throughout the phosphates value chain. Indeed, CRU Phosphates 2024 is set to break records with an impressive lineup of 23 technical innovation presentations and 12 dynamic technical showcases.

These will offer a deep dive into the intricacies of new technology, revolutionary processes, groundbreaking materials, and state-of-the-art equipment developments. Delegates will discover how these innovations can elevate efficiency, ensure environmental compliance, and increase productivity and plant capacities.

Register online now!

The full agenda for CRU Phosphates 2024 is online now. Register today for your place in Warsaw. For more information visit: www.phosphatesconference.com

A selection of CRU Phosphates 2024 abstracts from the conference's technical innovation track.

Use of low-grade phosphate for superphosphate production Bradley Pulverizer

This presentation from Bradley Pulverizer looks at how the decline in the quality of available phosphate rock sources is affecting the ability to produce high grade superphosphate fertilizers, even after beneficiation after mining (*Fertilizer International* 517, p53). Rock quality is also becoming a key consideration due to concerns about cadmium build up in soils. High silica levels in some rocks, meanwhile, also cause material handling and size reduction issues, as well as wear in the mills and acidulation mixer. The presentation will also look at the enhancement of final products via the production of high grade or specialist fertilizers such as high magnesium and high sulphur superphosphate.

Phosphoric acid plants – engineering by experience

De Smet Agro

De Smet Agro explains how to reduce operational problems at phosphoric acid plants, while maintaining a high on-stream factor, drawing on the company's accumulated engineering practice gained over more than 60 years. The key to this is the ability to properly complete the process package for phosphoric acid projects and design the related off-site elements and utilities.

The design basis for a new phosphoric acid plant is usually put together by the plant owner, licensor and licensee at the start of the project – and forms the foundation for successful engineering studies. It also allows all the parties involved to gain a better understanding of actual markets and therefore keep in-house engineering know-how up-to-date. The process design package (PDP) for the plant is usually prepared by the process owner or the licensor, who will provide process guarantees subject to certain conditions.

Fluorine management in phosphoric acid plants

JESA Technologies

The phosphate industry is being asked to put in place more and more environmental controls as time moves forward. Phosphate rock sourced from deposits worldwide contains fluorine that is largely liberated during the acidulation process at phosphoric acid plants. While most plant operators can meet their fluorine emission standards, this incurs extra costs due to the generation of fluorine-rich effluents. The fluorosilicic acid (FSA) obtained requires either further processing or neutralisation at additional cost. JESA Technologies (JT) has, however, patented a new process to handle these fluorine-rich liquid streams, regardless of FSA quality. This will shift the economics of fluorine management away from being a necessary cost to a potential source of revenue. JT believes this new technology will provide producers with an environmentally-friendly and economically attractive way of addressing the ubiquitous fluorine problem that is inherent to virtually every phosphoric acid plant globally.

A novel and sustainable Mg leaching process for phosphate rock Prayon Technologies

Prayon has developed a novel magnesium removal process which can be added as a chemical beneficiation stage after the existing mechanical beneficiation stage and upstream of the phosphoric acid plant. For the first time, this process enables high quality phosphate fertilizers (NPK, MAP, DAP, NPS) to be produced using phosphate rock with a high magnesium content (up to 3.5% MgO)

and high minor element (MER) ratio of up to 0.22. This highly sustainable process generates no effluent, according to Prayon, and will allow fertilizer and phosphoric acid producers to widen their sources of phosphate rock supply.

A novel calcite flotation collector for phosphate beneficiation

Nalco Water – Ecolab

Upgrading phosphate rock by flotation can be difficult due to the presence of gangue components (carbonaceous, silicious and clay minerals) in sedimentary phosphate deposits. Beneficiation of these types of phosphate rock typically requires multistage calcite and silica flotation. In response to this challenge, Nalco Water has developed a unique collector formulation (NALFLOTE®) that offers improved selectivity for carbonaceous gangue. It has been shown to deliver the desired phosphate concentrate grade and recovery during reverse flotation with a high slime-bearing flotation feed. The NALFLOTE® range is robust and delivers improved metallurgical performance for a variety of sedimentary ores from multiple regions across the globe – being able to withstand variations in gangue mineralogy and process water quality.

Use of phosphogypsum as an NPK filler

PT Petrokimia Gresik

The presentation showcases the use of phosphogypsum as an NPK fertilizer filler material. This application is the first of its kind in Indonesia. Phosphogypsum management costs Indonesian phosphate fertilizer producer PT Petrokimia Gresik \$160/t. In response to this, an in-house team developed a process that largely utilises the gypsum waste generated by the company's production operations. This has received a utilisation permit from the Indonesian government and has been granted a patent by the country's law ministry.

Gypsum regeneration with clean energy

Pegasus TSI, Inc.

The presentation reviews the technical and economic feasibility of using clean energy from sulphuric acid production to calcine clean gypsum and produce SO₂ and CaO. The SO₂ generated can be fed into the existing sulphuric acid plant to produce sulphuric acid. The CaO by-product, meanwhile, can be commercialised as a high-quality lime raw material with a low carbon footprint. The overall approach offers a unique way of managing fertilizer industry resources.

Debottlenecking IFFCO's Kandla fertilizer plant with a granulator pipe reactor

Casale SA

Casale's granulator pipe reactor (GPR) is recognised as one of the most globally advanced technologies for solid fertilizer production. Results are presented for a revamping project at IFFCO's Kandla plant in India. The project involved the design, installation, start-up and optimisation of Casale GPRs at Kandla's E&F trains. Both trains were originally designed in 1999 using Grande Paroisse (now Casale) DAP and NPK production technology. The objective was to increase production rates while minimising investment costs and maintaining high product quality. The revamp achieved a 15-25 percent increase in output at each train and, overall, the production of DAP/NPK grades increased by an average of 600-800 t/d.

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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Innovative magnesium removal technology

Prayon's Technophos semi-industrial demonstration plant, Varna, Bulgaria

Kevin De Bois of Prayon Technologies describes an innovative process for removing magnesium from phosphate rock. Increasingly, phosphoric acid producers are looking to consume low-grade phosphate rock as a feedstock due to the prohibitive costs of high-grade rock sources. This has potentially negative consequences as the presence of impurities such as magnesium can negatively affect both the phosphoric acid process and the quality of the acid produced.

Introduction

Two types of impurities are found in phosphate rock. The first type affects the quality of the final acid or phosphogypsum. These include heavy metals, such as Cd, As, Cr, Pb, and Hg, radionuclides, and elements such as fluorine that limit the range of applications of the final product.

The second type of impurities negatively affect the phosphoric acid and fertilizer production process. The three major impurities in this category are magnesium, aluminium, and iron. These three elements are collectively measured in phosphate rock, relative to P_2O_5 content, as the minor element ratio (MER). This is calculated as follows:

$$MER = (MgO + Al_2O_3 + Fe_2O_3) / P_2O_5$$

It is generally accepted that producing phosphoric acid from phosphate rock with a MER higher than 0.08 is problematic. This article will address this challenge by focusing on the removal of magnesium from phosphate rock.

Magnesium – a production plant poison!

While magnesium is a key element for plant health and growth, it is considered a 'poison' for phosphoric acid and fertilizer production. As Pierre Becker, one of the fathers of phosphoric acid technology, wrote: "With $MgO > 0.6\%$ in the phosphate rock, it is difficult to produce phosphoric acid."

In phosphoric acid plants, excess magnesium in phosphate rock will:

1. Increase the viscosity of the phosphoric acid.
2. Reduce the P_2O_5 yield.
3. Decrease the efficiency of gypsum crystal growth.

