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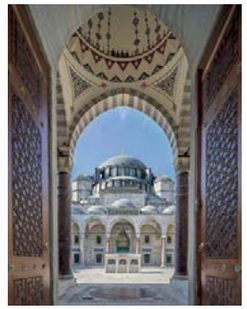

Cover: Gate to courtyard of Suleymaniye Mosque, Istanbul, Turkey. ihsan Gercelman/Shutterstock.com

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A return to market stability?

After two turbulent years, could the fertilizer market finally start to stabilise in 2023? Well, that's what Dutch agricultural finance house Rabobank is predicting…

Fertilizer consumption suffered in 2022 due to extreme market volatility and, at times, astronomical prices. Yet, with signs of fertilizer prices moving lower in 2023, a recovery in consumption in some regions is possible this year, according to Rabobank's latest fertilizer outlook[1].

"When geopolitics meets fertilizer markets, things get bumpy for fertilizers. That is exactly what has happened over the past two years, with tensions peaking after the invasion of Ukraine. But for 2023, we can expect things to settle somewhat," comments the outlook's lead author Bruno Fonseca, senior analyst for farm inputs at Rabobank.

In his view, fertilizer price movements in recent months, and corresponding changes to affordability, resemble patterns seen in the past.

"History repeats itself. That becomes more evident when we explore historical trends in the affordability index over time," said Fonseca.

Rabobank's fertilizer affordability index is a measure of farmer buying power. It works by benchmarking the price of a basket of fertilizer products against the price of a basket of agricultural commodities.

The bank's latest analysis suggests that fertilizer affordability is following a broad historical cycle that on average peaks every three years. Because of this, Rabobank expects to see fertilizer affordability improve in coming months – if its trajectory in 2023 matches the strongly cyclical pattern seen since the 2008 global financial crisis.

"The [fertilizer affordability] index's moving average is trending lower, as fertilizer prices are returning to pre-war levels. For the next three months, the index will continue to trend downward but remain above normal," Fonseca commented at the end of November. He noted, however, that Europe's natural gas crisis could potentially keep the index higher – i.e., less affordable – by making urea and ammonia more expensive.

Nitrogen fertilizers have experienced the highest price swings of the last 12 months due to their reliance on natural gas as a feedstock. Rabobank reports that annual urea price volatility, as of mid-October 2022, was above 60 percent – more than triple its five-year average.

"As long as the natural gas crisis in Europe lasts, volatility in the nitrogen-based fertilizer market will persist, with weeks of stronger demand pushing prices higher and weaker weeks pushing prices lower," Rabobank reports.

Phosphate fertilizer prices, meanwhile, are currently trending lower. This is linked to the demand destruction caused by record phosphate prices earlier in 2022. High phosphate production costs should, however, provide a floor and prevent large price decreases. The potential for phosphate price volatility in 2023 also remains due to logistics risks and potentially adverse weather affecting field applications.

The 2022 potash market price spike also destroyed demand, although consumption is recovering now that prices are moving lower. Nonetheless, the reconfiguration of global supply needed to keep potash exports from Belarus and Russia flowing (see our full article on page 50) will still pressurise prices in 2023.

The high commodity prices of the past two years have broadly benefitted agricultural producers, Rabobank reports, by generating outstanding returns and strengthening working capital. Margins will remain positive in 2023, although they will be down on the previous two years due to higher input costs.

Fertilizer buying in 2023 is likely to remain robust despite this cost squeeze, concludes Rabobank.

"With strong working capital and positive margins, [agricultural] producers will make minimum cuts to inputs," predicts Fonseca. "Their objective is to maximize yields, and that is not accomplished by cutting back inputs – particularly fertilizers."

Yet history doesn't always repeat itself, does it? As the popularity of the word 'unprecedented' in 2022 proves.

The last three years have each been scarred by a set of very different global disruptors – a worldwide pandemic, a breakdown in inter-regional supply chains, a surprise war in Europe – so emerging signs of stability in 2023 will be warmly welcomed. ■

> **"When geopolitics meets fertilizer markets, things get bumpy for fertilizers. That is exactly what has happened over the past two years."**

Simon Inglethorpe, Editor

1. Fonseca, B., 2022. *Fertilizer Outlook – Is History Repeating Itself?* Rabobank, November 2022.

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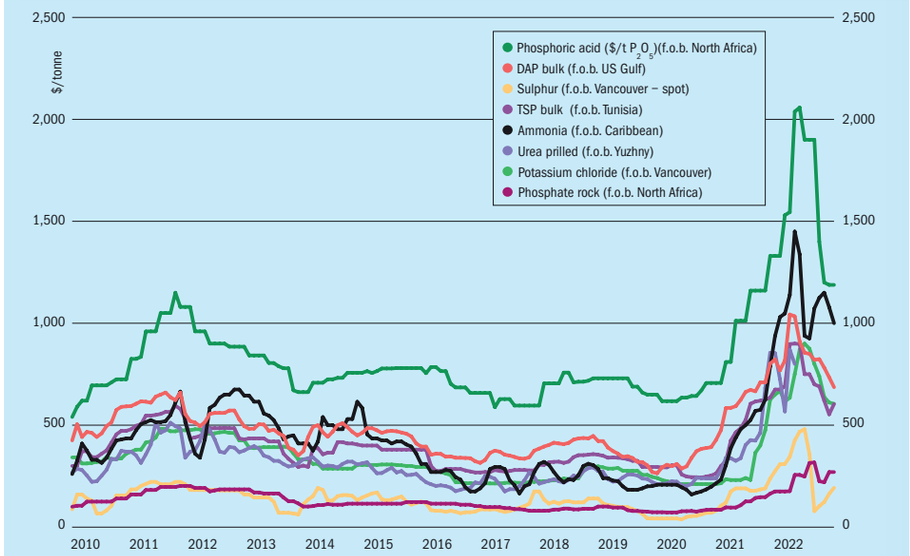
Market Insight

Historical price trends $/tonne



Source: BCInsight

Market Insight courtesy of Argus Media

PRICE TRENDS

Urea: The market remained weak at the start of the year with urea prices falling as producers fought for liquidity. Egyptian product fell by $40/t to $495/t f.o.b. in a matter of days, while f.o.b. prices in the Middle East and southeast Asia similarly fell to around $440/t. Urea prices in many end-user markets also slumped: US prices fell over the course of the first week of January by $30/t, Brazil by $15/t and many European markets by around $20/t.

With India out of the market currently, there is a clear urea supply overhang for January-loading cargoes. This applies to Russia, the Middle East and both north and west Africa.

Key market drivers: The removal of import duties saw the resumption of cargoes to European markets from the Middle East, southeast Asia and the US in early January. This forced north African producers to cut prices to stay competitive. India's decision to delay its next purchase tender until end-January has left many producers looking for sales in other markets, depressing prices across the globe.

Ammonia: With supply options continuing to outweigh demand in most regions, the start of January saw another week of price losses. Prices have now been falling steadily for the past twelve weeks. This has been the consequence of the market rebalancing itself with the ending of the European production curtailments that have been in place for much of 2022. Many European ammonia production plants are scheduled to ramp-up in January due to favourable economics. Steady gas price falls over the past few weeks have now put their production costs firmly below current import price levels.

Key market drivers: Weaker sentiment was illustrated by Yara settling the Tampa contract price with Mosaic at $975/t cfr for January – a $55/t fall from December and the lowest price since July 2022. European natural gas prices also fell sharply again in early January. TTF month-ahead prices dropped to $20/mn Btu on 4th January – their lowest level for nearly a year. The TTF price in mid-January ($22/mn Btu) translates to an approximate ammonia production cost of around $830-840/t. Saudi Arabia's export availability also looks set to be lower in January.

Phosphates: Major markets east and west of Suez continued to converge as January began. MAP rose to $645-650/t cfr Brazil, for example, while Indian DAP prices slipped to $688-695/t cfr. DAP prices out of China similarly fell to $685-690/t f.o.b. However, there is no clarity currently on phosphate export quotas from China for the first half of 2023.

The Pakistan market remains well stocked with little if any interest in purchases at current price levels. In Europe, meanwhile, DAP price levels remain broadly stable.

In Brazil, MAP prices climbed to $645-650/t cfr in the first week of January. A supplier sold 5,000 tonnes of Russian MAP at $645/t cfr for February loading. Non-Russian MAP offers were at $680-690/t cfr and even above.

Market price summary $/tonne – Early January 2023

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	930-975	460-490	f.o.b. E. Europe n.a.	f.o.b. US Gulf	655-688	-	-
f.o.b. Yuzhny	Port closed	Port closed	-	f.o.b. N. Africa	670-780	508-700	1,075-1,300
f.o.b. Middle East	820-900	418-485**	-	cfr India	690-720	-	1,175-1,200*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**			**Sulphur**	
f.o.b. Vancouver	477-732	-	cfr US Gulf	100-200	f.o.b. Vancouver	165-205	-
f.o.b. Middle East	507-750	-	-	-	f.o.b. Arab Gulf	154-165	-
f.o.b. Western Europe	-	900-1,050	-	-	cfr N. Africa	103-130	-
f.o.b. Baltic	488-700	-	-	-	cfr India	174-195+	-

Prices are on a bulk, spot basis, unless otherwise stated. (= contract ** = granular). Phosphoric acid is in terms of $/t P_2O_5 for merchant-grade (54% P_2O_5) product. Sulphur prices are for dry material. (+ Quotes for product ex-Arab Gulf). n.a. = not available.*

Key market drivers: Settlement of the January Tampa ammonia contract price at $975/t cfr. European gas prices were also lower with front-month natural gas futures of around €65-70/MWh in mid-January.

Potash: Granular MOP prices in Brazil have rebounded following a sustained period of falling prices in the second half of 2022. These rose by $5/t during early January to $525-540/t cfr as trade continues to gain momentum. East of Suez, the outcome of Pupuk Indonesia's standard MOP buying tender is being closely watched. Having received offers between $560-620/t cfr, Pupuk countered at $500/t cfr. Awards for this tender will help set a new price benchmark for the region.

Key market drivers: The Chinese government removed a one percent import tariff on MOP and SOP on 1st January. This move reduces purchase costs for importers. It also signals that Chinese authorities are now seeking to secure an ample and affordable supply of potash for its domestic market. Shipping through the Black Sea will no longer be insured against the Russia-Ukraine conflict, after protection and indemnity (P&I) clubs cancelled Black Sea war risk coverage at the start of January. This may affect Black Sea potash vessel shipments including those from Belaruskali.

NPKs: Trade of Russian complex fertilizers to India continued as 2022 ended. Russian 16-16-16 and 10-26-26 NPK grades were both sold in large volumes at prices that underlined the softening of the global NPK market. Elsewhere, prices mainly held steady in the absence of market activity. This was due to continued low demand in Southeast Asia, as well as the ongoing holiday season in Europe and the Americas.

Key market drivers: Borealis has completed the sale of Belgium-headquartered NPK producer Rosier to Turkey's Yildirim Group. The Austrian firm also expects to finalise the sale of its nitrogen business to Czech-owned Agrofert during 2023's first quarter. Urea prices have also fallen in an oversupplied environment.

Sulphur: 2023 kicked off on a softer note. Chinese demand in January was subdued and sulphur market fundamentals were generally weaker compared to a year ago. The downwards price correction seen in December is keeping product moving. First quarter contracts are also beginning to conclude. Although prices are up on fourth quarter contract agreements, they are below the top levels reached by the spot market during the last quarter. January spot demand was subdued, due to the ongoing contract negotiations, showing a sluggish start after the recent holiday period. In the Mediterranean, the generally softer market trend is being exacerbated by the release of lower priced Russian sulphur exports. This is adding to availability and reducing price ideas.

Key market drivers: First quarter contract agreements are starting to be settled. Lower offers have been made to China with some shipments already concluded. Demand is sluggish with many traders having placed tonnes for January ahead of time.

OUTLOOK

Urea: The sentiment among both importers and traders is that a floor in the urea price is still some distance away. This is exacerbating market softness. Breakeven production costs, which are still well below the latest trades, are offering little price support. Demand will rise across much of the northern hemisphere later in the first quarter, although whether this will be enough to return prices to current levels remains to be seen.

Ammonia: A downwards market correction is expected throughout the rest of the first quarter. The emergence of a clearer picture on seasonal fertilizer demand in Europe could, however, slow and stabilise downward price movements.

Phosphates: Affordability remains solid with continued buying west of Suez expected to lift prices further. Demand from Brazil, the US and Europe is set to ramp up from February onwards.

Potash: Steady demand in Brazil and the emergence of spring interest in Europe should help keep pricing stable. Prices are likely to be steady in Asia until new benchmark prices appear. These will be set by the India contract price or the latest Indonesian buying tender. SOP values, meanwhile, are likely to fall further as they play catch up with falling MOP prices.

NPKs: Price downturns lie ahead for most complex fertilizers. This correction is linked to further significant falls expected in the nitrogen market and the softer outlook for ammonia. Potash pricing, in contrast, has steadied. Demand for NPKs should play a significant role in phosphate pricing, given that price direction in that market has been split.

Sulphur: Softer pricing is expected in the short term. Demand will slow while Chinese buyers and those in associated markets celebrate the lunar new year. This will leave traders looking to place uncommitted cargoes. Prices should rebound from February, given the depressed level of sulphur pricing relative to fertilizer prices. ■

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ARGENTINA

Walter Hernández (left), the CEO of El Parque Papas, with Yara CEO Svein Tore Holsether (right).

PHOTO: YARA

Yara to supply green fertilizers for potato growing

Yara International is to supply fossil-free fertilizers to El Parque Papas, Argentina's largest potato grower, in 2023.