The primary effect of magnesium on phosphoric acid production is to increase viscosity. This, in turn, adversely impacts the filterability of phosphoric acid/gypsum slurries. The typical filterability of an acid with an MER of 0.04, for example, is around 8-10 tonnes P_2O_5/m^2 , while the filterability

of an acid with an MER of 0.15 is around 3-4 t P_2O_5/m^2 . In practice, this means that, at higher MER values, the filter's surface area will need to be more than doubled to achieve the same filtration throughput.

Additionally, magnesium also affects the P_2O_5 yield. This is because P_2O_5 losses occur when magnesium partially precipitates as pyrophosphate magnesium during phosphoric acid concentration².

Although magnesium's impact on gypsum crystallisation is not entirely clear, several studies suggest that magnesium affects this mechanism and its kinetics by inhibiting gypsum formation^{1,3,4}.

Previously, OCP and Jacobs Engineering have conducted pilot plant and lab tests to better understand the effects of the MgO content of phosphate rock on phosphoric acid production. Their results indicate that higher MgO levels in phosphate rock reduce filtration, and lower chemical yields due to the loss of water-soluble P_2O_5 ⁵.

As well as its impact on phosphoric acid production, magnesium also affects the ability to granulate phosphate fertilizers, such as MAP, DAP, NPK, and NPS, and reduces the mechanical strength of the resulting granules.

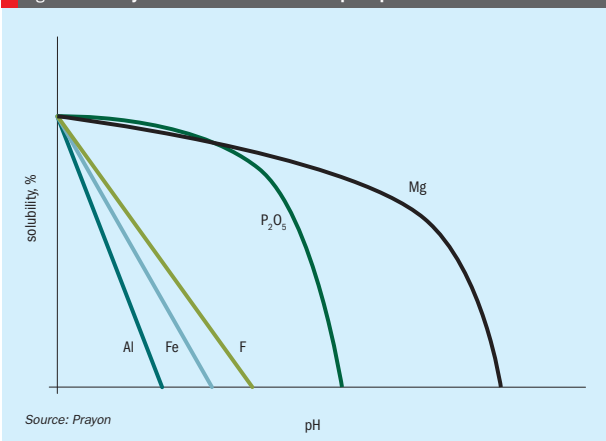
Treating low-grade rock – Ecophos and GetMoreP

In recent years, Prayon has been extensively developing and perfecting the Ecophos and GetMoreP (GMP) processes (*Fertilizer International* 512, p38) to address the increasing demand for the treatment of low-grade and/or high MER phosphate rocks.

The underlying principle of both the GMP and Ecophos processes is a nuanced and selective approach to solubility. In general, these two processes proceed as follows:

- Firstly, a controlled acid attack maximises the solubilisation of P_2O_5 from phosphate rock.
- This is followed by a step that gradually increases pH to induce the precipitation of aluminium, iron and, if necessary, fluorine.
- Following this pH adjustment, the slurry is filtered and the unwanted filter cake is disposed of to landfill.
- Simultaneously, a secondary increase in pH is used to precipitate P_2O_5 from the valuable liquid fraction – which contains the majority of the P_2O_5 – in the form of dicalcium phosphate (DCP).

Fig 1: Solubility curve for the GMP and Ecophos processes



Avoiding excessive pH adjustment is crucial as this prevents the precipitation of impurities like lead, cadmium and even magnesium with P_2O_5 . Such elements are typically precipitated in a subsequent third step, depending on the processes involved.

Targeting magnesium removal

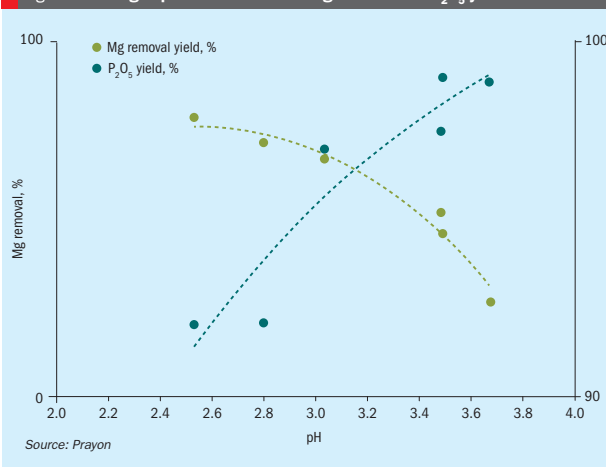
The GMP and Ecophos processes and their underlying principles are now well-established and understood. Collaboration with EuroChem, which has access to high

magnesium deposits in Kazakhstan, led Prayon to an obvious follow-up question: could these procedures be streamlined for certain types of phosphate rock where the sole objective was magnesium removal?

To answer this question properly, the relevant process costs versus the leaching/solubility objectives need to be considered, particularly in terms of acid and base consumption (calcium carbonate or hydrated lime), as illustrated in Figure 1.

Prayon and EuroChem carried out a series of leaching experiments to look

Fig 2: Leaching experiment results for Mg removal and P_2O_5 yield



CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

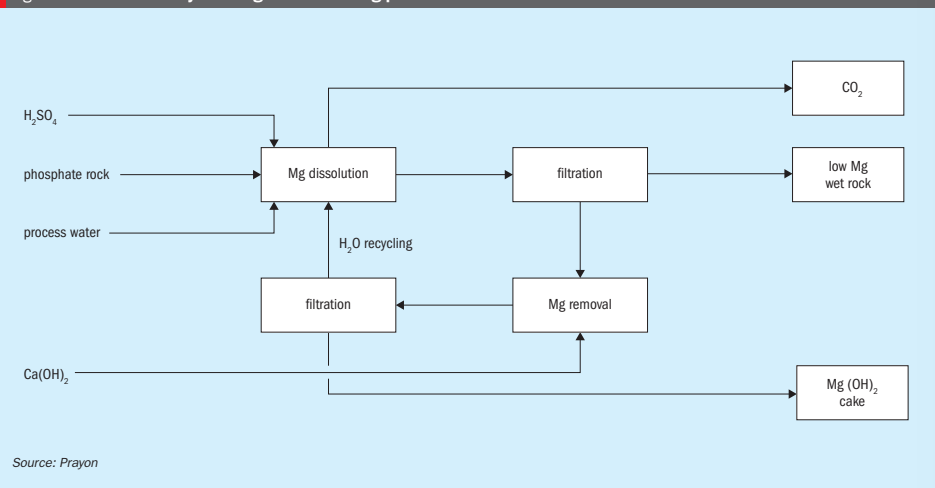
Phosphate market review

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Fig 3: Flowsheet for Prayon's magnesium leaching process



Source: Prayon

at the main factors affecting magnesium removal and P₂O₅ yield. Numerous rocks were leached at varying acid/base ratios to assess their influence on magnesium and P₂O₅ extraction.

The results obtained were surprisingly positive – as they revealed the potential to extract a substantial amount of magnesium while effectively still retaining the majority of P₂O₅ in the solid phase (Figure 2). These promising findings highlighted the effectiveness and viability of Prayon and EuroChem's joint leaching process and its ability to remove magnesium without compromising the integrity of solid-state phosphate.

Further tests were carried out subsequently to fine-tune the process via adjustments to variables such as residence time, temperature, the solids content, etc.

These supplementary investigations provided insights into the acid leaching process. Importantly, they confirmed conclusively that dissolving carbonate impurities with sulphuric acid is a promising and practical beneficiation method for phosphate rock.