Former racing driver Walter Hernández, the CEO of El Parque Papas, and Yara's CEO Svein Tore Holsether met in Oslo in early December to cement the deal and sign a memorandum of understanding. The new agreement marks the first step towards the decarbonisation of potato production in Argentina.

Yara is on track to start producing fossil-free fertilizers later this year. These will use green ammonia as their starting material. This will be manufactured from green hydrogen generated via water electrolysis using renewable electricity. By eliminating the use of natural gas feedstocks and the steam methane reforming (SMR) process, these fossil-free fertilizers have the potential to significantly reduce the carbon footprint of food and farming.

Yara calculates that the use of its green fertilizers for potato crop nutrition will cut greenhouse gas (GHG) emissions at farm level by around 29 percent, versus standard fertilization practice. Green fertilizers will also reduce the overall carbon footprint of consumer snacks like potato chips (crisps) by around 5-10 percent.

"Most people probably don't think about emissions when eating their chips. But there are huge opportunities to decarbonize snacks, if we find business models that enable each step of the value chain to contribute and to benefit. This is why the agreement between Yara and El Parque papas is important – we show that this can be done," said Svein Tore Holsether, Yara's CEO.

El Parque Papas is Argentina's single biggest potato farmer. The company supplies 14,000 tonnes of potatoes to Argentinian food processors every year. These are used to produce some of the country's most popular potato chips.

"Mass production of potato chips is actually a very complex operation involving many elements. My mission is to introduce a completely green, emission free potato in 2024. To do that, every company in the supply chain must take climate action. Collaboration is the only way to ensure that the end-product is climate neutral. A farmer can only do so much. Yara helps us make the last piece of the puzzle emissions free – the fertilizer itself," said Walter Hernández, the CEO of El Parque Papas.

Yara has been pioneering the introduction of green fertilizers to the market. The Norwegian production giant plans to start manufacturing these this summer.

The company signed the world's first commercial contract to sell fossil-free fertilizers to Lantmännen, a leading European agricultural cooperative, in January 2022 (*Fertilizer International* 506, p8). These will be produced by Yara and marketed by Lantmännen in Sweden later this year.

The manufacture of green fertilizers will be completely powered by renewable electricity. The result will be nitrate-based fertilizers with an 80-90 percent lower carbon footprint. These carbon savings will be validated by DNV, an independent assessor, using an established and reliable product carbon footprint (PCF) method.

Yara's first fossil-free fertilizer deliveries will use green ammonia sourced from a large-scale pilot project at the company's Porsgrunn plant in Norway. This is on track to begin commercial production in 2023. Porsgrunn will initially produce around 20,000 tonnes of green ammonia annually. This volume will then be converted into 60,000-80,000 tonnes of fossil-free green mineral fertilizer.

Yara should be well-positioned to scale-up green ammonia manufacture in future from its portfolio of under-development projects in Norway, the Netherlands and Australia. The company is planning to convert its entire Norwegian Porsgrunn plant to green ammonia within the next 5-7 years and is also actively expanding its clean ammonia business internationally. ■

WORLD

Fertilizer price falls expected in 2023

Fitch expects most fertilizer prices to fall in 2023. They will, however, stay above their mid-cycle levels, the US credit rating agency is predicting.

Fitch linked the continuation of historically high fertilizer prices to elevated natural gas costs and restricted – if improving – fertilizer supply. Crop prices are also expected to remain high this year.

The agency's assumptions for both potash and diammonium phosphate (DAP) prices in 2023 were unchanged in its recent December assessment. These are forecast to be lower than in 2022 for DAP and sharply lower for potash.

Although Chinese DAP exports are likely to recover over the next two years, Fitch still expects these to be two million tonnes below their 2016-2021 annual average when they stabilise in 2024.

"Phosphate demand will partially recover in 2023, returning to its 2021 level by 2024 as application rates rise next year. European demand is affected by a regional price premium," Fitch said.

"Our assumptions for phosphate rock continue to reflect limited export volumes from Morocco. But other producers, such as Jordan, Syria, Tunisia and South Africa, are gradually increasing their market shares," the agency added.

Fitch is forecasting that seven million tonnes of extra phosphate production capacity will arrive in 2023 – mostly located in Russia, Egypt, China, and the US.

In contrast to potash and DAP, Fitch's December assessment revised urea price expectations downwards due to new capacity expansion estimates. The agency is now forecasting the arrival of 3.8 million t/a of new global urea production capacity (excluding China) in 2022 with the addition of a further 3.2 million t/a in 2023 and 2.2 million t/a in 2024.

Fitch expects urea prices to have averaged $630/t in 2022.

"Our reduced 2022 assumption for urea reflects lower year-to-date prices, which we do not expect to recover for the rest of the year 2022," Fitch said. "We have kept all other assumptions unchanged as we maintain our view that new capacity additions will offset lost exports from China and supply disruptions due to the Russia-Ukraine war."

Ammonia prices should fall this year, forecasts Fitch, as supply constraints ease with the arrival of new Middle East capacity, and because of falling gas feedstock prices, and the restart of some previously idled European plants. Ammonia demand in 2023 should be supported by better affordability and strong crop prices, Fitch suggested.

UKRAINE

Resumption of Russian ammonia exports discussed

A deal to resume Russian ammonia exports via Ukraine looked imminent at the end of November, according to the UN's aid chief.

Martin Griffiths, Under-Secretary-General for humanitarian affairs and emergency relief at the UN's Office for the Coordination of Humanitarian Affairs (OCHA), told *Reuters* on 30th November that a deal was "quite close" and could happen within weeks.

"[If] we do not do fertilizers [exports out of Russia] now, we will have a food availability problem in a year. So, it is hugely important, almost more important than grain," said Griffiths. "Everybody understands that the operation of the ammonia pipeline from Russia through Ukraine to the port of Odessa … it can be started within a week or two."

The closure of the Russian pipeline and Black Sea ports on the 24th February last year resulted in the loss of around 200,000 tonnes/month of Russian ammonia exports to the global market (*Fertilizer International* 507, p8). Buyers in Morocco, Turkey, Bulgaria, and India, who previously relied heavily on Russian ammonia, have been forced to find alternative suppliers.

Speaking to the *Financial Times* in mid-December, Russian fertiliser billionaire Dmitry Mazepin called on global commodity traders to back a deal to resume Black Sea ammonia shipments.

A UN- and Turkish-brokered deal between Russia and Ukraine in July last year – subsequently renewed in November – opened the way for exports of previously blockaded Ukrainian grain. This agreement also included a pledge to restart exports of ammonia, according to Mazepin.

He told *Financial Times* that he had personally discussed the plan with Russian president Vladimir Putin at a meeting in November: "I asked for help, through diplomatic channels, to once again revisit those agreements that were signed in Istanbul regarding the grain deal to open ammonia."

The proposal from Mazepin, the founder and former owner of Russian nitrogen producer Uralchem, involves restarting the pipeline connecting the company's massive TogliattiAzot (TOAZ) ammonia production complex in Russia to the Ukrainian port of Yuzhny (*Fertilizer International* 507, p8).

Mazepin said ammonia exports via

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PHOTO: MAJUNOW1/ISTOCKPHOTO.COM

The use of sulphur containing fertilizers is on the increase in the US.

Ukraine could resume immediately with about 80 percent of output going to African countries. "We are ready to resume pumping," he said.

UNITED STATES

Strong demand for organic NPK pellets

Australian-listed phosphate producer Fertoz Limited has secured orders for 18,000 tonnes of its new 'Fertify' fertilizer pellets for delivery by April 2023. These blend and pelletise rock phosphate with organic chicken litter and other constituents to create an organic NPK product.

Fertoz plans to commence production of Fertify pellets in January at a plant constructed in Montana under a joint venture agreement with local company Excel Industries. Fertoz has invested $1.28 million developing the 80,000 t/a capacity pelletising plant. According to the company, the Montana production site is well situated for the cost-effective sourcing of key ingredients, including rock phosphate from Fertoz's nearby mines.

The NPK pellets contain 40 percent phosphate rock with Fertoz targeting customers in the North American organic and regenerative agriculture market. The company says it will accept more orders for Fertify as soon as extra production capacity becomes available.

"We are extremely pleased with the response by the market to Fertify which has quickly exceeded production capacity in the first four months of planned operations," said Daniel Gleeson, Fertoz CEO. "This early demand reflects need for the high-quality, value-added product we had envisioned for the market and look forward to making this available more broadly as the demand continues to grow."

Fertoz has also signed a 10-year offtake agreement with an unnamed North American fertilizer manufacturer for 120,000 tonnes of rock phosphate. The company says it on track to deliver around 40,000 tonnes of Fertify to customers in 2023.

Midwest sulphur fertilizer use increasing

The use of sulphur fertilizers is increasing in the Midwestern US, according to research published in *Communications Earth & Environment* in December.

The scientific paper compared sulphur fertilizer application rates across 12 Midwestern states with the declining rates of atmospheric sulphur deposition. The researchers from the University of Colorado and Syracuse University found that almost all the decline in atmospheric sulphur deposition was being replenished by the field application of sulphur fertilizers

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

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

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

CHINA

Stamicarbon secures largest ever Chinese urea project

Stamicarbon has won a contract for a large-scale urea project in China.

The urea plant, with a production capacity of 3,791 tonne/day, will be the largest ever licensed by Stamicarbon in the country. The customer, the plant's location and the value of the contract have not been disclosed.

The contract covers technology licensing, the plant's process design package (PDP), and the supply of proprietary equipment in Safurex®. The urea plant will be integrated with a dual-line melamine plant, making Stamicarbon's know-how on coupling urea and melamine plants of vital importance to the project.

The urea plant will have the capacity to provide 1,133 t/d of feed to the coupled melamine plant and manufacture 1,560 t/d of urea prills and 1,098 t/d of urea granules. This will allow the plant to serve three critical industries in China – being configured to produce urea prills, potentially urea granules, and even diesel exhaust fluid (DEF).

"We are proud to be part of this remarkable project that will bring forward best-in-class urea and melamine production in China," said Pejman Djavdan, Stamicarbon's managing director. "It is a genuinely solid project with an innovative concept that is bound to add value to the community and the region at large."

This contract was one of a tranche of new contracts announced by Maire Tecnimont Group at the end of December. The new contracts, worth $280 million in total, were secured by its wholly-owned subsidiaries Tecnimont, KT-Kinetics Technology and Stamicarbon from clients in North America and Latin America, Africa and the Far East. They include awards for process licensing and a range of services for engineering, procurement and construction.

"These new value-added, higher margins contracts further consolidate our Group's positioning in the global natural resource transformation market and provide strong evidence of the resilience of our technology-driven business model, leveraging on our companies' distinctive competencies," said Alessandro Bernini, Maire Tecnimont's CEO.

BRAZIL

EuroChem exports Salitre phosphate rock

In a first-of-its-kind delivery, EuroChem exported 22,000 tonnes of phosphate rock from its Serra do Salitre mine to Europe in January, via the port of Açu in Rio de Janeiro state.

The shipment is being delivered to Antwerp in a deal between EuroChem Brazil and EuroChem Belgium, according to Argus Media. On arrival, the beneficiated phosphate rock concentrate is likely to be consumed as a raw material by EuroChem's European fertilizer production units.

The port of Açu is pursuing a strategic expansion of its fertilizer operations. January's shipment is part of new export agreement between the port and EuroChem that is due to last until mid-2024. Açu expects to export a total of 100,000-130,000 tonnes of phosphate rock to Antwerp in 2023.

To help boost fertilizer exports, Açu port is tripling storage capacity at its multi-cargo terminal by opening two new warehouses in the first half of 2023. This will expand covered storage at the port from one warehouse with a capacity of 25,000 tonnes to three warehouses with a combined capacity of 75,000 tonnes. The new warehouses will provide an additional 550,000 t/a of operational capacity for fertilizers.

EuroChem is beneficiating phosphate rock at its Serra do Salitre project in Brazil's Minas Gerais state. Salitre was bought from Yara by the Swiss-headquartered but largely Russian based producer in February 2022 (*Fertilizer International* 507, p58).

The project's mine and beneficiation plant are fully operational with fertilizer production scheduled to begin in 2024. EuroChem expects Serra do Salitre to eventually reach an annual production capacity of one million tonnes for finished phosphate products such as MAP/NP and TSP/SSP.

Brazil's phosphate rock imports rose six percent year-on-year to reach 1.9 million tonnes in 2022, according to Argus Media. Imports were mainly sourced from Peru, Egypt and Morocco, with these three countries accounting for 50 percent, 18 percent and 14 percent of import volumes, respectively. Brazil itself exported 722,200 tonnes of phosphate rock in 2022 – mostly to Paraguay – a huge hike on the 100,600 tonnes exported in 2021.

CANADA

Mosaic temporarily curtails Colonsay

The Mosaic Company announced a temporary production curtailment at its Colonsay potash mine in Saskatchewan in early December.

The Florida-headquartered producer said its potash inventory levels were enough to cover near-term demand, as this had been slower than expected in the second half of 2022.

Colonsay had been operating at an annual production output of 1.3 million tonnes prior to the curtailment, with plans to expand this to 1.8-2 million tonnes by late 2023 following the restart of the mine's second mill. Mosaic says it will continue with underground development work to allow the restart of both of Colonsay's mills in early 2023.

"Our decision to temporarily curtail Colonsay reflects near-term dynamics and not long-term agricultural market fundamentals. Crop prices remain strong and continue to support healthy grower economics," said Joc O'Rourke, Mosaic's president and CEO. "After a year of reduced applications, we believe farmers are incentivised to maximise yields, which should drive significant recovery in fertilizer demand in 2023."