Prayon and EuroChem's results demonstrated that this targeted dissolution method is selective for carbonates, particularly dolomite (CaMg(CO₃)₂) yet, valuably, leaves the phosphate minerals intact and unaltered. Following leaching, a meticulous filtration and washing procedure is used to separate the benefi-

ciated solid rock from the acid solution containing the dissolved carbonates. The process generates gypsum (CaSO₄·2H₂O) and magnesium sulphate (MgSO₄) as co-products and releases CO₂ gas.

The refined and upgraded phosphate rock obtained – which is now entirely devoid of magnesium – can proceed seamlessly to the phosphoric acid plant for downstream processing. The residual acid solution, meanwhile, undergoes further treatment to precipitate magnesium as magnesium hydroxide (Mg(OH)₂). Finally, solid/liquid separation is used to recover the precipitated hydroxide and generate a water filtrate (Figure 3).

Process validation at Technophos

All of these experimental data required validation at pilot-scale and semi-industrial level. The was necessary to substantiate laboratory findings for this novel leaching process, define its key technical features and demonstrates its resilience at larger scale.

The necessary verification was carried out at Technophos, Prayon's showcase pilot and semi-industrial demonstration plant in Varna, Bulgaria. Technophos is equipped with semi-industrial reactors, ranging from 1 to 10 m³ capacity, and various industrial solid/liquid separation units, including vacuum filters, press filters and settlers.

The versatile and advanced test unit at Varna was used to comprehensively assess a modular production process for the digestion of phosphate rock with dilute acid. Technophos uses a systematic three-stage approach to provide a gradual but comprehensive process evaluation:

- Phase 1: Laboratory tests
- Phase 2: Pilot tests
- Phase 3: Semi-industrial demonstration test.

Satisfactory results were obtained from the initial laboratory and pilot test campaigns at Technophos conducted and managed by specialists from Prayon and EuroChem – with the beneficiated rock produced meeting all the necessary requirements and specifications. Building on these successful outcomes, the decision was made to proceed with a demonstration test project to prove the feasibility of continuous beneficiated rock production at semi-industrial scale. The following findings were all provided by this semi-industrial trial.

Overall, the semi-industrial test results demonstrated the ability of the method to effectively process and upgrade phosphate rock with a magnesium content of up to 3.6 percent MgO. Phosphate rock containing this high level of magnesium would – without effective removal technology – be unsuitable for phosphoric acid production.

The following two modules were evaluated during the Technophos trial:

Magnesium leaching module. A highly efficient vacuum filtration process was chosen to separate the beneficiated rock from the magnesium leaching solution. By meticulously selecting a filter cloth with a high air permeability, the larger rock particles, sand and gypsum generated by the acidulation reaction were retained effectively. The chosen filter, by ensuring a uniform cake distribution, enhanced both filterability and drying efficiency. The outcome of these choices was a beneficiated rock with an impressively low average moisture content (less than 15%). This also translated into a desirably low water consumption (one tonne of water per tonne of P₂O₅).

Neutralisation module. The magnesium leaching module delivered highly positive results, efficiently precipitating P₂O₅, magnesium, and sulphate. The standard quality water generated was also suitable for recycling in the leaching process. Semi-industrial testing also highlighted the significance of temperature in the neutralisation module. Hydrated lime was used for logistical reasons, although the use of quicklime is generally recommended at industrial-scale to optimise operational expenditure (opex). Filter presses proved to be exceptionally efficient at separating the slurry generated in the neutralisation module, although alternative vacuum filtration methods will be explored in future. The resulting cake, which comprises of pure gypsum dihydrate and magnesium oxide, could be recycled at fertilizer production plants to enhance the magnesium content of specific fertilizers.

A sustainable beneficiation process

The above two modules can be operated in a loop as a sustainable process that generates minimal residues. The beneficiated rock product can be directly supplied as a feedstock for downstream phosphoric acid plants, while the residue from the neutralisation module can be valorised in the fertilizer plant, as suggested. The water consumed in the process is completely recyclable with no liquid waste discharge.

Concurrently, a pilot test was carried out with Prayon's Mark IV di-hydrate (DH) process using the beneficiated rock from the semi-industrial Technophos trial as a feedstock. Results showed that 75 percent of the MgO present in the beneficiated rock passed into the phosphoric acid.

DH phosphoric acid production remained stable, albeit with slightly lower filterability rates than observed with low magnesium phosphate rock. The phosphoric acid generated was used to successfully manufacture standard-grade fertilizers such as NPK (15-15-15) and monoammonium phosphate (MAP) without any issues. The fertilizer granules obtained also exhibited excellent mechanical strength (above 15 MPa).

Conclusions

To conclude, the magnesium leaching process developed by Prayon and EuroChem provides several notable advantages:

- 1. High magnesium removal from phosphate rock:** The initial magnesium extraction phase is remarkably efficient, achieving more than 60 percent magnesium removal.
- 2. High P₂O₅ yield:** P₂O₅ losses are minimal (below 5%) with the process delivering a stable 98 percent yield. This high efficiency is crucial as it optimises the quality of the beneficiated rock.
- 3. Feasibility of treating high-magnesium rock:** Results demonstrate the feasibility of beneficiating high magnesium phosphate rocks (1.9% Mg equivalent to 3.5% MgO) which – without effective Mg removal technology – are unsuitable for use in phosphoric acid production.
- 4. Low operational costs:** The process is cost-effective with raw material consumption limited to water (one tonne per tonne of P₂O₅) and quicklime (0.15 tonne per tonne of P₂O₅).
- 5. Filtration process efficiency:** Given the importance of filtration in the fertilizer industry, the successful use of under-vacuum filtration in the magnesium leaching module, and the excellent filterability in the neutralisation module, gives confidence in the easy industrialisation of the process.
- 6. Sustainable process:** The magnesium leaching and magnesium neutralisation modules can be operated in a loop as a sustainable process. Overall residues are minimal, as the beneficiated rock product obtained directly supplies the phosphoric acid plant, while the residue from the neutralisation module can be valorised in the fertilizer plant or elsewhere. Finally, the water consumed is entirely recyclable and the process therefore generates zero liquid discharge.
- 7. Validated for fertilizer production:** The semi-industrial beneficiation test was supplemented by a pilot test on

the beneficiated rock with the Prayon Mark IV di-hydrate (DH) process. The acid produced was successfully used to manufacture standard-grade fertilizers, such as NPK 15-15-15 and MAP. These granulated without any issues and exhibited excellent mechanical strength (above 15 MPa).

- 8. Easy integration into existing plants:** The magnesium leaching process can be seamlessly integrated into existing plants, as a key intermediate step between mechanical beneficiation and phosphoric acid production, requiring only minor operational changes.

In summary, semi-industrial testing by Prayon and EuroChem has successfully demonstrated the viability of magnesium leaching as an effective phosphate rock beneficiation process. The positive results obtained highlight its potential industrial application in high-quality fertilizer production. By optimising key parameters and improving process efficiency, the approach to beneficiation outlined in this article should contribute to the overall sustainability and environmental performance of the phosphoric acid industry.

EuroChem and Prayon have signed a licensing and patent agreement for this joint process and a joint international application has been submitted. As per the terms of this agreement, Prayon has the right to license and replicate this process worldwide with certain limitations. ■

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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IMAGE: DE SMET AGRO

Phosphates project listing 2024

De Smet Agro (DSAG) was the EPCM contractor for the Emaphos 2 purified phosphoric acid plant, Jorf Lasfar, Morocco, commissioned in 2023.

Fertilizer International presents a global round-up of phosphate rock, phosphoric acid and finished phosphates projects.