Post-harvest applications of potash have fallen behind in the US, according to reports, with late harvesting in some areas in 2022 lessening demand. Slow barge transportation due to low river levels has also left significant carryover inventory in places. Nola potash barge movement are reported to have been increasingly thin during the 2022 fall application season.

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People

Håkon Reistad Fure stepped down from Yara International's board of directors in mid-November due to new professional commitments, the company has announced.

Rohit Bhardwaj and **Paul Householder** joined the board of directors of Ag Growth International (AGI) in early November. Paul's directorship follow his appointment as AGI's new president and CEO at the end of September. He was previously the COO of the company.

Commenting on the appointments, AGI's chair Bill Lambert said: "We are thrilled to have Rohit and Paul join our board. We are confident they will provide valuable perspectives as we continue to execute our strategy, drive organic growth, and enhance value for AGI shareholders."

Paul Householder joined AGI in 2019 as International EVP with responsibility for leading all aspects of AGI's businesses outside of North America. Paul's responsibilities later expanded to include AGI's North American business when he was promoted to EVP for Global Operations in 2020. Mr Householder subsequently become AGI's COO in 2021, providing day-to-day strategic, organisational, and administrative leadership. He finally became the company's president and CEO in September 2022.

Prior to AGI, Paul spent 28 years at Air Products and Chemicals where he held several executive positions. These included general management and global leadership roles – with a focus on continuous improvement, business development, sales, and engineering. Paul holds a BSc degree in mechanical engineering from Lafayette College and an MBA from Lehigh University. He has also completed Harvard's Executive Leadership Program.

"Paul's recent appointment as president and CEO of AGI demonstrates the confidence that our board has in his ability to lead AGI through our next phase of growth," said Bill Lambert. "His extensive operating experience will provide valuable insight to the board and further strengthen our ability to accelerate execution of key growth objectives."

Rohit Bhardwaj has more than 25 years of business experience in listed multinational companies. Rohit is currently the CFO of Chemtrade, having joined the company in 2006, where he oversees the finance, information technology, investor relations, corporate development, and legal departments. He previously held several executive positions at Inscape Corporation.

Rohit is a Certified Management Accountant (UK), a fellow of the Chartered Association of Certified Accountants (UK) and a Certified Public Accountant (CGA). He has an MBA from the Kellogg School of Management (Northwestern University) and the Schulich School of Business (York University).

"Rohit is a seasoned executive who will contribute significant experience in managing international operations in addition to providing strong financial oversight," said Bill Lambert. "These are key board skills that will help enable AGI to deepen the level of integration and optimization across many of our businesses."

OBITUARY

Ron Pustjens, Stamicarbon process engineer has unfortunately passed away

Shortly after publishing the well-received article 'Stepwise approach to revamping urea plants' in our July/August 2022 magazine (*Fertilizer International* 509, p48), Stamicarbon process engineer Ron Pustjens passed away, aged 38. Ron was a highly respected colleague with an outstanding commitment to revamping urea plants. Ron is survived by his wife Irene and their two children. He is dearly missed.

Calendar 2023

FEBRUARY

6-8
IFA Smart & Green,
Virtual Event
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

27-1 MARCH
CRU Phosphates 2023 Conference & Exhibition, ISTANBUL, Turkey
Contact: CRU Events,
Chancery House, 53-64 Chancery Lane, London WC2A 1QS, UK.
Tel: +44 (0)20 7903 2444
Fax: +44 (0)20 7903 2172
Email: conferences@crugroup.com

MARCH

6-8
CRU Nitrogen+Syngas 2023 Conference & Exhibition,
BARCELONA, Spain
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup.com

27-29
IFA Global Sustainability Conference,
Virtual Event
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

MAY

22-24
IFA Annual Conference 2023,
PRAGUE, Czech Republic
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

JUNE

9-10
46th AIChE International Phosphate Fertilizer & Sulfuric Acid Technology Conference, CLEARWATER, Florida, USA
Contact: Bob Andrew,
Clearwater Convention chair
Email: vicechair@aiche-cf.org

OCTOBER

17-19
Argus Fertilizer Europe Conference,
LISBON, Portugal
Contact: Argus Media
Tel: +44 (0)20 3923 0741
Email: conferencesupport@argusmedia.com

The year ahead – affordability vital

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 2023.

SOURCE: MANHHAI/FLICKR

Ukrainian soldiers inspect destroyed Russian armour in Bucha, Ukraine.

The world economy – recessions ahead

The macroeconomic outlook for 2023 is particularly weak. Rabobank, for example, expects global growth in 2023 to fall to a mere two percent, with many economies entering recession. Inflation, while expected to fall in 2023, will also stay elevated.

"2022 is unfolding as a terrible year for the world economy," commented Rabobank at the end of last year. "The war in Ukraine, with a big inflation shock in its wake, ongoing lockdowns, a real estate crisis in China, and central banks around the globe rapidly tightening policies, are all starting to take their toll."

The world economy is now experiencing a broad and sharp slowdown, says the IMF, with inflation higher than seen in several decades. It expects global growth to slow from 6.0 percent in 2021 to 3.2 percent in 2022 and 2.7 percent in 2023. This is the weakest growth trajectory of the last twenty years, except for the global financial crisis of 2008 and the acute phase of the Covid-19 pandemic.

The IMF currently forecasts that global inflation will rise from 4.7 percent in 2021 to 8.8 percent in 2022, before falling back to 6.5 percent in 2023 and to 4.1 percent by 2024.

"The cost-of-living crisis, tightening financial conditions, Russia's invasion of Ukraine, and the lingering Covid pandemic all weigh heavily on the outlook," comments the IMF.

Fertilizer market turmoil

The fertilizer market has not been immune to these shocks and has undergone months of turmoil since Russia's invasion of Ukraine in February 2022. The threat of severely restricted global supplies led to fertilizer prices rocketing to all-time highs in May 2022 (*Fertilizer International* 508, p4). This was part of wider volatility in global commodity markets driven by the threat of energy, fertilizer and food disruption.

Following last February's invasion, the fertilizer market faced uncertainty over Russia's ability, as a major international market supplier, to export fertilizers – due to sanctions on Russian companies, individuals, entities and its banking sector. Market uncertainty in 2022 was exacerbated by factors such as[1]:

- The international shortfall in Belarusian potash supply following the imposition of sanctions on that country in 2021
- China's imposition of export restrictions on nitrogen and phosphate fertilizers
- The widespread third-quarter ammonia plant shutdowns in Europe provoked by unprecedented natural gas prices.

Not all these disruptions were a result of the war in Ukraine, as the International Fertilizer Association (IFA) has pointed out[1]:

"Fertilizer markets have been in a tightened state since the onset of Covid-19, when a renewed emphasis on food security globally, and strong agricultural fundamentals, led to record fertilizer use. Supply disruptions also occurred in this period, with unplanned plant outages, rising raw material costs and sanctions on Belarus."

International benchmark prices for phosphate fertilizers and potash have fallen back since the second-quarter of 2022. Nitrogen prices, although more volatile, also fell overall between May and October 2022[1].

By the end of 2022, fertilizer prices had returned to 2021 levels. Nonetheless, they remain above pre-2020 norms currently, inflated by high production costs and tight supply. IFA has linked fertilizer price volatility since May 2022 to a competing set of market loosening and market tightening drivers[1]. Market loosening factors include:

- Record nitrogen and phosphate output in Russia, contrary to earlier expectations
- Delayed and reduced buying interest for phosphate fertilizers and potash due to poor affordability

While the main market tightening factors include:

- The effects of record high European gas prices on the marginal cost of nitrogen production globally

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- Chinese nitrogen and phosphate fertilizer export restrictions
- The two-fold impact of sanctions on both Russian and Belarusian potash export supply.

Near record food prices

Food prices on an annual basis remain exceptionally high. The FAO Food Price Index (FFPI) averaged 143.7 points in 2022, up by 14 percent on the 2021 average (125.7 points).

Having peaked at around 160 points – a new all-time record – earlier in 2022, the FFPI then fell nine consecutive months in a row to average 132.4 points in December. This value was, however, still only slightly below the December 2021 average (133.7 points), the previous end-of-year record (*Fertilizer International* 506, p13)

The FAO's cereal price index averaged 154.7 points last year, a new record high and around 18 percent up on its 2021 average. It surpassed the previous annual average record, dating from 2011, by nine percent. The index was boosted by a host of factors, including market disruption and uncertainty, higher energy and input costs, adverse weather, and strong global food demand. Average world maize and wheat prices both reached new record highs in 2022, while rice export prices were on average three percent above their 2021 level.

The vegetable oil price index declined to an average of 144.4 points in December, its lowest level since February 2021. However, the index still averaged 187.8 points for 2022 – up by 14 percent on the 2021 average to set a new record annual high.

The sugar price index rose to its highest level in six months to average 117.2 points in December. Higher international sugar price quotations were linked to concerns about the impact of adverse weather on crop yields in India, the world's second largest sugar producer, and sugarcane crushing delays in Thailand and Australia. The index for 2022 as a whole averaged 114.5 points – up by five percent on 2021 and the highest annual average since 2012.

Ag commodities look bearish

Rabobank, in its annual outlook, is taking a generally bearish view on agricultural commodities. Its two main assumptions are that better weather conditions will prevail in 2023, with an expectation that La Niña will "go away" early on, and that demand will be hit by the recessionary economic outlook. However, the bank also warns of the potential for price volatility ahead, if the weather does not normalise as expected, and given the generally low levels of commodity stocks in exporting countries.

While the high ag commodity prices seen currently would normally stimulate supply, agricultural output is relatively inelastic to prices at present due to the following factors:

- Limited growing area availability – as swathes of very fertile Ukrainian crop land have been lost
- Farm input costs are high
- La Niña is active
- Farm financing costs have increased.

This has placed more pressure on a fall in ag commodity demand to balance the equation. A global recession, suggests Rabobank, would limit demand on many fronts, affecting both feed and energy-related agricultural commodities as well as 'non-essentials' such as cotton, coffee and cocoa.

"Here we start to see some weakness that might continue through much of 2023," comments Rabobank. "Global inflation has resulted in a loss of purchasing power globally, and subsequent hikes in interest rates could result in some major economies going into recession."

Fertilizer demand

The fertilizer demand outlook is once again dominated by fertilizer availability and affordability concerns – echoing last year's International Fertilizer Association (IFA) market assessment (*Fertilizer International* 506, p13)

If anything, affordability has become even more important in defining fertilizer consumption, although availability risks remain. Indeed, IFA expects fertilizer affordability to drive global fertilizer use over the three fertilizer years (FY) between 2021 and 2023. While fertilizers have become less affordable in general since 2021, price volatility – with large ups and downs – has also made the timing of fertilizer purchases critical[1].

Global fertilizer consumption looks set to fall by 4.8 percent during 2022, after a 2.4 percent decline in 2021, according to IFA's latest outlook (Figure 1). Combined, the drop in consumption over these two years comes close to the spectacular eight percent fall seen in 2008. Indeed, the expected decline in nutrient consumption ($N + K_2O + P_2O_5$) – 4.9 million tonnes in 2021 and 9.5 million tonnes in 2022 – would bring global fertilizer consumption back to its 2018 level of 188 million tonnes[1].

The most significant declines in fertilizer use are expected in 2022. In particular:

- Latin America is leading the decline, with an 18 percent year-on-year fall in consumption, due to affordability and weather issues
- Ukraine's fertilizer use has sunk due to the war
- In sub-Saharan Africa, many countries had not covered their annual fertilizer supply needs, in terms of inventories and market size, as of September 2022
- Turkey's fertilizer use has also fallen due a weakening lira.

A contraction in global cereal area and reduced fertilizer application rates also negatively affected fertilizer consumption in 2022. Farmers gave priority to nitrogen fertilizers over potash and phosphate products, for example, or skipped their second applications. This was accompanied by changes to the crop mix that favoured crops requiring less fertilizers and/or with an ability to generate higher revenues[1].

In particular, farmers have reduced the area planted to fertilizer intensive cereals and expanded the area planted to less fertilizer intensive soybeans. Globally, the International Grain Council expects cereals area to contract by 10.8 million hectares in 2022/23, while soybean area is expected to expand by 6.8 million hectare[1].

Looking ahead, IFA expects to see global fertilizer use partially recover to 194 million tonnes of nutrients during the fertilizer year 2023. This 5.9 million tonne year-on-year rise would return global consumption to just above 2019 levels. Nitrogen consumption in 2023 is expected to grow by two percent while P_2O_5 and K_2O consumption each look set to grow by four percent, suggests IFA[1]. In particular:

- Latin America is expected to lead the partial recovery in global fertilizer consumption in 2023, most visibly for P_2O_5 and K_2O
- South Asia (mainly India and Pakistan) is likely to make second largest contribution to the recovery in N and P_2O_5 consumption
- East Asia, meanwhile, is forecast to be the second largest contributor to K_2O consumption growth – driven by the two palm oil producing powerhouses Malaysia and Indonesia
- Africa, with an expected nine percent consumption rebound, is set to be the fourth largest contributor to global growth in N consumption in 2023.

Fertilizer supply capability

For its 2023 outlook, IFA has introduced a new supply measure known as 'capability'. This adjusts announced capacity developments using an effective operating rate based on historical trends. The resulting supply forecast is based on three scenarios: optimistic, middle ground and pessimistic. These scenarios assume different severities of impact for the following key fertilizer market influences[1]:

- The evolution of Russia's war in Ukraine
- Sanctions placed on Russia and Belarus
- Logistical ability of both Russia and Belarus to export to 'friendly' countries
- The introduction of protectionist policies (e.g. export bans) enacted by key food and fertilizer exporting countries
- The agricultural backdrop, particularly fertilizer affordability.