Phosphate rock*

Plant/project	Company	Location	capacity ('000 t)	Status	Start-up date
AUSTRALIA					
Ardmore	Centrex	Mount Isa, Queensland	625	UC	2024
CANADA					
Lac-à-Paul	Arianne Phosphate	Quebec	3,000	FS	n.a.
REPUBLIC OF CONGO					
Hinda	Kropz	Hinda	1,000	FS	n.a.
GUINEA-BISSAU					
Farim	Itafos	Guinea-Bissau	1,300	FS	n.a.
SOUTH AFRICA					
Elandsfontein	Kropz	Elandsfontein	1,000	C	2023


*Excluding China. Standalone, non-integrated projects only. At present, there are tens of junior phosphate mining projects globally. However, only capacity developments with a published feasibility study are listed here. In general, these projects have yet to secure the necessary finance and, consequently, none have committed to a firm construction schedule and start-up date currently. Africa, Australia and Canada are undoubtedly the locations with the most potential for virgin phosphate rock projects – although large uncertainties over individual projects and their timescales remain. OCP Group is, however, pressing on with ambitious plans to increase phosphate rock capacity at Khourigba and Meskala in Morocco. Major expansions in phosphate rock capacity are also expected out to 2026 from established phosphate producers in Russia and Kazakhstan (Acron, EuroChem, PhosAgro), Brazil (EuroChem, Itafos) and Mexico (Fertinal). This extra supply will be largely consumed in integrated, downstream operations. Kropz's Elandsfontein one million tonne capacity, export-oriented project in South Africa is currently in the commissioning phase. In Australia, Centrex plans to ramp up monthly phosphate rock production at its flagship Ardmore project in Queensland from 10,000 tonnes currently to 30,000 tonnes this year. EuroChem recently began shipping phosphate rock concentrate to its European production units from its Serra do Salitre project in Brazil.

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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Phosphate fertilizer, phosphoric acid and integrated phosphate rock projects**

Plant/project	Company	Location	Product	capacity ('000 t)	Status	Start-up date
AUSTRALIA						
Ammaroo	Verdant Minerals	Northern Territory	Phosphoric acid (P ₂ O ₅)	500	PL	2026/27
Ammaroo	Verdant Minerals		DAP/MAP	1,000	PL	2026/27
BRAZIL						
Santana	Itafos	Para State	Phosphoric acid (P ₂ O ₅)	200	PL	2026
Serra do Salitre	EuroChem	Patrocinio, Minas Gerais	Phosphoric acid (P ₂ O ₅)	250	UC	2024
Serra do Salitre	EuroChem	Patrocinio, Minas Gerais	SSP	650	UC	2024
Serra do Salitre	EuroChem	Patrocinio, Minas Gerais	DAP/MAP	350	UC	2024
EGYPT						
El Wadi	WAPHCO	Abu Tartur	Phosphoric acid (P ₂ O ₅)	500	UC	2024
El Wadi	WAPHCO	Abu Tartur	DAP/MAP/TSP	1,391	UC	2024
INDIA						
Orissa expansion	Paradeep Phosphates	Paradeep	Phosphoric acid (P ₂ O ₅)	120	UC	2023
Orissa expansion	Paradeep Phosphates	Paradeep	DAP/NPK	691	UC	2023
Tuticorin expansion	Greenstar Fertilizer	Tuticorin	DAP	683	UC	2024
KAZAKHSTAN						
Taraz	Kazphosphate	Taraz	Phosphoric acid (P ₂ O ₅)	220	C	2022
Taraz	Kazphosphate	Taraz	DAP/MAP	478	C	2022
MOROCCO						
Phosphore 3&4	OCP Group	Jorf Lasfar	Phosphoric acid (P ₂ O ₅)	520	C	2022
Phosphore 3&4	OCP Group	Jorf Lasfar	TSP/SSP	1,174	C	2022
Phosphore 3&4	OCP Group	Jorf Lasfar	TSP+S	587	UC	2023
Phosphore 3&4	OCP Group	Jorf Lasfar	NP+S	1,130	UC	2023
RUSSIA						
Dorogobuzh	Acron	Dorogobuzh	Phosphoric acid (P ₂ O ₅)	400	PL	2024
Dorogobuzh	Acron	Dorogobuzh	DAP/MAP/NPK	1,000	PL	2024
Volkhov expansion	PhosAgro	Volkhov	Phosphoric acid (P ₂ O ₅)	405	UC	2022
Volkhov expansion	PhosAgro	Volkhov	MAP	1,615	UC	2022
SAUDI ARABIA						
Third mega project	Ma'aden	Ras al Khair	Phosphoric acid (P ₂ O ₅)	1,500	PL	2027
Third mega project	Ma'aden	Ras al Khair	Finished phosphates	3,260	PL	2027
TUNISIA						
M'dilla II	GCT	M'dilla	Phosphoric acid (P ₂ O ₅)	180	n.a.	2027
M'dilla II	GCT	M'dilla	TSP	500	n.a.	2027

KEY FOR BOTH TABLES

- FS Feasibility study complete
- PL Planned
- UC Under construction
- C Project completed
- n.a. Not available
- DAP Diammonium phosphate
- DCP Dicalcium phosphate
- MAP Monoammonium phosphate
- PPA Purified phosphoric acid
- SSP Single superphosphate
- TSP Triple superphosphate

**Excluding China.

The International Fertilizer Association (IFA) expects investments by OCP Group to add 1.7 million t/a to Morocco's finished phosphates capacity in 2023. In Egypt, WAPHCO is currently constructing a major phosphate production complex at Abu Tartur. EuroChem is also pressing ahead with the development of its one million tonne capacity Serra do Salitre project. The third phosphates mega project announced by Ma'aden and its partners could eventually ramp-up Saudi Arabia's phosphates production capacity by a further 3.3 million t/a.

PHOSPHATE TECHNOLOGY AND ENGINEERING PROFILES

PHOTO: PROFILE



Profile

Profile's Model 30-220 tilting pan filter at OCP's Jorf Lasfar production complex in Morocco.

Bravely facing new challenges

Paul-Henri Legros, general manager, Profile, a division of Prayon s.a. provides a personal update on latest phosphate industry developments:

"Feeding the world is a wonderful motivation and the ultimate goal for our phosphoric acid-fertilizer industry. The world's current trajectory is placing new obstacles in our path and – to succeed – we will need all our knowledge and experience to overcome these.

"On the one hand, you have a continuous growing global population. Yet there's also a constant need to improve the living conditions and health of the whole population. So, as time goes on, everybody on the planet will be looking for better quality food together with more food availability worldwide.

"Currently, we are all witnessing the decrease in the area of land available and dedicated to agriculture – the main factors being urbanisation and changing climate and weather patterns across the world. In parallel, the quality of available phosphate rock resources is decreasing – while, at the same time, the necessity to think sustainability, save energy, and shift to 'green' production is also becoming more evident.

"Great, we have found our challenges for the next decade! So now is the time for the industry, for the chemists, for the engineers, for all men of good will, to put in place the solutions to these.

"At Prayon, we have an opportunity to strongly influence the future of the phosphate industry – a prospect that, I must admit, is very exciting. Being able to bring to the market our experience, our knowledge, our achievements in continuous process and equipment development. These skills combined will really enable us to make the difference.

"25 years ago, we were proud to introduce a Prayon Tilting Pan Filter® with a total surface of 100 m² into a 400 tonne (P₂O₅) per day capacity production plant. Today, we are announcing the possibility of achieving a total surface of 360 m² in a single Prayon Tilting Pan Filter®.

"As well as this, in a relatively short period – by dedicating time and sinking resources into fundamental research – we have been able to reduce the power consumption of our process agitators by 50 percent. Additionally, the successful recovery of P₂O₅ and fluorine droplets from the exhaust gases at installations, using Prayon's efficient and effective PRAYSEP® separator, has allowed operators to increase their process yields by almost two percent.