The 2023 supply capability forecast for all three major nutrients is summarised in Table 1.

The pessimistic and middle ground scenarios for nitrogen capability reflect a situation where European production economics, and the ability of Russia to export nitrogen products to the international market, either stay constant or deteriorate[1].

Phosphate capability was adjusted according to Russia's ability to export, and on the basis of European ammonia raw material costs. The optimistic and middle ground phosphate capability scenarios reflect the potential market upside for capacity expansions, while the pessimistic scenario reflects higher raw material costs and a worsening phosphate export situation[1].

Potash capability was adjusted according to the ability of Russia and Belarus to export, including the potential for overland trade from Belarus to China via Russia. The optimistic capability scenario includes the start up of two new potash mines in 2023, one in Russia and the other in Lao[1].

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 and the macroeconomic outlook
- 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 recycling

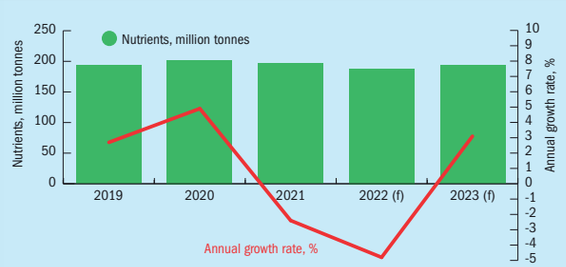
The importance of these factors varies from country-to-country and region-to-region. Adding to the complexity, these primary drivers are in turn influenced by a host of secondary considerations.

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 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.

Fig. 1: **World fertilizer consumption (nutrient tonnes) and annual growth rate: fertilizer year (FY) 2019-2023**



Note: 2022 & 2023 = Forecast *Source: IFA (November 2022)*

Table 1: **Year-on-year change in global nutrient supply capabilities, 2023 vs 2022, million tonnes**

	2023 supply capability		
Scenario	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
Optimistic	+1.1	+1.5	3.2
Middle ground	-1.8	0.9	1.7
Pessimistic	-5.8	-1.0	0.6

Source: IFA (November 2022)

References

1. IFA, 2022. *Short-Term Fertilizer Outlook 2022-2023.* Public Summary. IFA Market Intelligence Service, November 2022. International Fertilizer Association, Paris.

2023 MARKET OUTLOOK

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Turkey's fertilizer market

Turkey's thriving agricultural sector has created a large and dynamic fertilizer market at the crossroads of Europe and Asia, explains **Hakan Goral**, the CEO of Tekfen Agri Industry Group.

Turkish fertilizer production has roots dating back to the late 1950s when the government invested in and owned the industry. The private sector first entered the market in 1970s – and again in the early 2000s – with the privatisation sales of state-owned plants.

Currently, Turkey has seven major domestic fertilizer producers (Figure 1). The country's total fertilizer production capacity is around 7.5 million tonnes per annum. The production of phosphate and nitrate fertilizers predominates with capacities of around 3.7 million t/a and 2.3 million t/a, respectively.

Although Turkey's apparent fertilizer production is high, most of its manufacturing raw materials need to be imported, as domestic sources are either limited or not available. Natural gas, for example, is imported, while phosphate rock production is very limited. There are also no potash mines in Turkey.

Only three domestic plants in Turkey have a production capability for ammonia, with one each dedicated to nitrates, urea and phosphates production. These have a combined operating capacity of 830,000 t/a. Urea production is currently limited to one plant with a capacity of 560,000 t/a, although a second under-construction plant is expected to start production in 2023. Phosphoric acid is also a rare commodity in Turkey. Total production capacity of 510,000 t/a is divided across three plants, only one of which has its own dedicated phosphate mine.

Toros Agri, a subsidiary of Tekfen Holding, is the country's largest fertilizer producer with a total production capacity of two million t/a. This is divided between manufacturing operations at three plants located in Ceyhan, Mersin and Samsun. These produce ammonium nitrate (AN), calcium ammonium nitrate (CAN), diammonium phosphate (DAP) and compound NPKs. In a landmark move, the company introduced its first organomineral fertilizers to the market in 2017.

Fig. 1: **Turkey's main fertilizer producers**

Source: Toros Agri

1 Producer: **Ege Gübre**
Location: Izmir
NPK: 297 kt or DAP: 149 kt

2 Producer: **Bagfaş**
Location: Bandirma
NPK: 584 kt or DAP: 420 kt
AS: 264 kt
Phosphoric acid: 150 kt
NSP/TSP: 180 kt
CAN: 660 kt

3 Producer: **Gemlik Gübre**
Location: Bursa/Gemlik
AN/CAN: 594 kt
Ammonia: 363 kt

4 Producer: **Gübretaş**
Location: Kocaeli/Yarimca
NPK: 800 kt
TSP: 185 kt

5 Producer: **Igsaş**
Location: Kocaeli/Korfez
NPK: 225 kt
Urea: 560 kt
Ammonia: 396 kt

6 Producer: **Igsaş**
Location: Kütahya
CAN: 338 kt

7 Producer: **Toros Agri**
Location: Samsun
NPK/DAP: 654 kt
Phosphoric acid: 210 kt

8 Producer: **Toros Agri**
Location: Mersin
AN/CAN: 660 kt

9 Producer: **Toros Agri**
Location: Ceyhan
NPK: 660 kt or
330 kt NPK and
198 kt DAP

11 Producer: **Etibakır**
Location: Samsun
AS: 549 kt
DAP: 400 kt

10 Producer: **Etibakır**
Location: Mazıdağı
NPK: 750 kt or
DAP: 400 kt
Phosphoric acid: 150 kt
Ammonia: 75 kt

Product	Capacity, kT
Ammonia	834
Phosp. A	510
Urea	560
CAN	2,252
AS	858
DAP	734
NPK	2,979
TSP	185
Total (2022)	**7,568**

In terms of the balance between installed domestic capacity and fertilizer demand, Turkey is self-sufficient in NPKs with excess capacity, whereas it needs to import phosphate, urea and AS to meet its needs.

Turkish growers generally behave conservatively when selecting fertilizer products. Consequently, around 10 seller codes (SKUs) make up 95 percent of the total mineral fertilizer market. The preference for these fertilizer types and traditional buying behaviour have tended to act as a disincentive for research and development by Turkish producers and a barrier to investment in new fertilizer products. Toros has, nonetheless, pioneered Turkish fertilizer innovation by establishing the first certified R&D centre for plant nutrition in 2017.

Turkey's financial support for agricultural producers, as a share of gross farm receipts, is slightly above the OECD average. This is mostly in the form of market price support for products. The remaining sector support typically comprises of premium payments to specific agricultural commodity producers, area-based payments to farmers in the form of crop insurance, and farm payments to defray the cost of diesel and fertilizers. Fertilizer subsidies reached the equivalent of $11.2-24.6/ha (TRY21-46/decare in local currency) when fertilizers prices reached record high levels in 2022.