"These new developments, together with the confidence shown in Prayon by the world's great fertilizer producers – in Morocco, Saudi Arabia, Jordan and Egypt to name just a few – have allowed these leading companies to develop new production lines with a P₂O₅ capacity of more than 1,200 tonnes/day – that's despite the general decrease in phosphate rock quality already mentioned.

"Our progress in both phosphoric acid plant design and chemical process implementation holds the key to our market impact. Being able to show our customers and fellow producers that it's possible to produce more, at better quality, while drastically reducing their energy and water consumption, and being more green, is a really satisfactory reward for all the efforts put in place by Prayon.

"Just taking into account those projects which Prayon participates in, we anticipate the addition of more than 20,000 tonnes/day of extra P₂O₅ production capacity before 2030. This expansion in production, combined with fertilizer industry decarbonisation and resources savings, will allow us to say that we have faced up to global challenges and responded positively. Yes, we know how to feed the world and, yes, we have the capabilities to change the world into a better place for upcoming generations."

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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Prayon Technologies (PRT)

Prayon Technologies (PRT), the licensing division of Prayon, is internationally renowned for its phosphate production technologies. Currently, plants fitted with Prayon technology are responsible for one third of worldwide phosphoric acid production. Prayon's notable achievements include more than:

- 130 references in over 30 countries
- 20 production processes
- 65 validated phosphate rock types.

Experts at PRT dedicate themselves to designing easily operable and highly reliable phosphoric acid plants. This expertise comes from the company's know-how and its track record with production plants gained during more than 70 years of experience. Prayon incorporates the very latest process developments into its plant designs to benefit all of the phosphoric acid producers the company works with.

PRT offers the widest range of technologies for phosphoric acid production. Each of the company's five processes has its own characteristics. This allows Prayon to offer its partners successful tailor-made production options. The ability to deliver operationally successful phosphoric

acid plants is reinforced by incorporating premium-quality equipment specifically designed by Profile, the process filtration and liquid equipment division of Prayon.

Alongside the traditional route for producing feed phosphates from high-grade phosphoric acid, Prayon now offers two cutting-edge technologies that can use low-grade phosphate rock as a starting material. These innovative processes can significantly reduce production costs while generating feed phosphates of the same grade.

Prayon is aware that technological innovation will be vital for improving production processes to meet the needs of future generations. This includes developing technologies that are able to capture and use recycled raw materials. These will allow the phosphate industry to convert waste into valuable products while at the same time increasing the size of available phosphate resources.

PRT works closely with phosphoric acid producers to ensure they meet local environmental regulations. Reliable Profile-designed equipment, such as gas scrubbers and towers, enable businesses to reach high performance levels with close to zero emissions. The liquid bleed from these systems is either cleverly recycled into the process or

concentrated to generate valuable co-products. Technologies are available to selectively remove deleterious and unwanted impurities (As, Cd, F, SO₄, Mg, etc.). Prayon has also developed a new Mg leaching technology – a chemical beneficiation process – which can be added as a stage between the existing mechanical beneficiation and the phosphoric acid plant. This beneficiation innovation will enable phosphate rocks with high MgO content to be used in the production of high grade fertilizers such as DAP.

Our in-depth process knowledge and understanding is the key to getting the best from a phosphoric acid plant. Prayon, through its wide range of services, always accompanies the owner at each and every stage of their project – starting by providing a tailor-made plant design all the way through to offering consultancy services during plant operations.

The company's expertise encompasses:

- Lab to semi-industrial scale testing and validation
- Plant simulation training
- Technical surveys
- Achieving operational excellence through data management and plant optimisation.

Ballestra

Milan-headquartered Ballestra SpA has extensive experience in the design and supply of chemical plants.

For the fertilizer industry, the engineering company offers production plants for sulphuric acid, merchant-grade phosphoric acid (MGA), single superphosphate (SSP), triple superphosphate (TSP), potassium sulphate, granulated NPK compound fertilizers, ammonium nitrate (AN), ammonium sulphate nitrate (ASN), calcium nitrate (CN), calcium ammonium nitrate (CAN), urea ammonium nitrate, urea ammonium sulphate (UAS), and slow/controlled release fertilizers

From initial design through to plant start-up, Ballestra offers support to clients during all of the following project phases:

- Feasibility studies
- Material supply
- Process design
- Project implementation
- Detailed engineering
- Plant start-up the phases
- Follow up services along the entire plant life cycle.

Ballestra phosphoric acid plants are highly flexible. The design of each plant is bespoke, being specifically tailored to individual client needs. To maximise process efficiency, plants are customised to accommodate different types of phosphate rock.

Uniquely globally, Ballestra is the permanent licensee of the major technology providers Elessent MECS for sulphuric acid and Prayon Technologies for phosphoric acid.

Ballestra offers phosphoric acid plants based on the following processes:

- DH: Di-Hydrate (single crystallization)
- HH: Hemi-Hydrate (single crystallization)
- CPP: Central Prayon Process (double crystallization DH-HH)
- HDH: Hemi-hydrate to Di-Hydrate (double crystallization HH-DH)
- DA-HF: Di-hydrate attack, Hemi-Hydrate filtration (double crystallization DH-HH).

These versatile, well-proven and market-leading processes are widely employed in many phosphoric acid projects around

the globe. The most suitable process is selected based on a range of factors, such as rock quality, performance parameters and production economics. All the above processes enable the production of 52-54 percent concentration phosphoric acid, an intermediate in the manufacture of phosphate fertilizers.

Plants can also be configured to allow the recovery of fluosilicic acid (FSA). This is obtained as a process by-product – in concentrations up to 18 percent – and can be sold to market, or converted into valuable anhydrous hydrofluoric acid (AHF) or AlF₃ under a technology collaboration with Ballestra's fully owned subsidiary Buss ChemTech. Alternatively, it can be neutralised for disposal.

Ballestra is also an established supplier of potassium sulphate (SOP) plants delivered via a greatly improved Mannheim process or through its innovative and proprietary WET SOP technology. Finishing plants for all the fertilizer technologies are also available.

De Smet Agro

De Smet Agro (DSAG) has been providing project management, engineering, procurement and construction management services to the fertilizer industry for more than 65 years. The company, a division of De Smet Engineers & Contractors, is based near Brussels, Belgium, with satellite offices in France, Morocco, Argentina and India.

DSAG has strong and globally recognised expertise in the engineering and construction of fertilizer complexes, working in collaboration with multiple partners and different technology licensors. This has enabled the company to deliver more than 250 industrial plants in 35 countries since 1957 – including numerous sulphuric, phosphoric acid and fertilizer granulation plants.

The multi-disciplinary team at DSAG offers engineering services for new 'greenfield' plants. The company also offers revamping and capacity improvement projects at existing production sites.

DSAG is recognised worldwide as the most experienced and wide-ranging licensee for Prayon Technologies (PRT), offering all of the company's industry-leading phosphoric acid production routes, and its processes for phosphoric acid derivatives and by-products. This longstanding cooperation with PRT, which dates from 1960, has delivered many notable project achievements globally.

DSAG has full in-house expertise for all the engineering, procurement and construction supervision needed to deliver phosphoric acid projects. (Prayon's process design package being the starting point for these activities.) The company's project capabilities cover the complete pro-

duction process, from raw materials to the handling and storage of the final product. DSAG possesses in-depth expertise for:

- Single and double crystallisation phosphoric acid processes
- Phosphoric acid purification technologies (solvent and membranes)
- Phosphate salt technologies, including those for food phosphates, and new processes such as those for soluble fertilizers
- Dicalcium phosphate (DCP) processes (HCl- or H₂SO₄-based) including a phosphoric acid production process based on DCP
- Fluorine gas scrubbing
- Phosphoric acid concentration and fluosilicic acid recovery
- Phosphate rock solids or slurry handling and storage
- Acidic cooling tower design
- Gypsum transfer as solids or slurry, storage and valorisation.

Additionally, DSAG offers fully proven in-house technologies for nitrogen fertilizer production. The company's nitrogen process design expertise covers synthesis, evaporation, crystallisation, prilling and granulation units for clients all over the world. Specific areas of expertise include:

- In-house fluidised drum granulation technology for ammonium nitrate products (AN/CAN/ASN) and calcium nitrate (CN)
- Prilling of low density ammonium nitrate (LDAN)
- Ammonium Sulphate (AS). DSAG also offers a comprehensive

range of construction services for fertilizer granulation. These services cover the construction of granulation units for:

- Monoammonium phosphate (MAP)
- Diammonium phosphate (DAP)
- NPKs.

The company's granulation expertise also includes the design of gaseous effluent cleaning systems.

To meet client or project needs, DSAG has the capability to team up with other recognised fertilizer technology providers/contractors, thanks to strong relationships built over decades. This provides industry customers with complete responsibility for the delivery of their fertilizer projects.

DSAG provides a complete range of services to the fertilizer industry all around the world. These range from technical audits to the full delivery of EP and EPCM contracts and typically include:

- Technical audits
- Prefeasibility, feasibility studies, capex and opex estimates, including all on-site and off-site facilities
- Financial studies
- Overall project management
- Front-end engineering design (FEED), basic and detailed engineering design
- Procurement
- Construction management and site supervision
- Training of client personnel
- Pre-commissioning and commissioning services
- Start-up assistance and performance guarantee tests.

Client: Emaphos
Location: Jorf Lasfar, Morocco
Project: Emaphos 2 purified phosphoric acid plant

This plant was commissioned in 2023 and consists of a pretreatment unit and a solvent extraction purification section. De Smet Engineers & Contractors and its subsidiary DSAG completed the project's EPCM mandate.

The Emaphos 2 purified phosphoric acid plant, Jorf Lasfar, Morocco.



IMAGE: DE SMET AGRO

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
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JESA Technologies

JESA Technologies (JT), based in Lakeland, Florida, has proudly served the global phosphate industry for over a half century. The company, backed by two global powerhouses, OCP and Worley, offers licensed technology to the phosphates industry covering the whole production process, from mine to market. The company is a leading licensor for three process steps in particular: phosphate rock beneficiation, phosphoric acid production and granular fertilizer manufacture.

Additionally, JT offers on-site pilot plants, for both beneficiation and phosphoric acid, supported by a fully equipped analytical laboratory. The ability to combine in-house technical and engineering design know-how – from mined rock all the way through to the finished product – with on-site pilot plants makes JT unique as a licensor.

Since its establishment in 1974, JT has been responsible for the design of over 150 process facilities for the phosphate fertilizer industry in 29 countries. The plants designed by JT include the largest single-train phosphate operations in the world. Notably, these include a phosphoric acid plant with a demonstrated capacity above 3,000 tonnes per day – plus numerous examples of DAP/NPK plants with capacities in excess of one million tonnes per year.

In addition to designing new plants, JT has an extensive track record in revamping operational plants. These revamps have successfully delivered a range of desired outcomes for customers – including increased production capacity, product quality improvements, energy savings and improved environmental performance.

JT's extensive test facilities in Lakeland, Florida, include:

- A comprehensively equipped analytical laboratory
- A bench-scale metallurgical laboratory, capable of testing ore samples obtained from core drilling or pits
- A fully-equipped pilot plant capable of batch or continuous operation
- A continuous phosphoric acid pilot plant.

These test facilities make a vital contribution to feasibility studies. By developing process design data, they enable JT to offer its customers process guarantees. They are also engaged in contract research for clients.

Two case studies of phosphate industry projects recently awarded to JT are provided below:

Client: Itafos Conda Phosphate Operations

Location: Soda Springs, Idaho, USA

Project: Beneficiation improvement project – detail engineering

Itafos Conda Phosphate Operations (CPO) operates a phosphate fertilizer production complex in Soda Springs, Idaho. Prospecting activities indicate that in the coming years, the magnesium content of the ore recovered from mining operations will be elevated to the point that the current processing plant may not be able to produce fertilizer products with acceptable levels of magnesium impurity. Improvements to the ore beneficiation process are therefore needed.

Commencing in the fall of 2021, JT has assisted Itafos with the development of a new processing flowsheet which incorporates froth flotation to improve the beneficiation plant concentrate product quality. Laboratory and pilot plant test results indicated that additional processing steps would be necessary to optimise phosphate recovery and improve the operability of the plant. A subsequent basic engineering and design stage was used to define the exact beneficiation requirements and estimate the budget for this brownfield project.

Itafos and JT, based on this revised concept and a value engineering study, then proceeded to the detailed engineering and procurement phase of the project in January 2024.

Client: Ma'aden

Location: Ras Al Khair, Saudi Arabia

Project: Front-end engineering design (FEED) for two large-scale granular fertilizer plants

JT has been selected as the licensor for a major granular fertilizer project as part of Phase 1 of Ma'aden's 'Phosphate 3' mega project. Two large-scale granulation plants, with a total annual production capacity of two million tonnes, will be designed to produce over 25 different fertilizer grades.

As licensor, JT will be involved throughout the life of the project – all the way through from technology and design to staff training and then plant commissioning and start-up, supporting the engineering, procurement and construction (EPC) contractor.

JT's mission is to provide the client with reliable, efficient designs that demonstrate the excellence of its expertise and unrivalled leadership in the phosphate industry. ■



PHOTO: ITAFOS

JESA Technologies is carrying out beneficiation improvements for Itafos at its Conda phosphate plant in Soda Springs, Idaho, USA.

PHOTO: TOMRA



An array of four TOMRA sorting machines at the MWSPC mega project in Saudi Arabia.

TOMRA

The use of TOMRA sorting machines at a major new phosphate mining and processing operation is showing how phosphorus can be extracted from ore with greater environmental and economic efficiency.

Transforming phosphate rock into a high-quality and commercially-usable concentrate can be costly, logistically complex and technically-demanding. Fortunately, the introduction of innovative and pioneering sorting technology is now helping to improve the efficiency of phosphate fertilizer production.

Indeed, the installation of TOMRA sorting machines at a new large-scale phosphates mining and processing complex in Saudi Arabia has shown how it is possible to cut production costs – while at the same time turning traditionally discarded waste into usable phosphate.

The massive complex, located in the remote north of the Kingdom, is run by the Ma'aden Wa'ad al Shamal Phosphate Company (MWSPC), an \$8 billion joint venture between Saudi mining giant Ma'aden, Saudi Basic Industries Corporation (SABIC) and US-based Mosaic, a leading international fertilizer producer. The successful completion of the MWSPC project in 2018 has turned Saudi Arabia into the second-largest phosphate producer in the Middle East.

The biggest challenge at the MWSPC plant – in common with many other phosphate operations around the world – is removing significant amounts of unwanted silica, also known as flintstone or chert. This needs to be eliminated from run-of-mine material to improve its quality and ensure that phosphate rock concentrates are suitable for downstream chemical processing.

This challenge is even tougher for MWSPC. That's because contaminants are traditionally removed from phosphate ore using large quantities of water (and chemicals). Yet this is not possible at the company's arid inland desert location due to the lack of a natural rain-fed water supply.

TOMRA therefore collaborated closely with the designers of the MWSPC plant to find a way of reducing water (and electricity) consumption in downstream production processes. The installation of high-capacity TOMRA sorting machines emerged as the most viable and practical option. These machines are capable of efficiently identifying and ejecting unwanted silica from large volumes of phosphate feed materials.

Following their installation, TOMRA's XRT (X-Ray Transmission) machines are now pre-processing more than half of the total 13.5 million tonnes of phosphate ore handled by the MWSPC plant every year. Running at a rate of 1,800-2,000 tonnes per hour,

the XRT machines recognise and separate materials according to their specific atomic density. Advantageously, this process is completely dry and avoids the need for wet, water-based cleaning of materials.

The sorting machines have performed remarkably well at the MWSPC plant, delivering large efficiency gains and cost savings. "Now that this plant has been running for years, the effectiveness of XRT sorting is clear," comments Jens-Michael

Bergmann, TOMRA's area sales manager for Europe, MENA and India. "By making it possible to remove 98 percent or more of liberated silica contaminants, XRT has reduced the workload and costs of crushing by about 75 percent, reduced the costs of milling by 45 percent, and reduced water consumption by 45 percent."

He adds: "What's more, the ability to reduce the size of the flotation plant has saved millions of dollars in construction costs, and continues to save about \$10 million per year in the cost of flotation reagents alone."

XRT sorting technology can perform equally well at improving the phosphate-processing efficiencies of many other operations globally. That's the main lesson from the successful installation of TOMRA sorting machines at the MWSPC plant – in some of the most hostile working conditions on earth. ■

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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2023: the phosphates year in review

PHOTO: THE MOSAIC COMPANY

With phosphate supply concerns persisting as 2023 draws to a close, CRU's Senior Analyst **Logan Collins** looks back at what's been a dynamic year for the global phosphate market.

Weak first quarter demand

Prices of phosphate fertilizers (DAP/MAP) were softening in most key global markets as 2023 began. Demand was limited in India, the US, and Europe, with the latter region particularly slow due to the persistence of a price premium.

Notably, steady sales were still recorded from China, despite the reported lack of Chinese DAP/MAP availability under Q1 export quotas set by the government. These Chinese export sales added to the downward price pressures linked to weak demand.

Brazil was the one market which bucked the early 2023 trend. Instead, the affordability of MAP relative to crop prices in Brazil was favourable enough to encourage buying interest.

At the start of January, India DAP prices were around \$700/t cfr, while Brazil's MAP prices were roughly \$50/t lower.

Global DAP/MAP prices did, however, converge in the weeks that followed, as

DAP prices in India dropped amid rumours of an unprecedented mid-season subsidy cut. Delays to the settlement of India's Q1 benchmark phosphoric acid contract price, together with falling nitrogen costs, also weighed on global DAP/MAP prices as February began.

In a reflection of ongoing DAP price declines, India's Q1 phosphoric acid price was eventually agreed at \$1,050/t cfr (100% P₂O₅), marking a decline of \$125/t from 2022 Q4.

DAP/MAP markets were generally characterised by persistently weak demand over the remainder of the first quarter – this more than offsetting low supply from China and Morocco. OCP at this time was operating its granular fertilizer capacity at just 50 percent, according to CRU estimates.

By the end of Q1, India's DAP prices had slumped an average of \$112/t since the start of the year, with the pace of decline accelerating.

State-of-the-art remote operation station at Mosaic's Integrated Operations Center, Lithia, Florida. The operator is controlling high-pressure water guns in the phosphate mining area located miles away.

Brief Easter respite in the US

Most global DAP/MAP prices were pushed lower in early Q2 by a combination of reduced raw-material costs, rising stocks, limited demand, and growing expectations of easing export quotas in China. An additional expectation that India would cut its Kharif season subsidy added to the price downside.

In the US, however, the Easter period saw a DAP/MAP price surge on the back of spring demand. This resulted in the New Orleans (NOLA) DAP price becoming the world's highest benchmark, reaching \$620-700/st f.o.b. (\$681-770/t) during this period (Figure 1). The upper end of this range was more than \$200/t above DAP prices in India (Figure 2). Nonetheless, outside the region, price declines continued.

The US price surge eventually came to an abrupt halt when India's Q2 phosphoric acid contract price was agreed at \$970/t cfr (100% P₂O₅) in late April, down \$80/t from Q1. This prompted a memorable collapse in NOLA DAP prices in early May – the last bulwark of price support globally – by \$150/st in just one week, as spring buying petered out (Figures 1 and 2).

Market sentiment was therefore overwhelmingly bearish as participants gathered for the International Fertilizer Association (IFA) annual conference in Prague in May. With DAP/MAP prices still under downwards pressure, buyers were looking to take further advantage. OCP's strategy dominated the discussions in Prague, given that the Moroccan producer had yet to increase its sales volumes.

It was around this time that China's government acted to ease export restrictions by cutting inspection times for DAP/MAP exports to a maximum of 10 days. The move almost immediately resulted in greater overseas market availability at more aggressive prices. Consequently, China's DAP export prices started slipping below \$500/t f.o.b. in mid-to-late May, while domestic prices also tumbled (Figure 3).

As Q2 ended, DAP/MAP markets awoke from their temporary slumber on reports of an India Q3 phosphoric acid settlement at \$970/t cfr (100% P₂O₅) – down \$120/t from Q2.

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RELIABILITY THROUGH EXPERIENCE

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

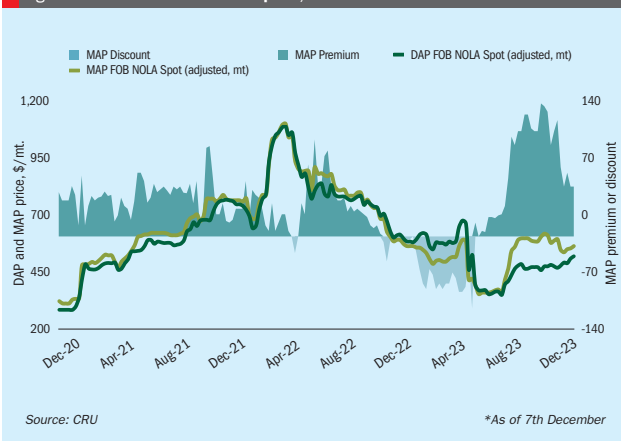
Phosphate market review

FERTILIZER INTERNATIONAL
ISSUE 518
 JANUARY/FEBRUARY 2024



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Fig 1: New Orleans DAP vs MAP price, December 2020 – December 2022*



Rising from the floor

Although India's DAP prices remained under downwards pressure at the start of Q3, other markets had reached their floor. Brazil's MAP prices, for example, which had touched as low as \$420/t cfr in late June, started to firm on the back of improved demand. In fact, these MAP price levels were the lowest recorded in Brazil since the beginning of 2021.

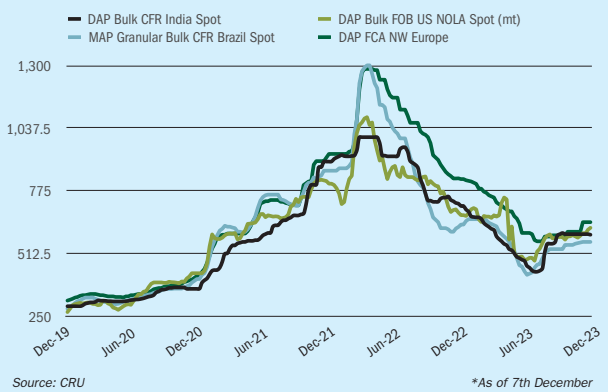
Rising Brazilian MAP prices and softening Indian DAP prices converged during July (Figure 2). Steady export volumes from China, meanwhile, in advance of that coun-

try's autumn application season, allowed Indian buyers to take advantage and secure cargoes. Tight supply in the US around this same time was supporting a strong rebound in DAP/MAP prices (Figure 2).

Then, in August, a drop in DAP export supply from China prompted a price surge in India, with sales in the second week of August reported to be as much as \$90/t higher on the preceding week. These steeper than expected Indian DAP price rises spread the bullish sentiment to other markets.

Prices climbed higher across most key global benchmarks in September as global

Fig 2: Selected DAP/MAP benchmarks, December 2020 – December 2022*



DAP/MAP supply tightened. Availability from China was scaled back and plant maintenance restricted Russian availability in September-October. Production issues were also reported in the US and in Saudi Arabia. In addition, monthly volumes from OCP were judged to be below production capacity, despite an apparent increase in sales. Steady demand from India also tightened supply.

Changes to subsidies, duties and export restrictions

India once again took centre stage in late October as the government finally announced a cut to the nutrient-based subsidy (NBS) for fertilizers in the Rabi season. The 31 percent drop in the NBS for DAP from 1st October was widely expected in the market and therefore did not impact DAP prices. These remain flat and in the mid-\$590s/t cfr at the time of writing (mid-December).

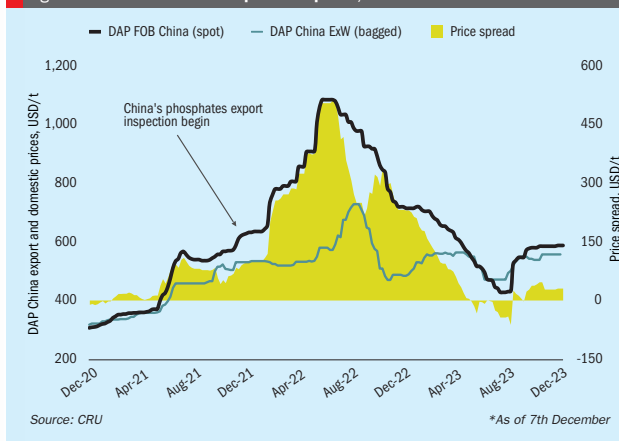
Elsewhere, the intensification of the Israel-Palestine conflict in early October – which saw some of the worst fighting in the region in more than half a century – raised phosphate and potash supply concerns. Although the conflict continues to pose an upside risk to prices, regional production, logistics, and trade were understood to be largely normal, as of mid-December.

The US Department of Commerce (DoC) slashed the countervailing duty (CVD) rate on imports from Morocco's OCP from 19.97 percent to just 2.12 percent at the start of November, while at the same time tripling the CVD on imports from Russia's PhosAgro from 9.19 percent to 28.5 percent. This should increase DAP/MAP supply from Morocco to the US, in CRU's view, as well as narrow the US MAP price premium over DAP. However, an increase in Morocco supply is only likely to happen in Q3 ahead of the fall 2024 application season.

Also in November, China's National Development and Reform Commission (NDRC) tightened DAP/MAP export restrictions by suspending export inspections. These latest restrictions, which are likely to persist until China's domestic spring season concludes at the end of Q1 2024, have led CRU to revise down its Q1 Chinese DAP/MAP export forecast to 0.67 million tonnes.

Originally, prior to the introduction of fresh Chinese export restrictions, CRU had been forecasting global DAP/MAP prices

Fig 3: Chinese domestic vs export DAP prices, December 2020 – December 2022*



to reach a ceiling in 2023 before facing downwards pressure over the remainder of the year. DAP demand from India did drop, for example, as the NBS cut pushed import margins into strongly negative territory. This subsidy cut, given that demand elsewhere is still not particularly strong, could have been the final nail in the coffin for phosphates producers.

Yet DAP/MAP supply remains tight – a situation that has been further compounded by stricter Chinese export controls. Therefore, for now, limited availability is more than offsetting seasonally slow demand in some global markets.

Demand from key buyer India should also improve over the coming months. The Indian government signalled its

intention to increase the fertilizer subsidy for the remainder of the Rabi season as market participants gathered in New Delhi to attend the annual FAI conference in early December. Although it is unclear to what extent this will improve the NBS for DAP, the rumoured increases should be enough to boost Indian import demand. It looks as if both Indian buyers and the government are becoming more concerned about DAP availability in advance of the national election in 2024.

Prices lower but historically high

Global DAP/MAP prices will end 2023 at notably lower levels than at the end of 2022 (Figure 2). Yet benchmarks remain historically high amid ongoing geopolitical tensions and wider concerns over fertilizer availability and food security.

While some supply constraints have largely normalised since Russia's invasion of Ukraine and the height of the Covid-19 pandemic, significant market uncertainty remains.

Phosphate fertilizer prices are unlikely to see sustained declines until well into 2024, in CRU's view, and many benchmarks could even remain at historically high levels beyond this.

2023 SUMMARY

A year of two halves

Phosphate fertilizer (DAP/MAP) price movements were mixed across key global markets as 2023 began. While weak demand pressured prices in India, the US, and Europe, improving affordability was supporting prices in Latin America.

Even Latin America was not immune. And the fundamentals dragging prices lower outside of the region eventually overpowered isolated demand support within Brazil. The upshot was gradual falls in most key DAP/MAP benchmarks – including Brazil – throughout the first half of 2023 (Figure 2).

Since July, DAP/MAP prices have rebounded, however, with the biggest gains recorded east of Suez on the back of steady demand from India. More recently, tight DAP/MAP supply has supported global prices more generally (Figure 2). This tight supply being compounded by the latest round of Chinese export restrictions.

As of early December, limited early availability of DAP/MAP was still supporting global price benchmarks, most of which were either stable or firming (Figure 2). Global phosphate fertilizer prices – although noticeably lower than at the end of 2022 – are therefore set to end 2023 at historically high levels. This pricing environment is likely to persist over the short term, in CRU's view.

Timeline of key 2023 events

1. India Q1 phosacid agreed at \$1,050/t cfr, down \$125/t from 2022 Q4
2. India's imported P&K nutrient based subsidy (NBS) cut by 36 percent year-on-year for the 2023/24 fertilizer season
3. India's Q2 phosacid agreed at \$970/t cfr (100% P₂O₅), a further fall of \$80/t from Q1
4. Chinese government cuts inspection period for DAP/MAP exports to 10 days maximum
5. India's Q3 phosacid agreed at \$850/t cfr (100% P₂O₅), down yet again by \$120/t from Q2
6. India's Q4 phosacid price finally rebounds, reportedly up \$135/t at \$985/t cfr (100% P₂O₅)
7. Flare-up of the Israel/Palestine conflict poses potential risks to global fertilizer supply
8. India's government announces a 31 percent cut in the Rabi season NBS for DAP
9. US Department of Commerce cuts countervailing duties (CVD) on OCP's imports
10. China's National Development and Reform Commission tightens DAP/MAP export restrictions in early November.

CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

COVER FEATURE 3

Magnesium removal from phosphate rock

COVER FEATURE 4

Phosphate market review

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates 2024 conference, Warsaw

COVER FEATURE 2

Fertilizer markets – what's in store for 2024

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CONTENTS

What's in issue 518

COVER FEATURE 1

CRU Phosphates
2024 conference,
Warsaw

COVER FEATURE 2

Fertilizer markets
- what's in store
for 2024

COVER FEATURE 3

Magnesium
removal from
phosphate rock

COVER FEATURE 4

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review

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