Organomineral fertilizers have been developed as a new product category in the last five years to address the general lack of organic matter in Turkish soils. These products incorporate organic material within mineral fertilizers. Studies have shown that organomineral fertilizers provide major yield increases and nutrient use efficiency improvements. Only Toros Agri uses compost as an organic source in the production of organomineral fertilizers. The company sources compost from its own biogas plants. These convert animal and agricultural wastes into biogas for electricity generation and produce organic material for composting.

Fertilizer tracking: a safe yet costly system

Turkey's Agriculture and Forestry Ministry signed a deal for a fertilizer tracking system for all fertilizers, especially for strictly controlled CAN fertilizers, in July 2017. In this system, all fertilizer bags have a QR code that can be traced back through the supply chain from farmer to dealer to producer. As well as QR codes, all nitrate fertilizers (and eventually all nitrogen fertilizers) also have a DNA marker to identify their origin. These markers are explosion-resistant and can therefore identify the origin of explosives even in the worst scenarios.

The first DNA-tagged products placed on the market were loaded from Toros Agri's Mersin plant in January 2018. Fertilizer tracking was subsequently completely integrated into other systems by March 2019. Since then, the tracking system has worked as planned, although it has introduced fertilizer sector costs which have then been passed on to farmers. For the 3.7 million tonnes of nitrogen fertilizers and 2.6 million tonnes of phosphate fertilizers sold in the market in 2021, for example, the total cost of fertilizer tracking system – paid for by farmers – was more than $35 million.

Currency shocks: a new normal in Turkish economy

With the country's current account deficit at elevated levels, the Turkish economy has remained fragile over the last decade. How to finance this deficit is now being questioned and become a hot topic for public debate. The Turkish people have survived two currency shocks in the last five years (Figure 2). Both shocks were particularly badly timed for farmers.

The first currency shock came in the summer of 2018. Following escalating tensions with US, the Turkish lira (TRY) lost its value against other currencies and the USD/TRY exchange rate, for example, increased to 6.88 from 4.88 in just 10 days. After this initial spike, currency levels hovered between 5-6 until the Covid-19 shutdowns in 2020.

The second shock started in the last four months of 2021 when the central bank of Turkey started to lower interest rates to stimulate the economy. As a consequence, the USD/TRY rate doubled from 8.2 to 16.4. The government subsequently intervened with several measures to con-

COUNTRY PROFILE

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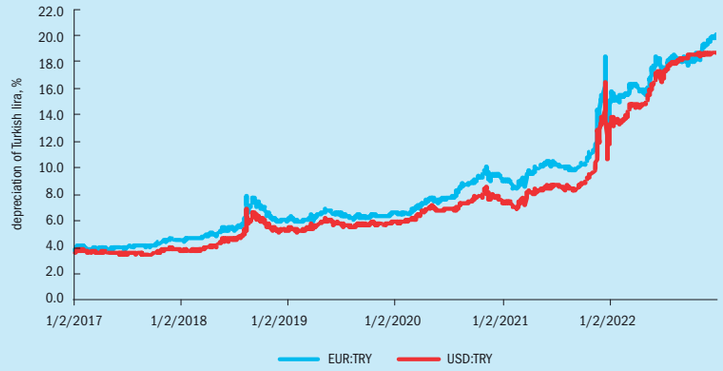
Fig. 2: **Depreciation of the Turkish lira (TRY) against the euro (EUR) and US dollar (USD), 2017-2022**



Source: market information

Both currency shocks had one common factor that badly affected agriculture: they both started after harvest time when farmers sell-off their products.

trol currency rates. Since then, the USD/TRY rate has followed a more stable path in 2022, although it has still been on an upwards trajectory – increasing from 13.3 to 18.7 over the course of the year.

Both shocks have one common factor that badly affected the agriculture sector: they both started after harvest time when most farmers sell-off their products. The second shock also had a major impact on fertilizer affordability for Turkish farmers as it coincided with a severe global fertilizer crisis – arguably the worst history – and record fertilizer prices. In the end, the Turkish agriculture sector survived this very harsh period of turmoil. After the good harvest and prices of 2022, some have forgotten the past rough watersand have increasing hope for the upcoming season.

Export ban: are we allowed?

The Turkish government gradually introduced an export ban on fertilizers in September-October 2021 and subsequently issued export permits for limited fertilizer formulations until May 2022. During May-September 2022, fertilizer companies were allowed to export up to 50 percent of their capacity. Then, from September 2022 to January 2023, only nitrate exports were allowed.

Export permissions, in terms of allowed products, capacities, and start/cut-off dates, have all changed several times since autumn 2021. Currently, export bans on both nitrate and phosphate products are in place – with no clear guidance on when or how this ban will end. This uncertain situation is preventing Turkish companies from making long term commitments and investment plans.

Toros Agri – sustainability and innovation

Toros Agri's mission, wherever it operates, is to help feed the world sustainably and ensure food security, as well as delivering long-term value, both for farmers and the whole of Turkish agriculture.

The company, as Turkey's largest fertilizer producer and a major regional player, is leading the way in diverse areas such as: responsible sourcing, production and use of fertilizers; the promotion of sustainable agricultural practices; digital farming; and long-term programmes that create social value.

When making new investment decisions and selecting innovative R&D projects, Toros Agri's makes environmentally conscious choices that increase agricultural productivity, help maintain ecosystems, and strengthen capacity for climate change adaptation.

Sustainability is a priority for Toros Agri. The company's innovative approach to plant nutrition embraces sustainable agricultural practices that create value for all its stakeholders in the long term.

Toros Farmers Academy: Toros Agri is helping Turkish agricultural development by offering a range of free services and training for framers. This includes assistance on efficient fertilizer use, balanced fertilization practices, and soil, leaf, and water analyses. To this end, Toros Agri also launched the Toros Farmers Academy (a mobile training bus) and agricultural technical and digital marketing projects in 2018.

Toros Farmer app: Toros Agri introduced its 'Toros Farmer' app in 2016 to ensure farmers will benefit from emerging digital technologies. This farmer-friendly, decision-support app is available as a free download for desktop computers, smart phones and tablets. The app combines weather forecasts with soil and plant data, monitoring these conditions on a field basis. By developing recommendations for farmer activities, the app is designed to help farmers make the correct production and operational decisions in a timely manner.

Women Farmers Loan project: Toros Agri is using its expertise and resources to help local farm communities. The Women Farmers Loan project, for example, is helping women who wish to work in agriculture but do not have the financial means to start their own businesses. It receives funding from the Tekfen Foundation and the Turkey Waste Prevention Foundation (TISVA). As part of this project, Toros Agri's expert agricultural engineers are providing women farmers with free basic agriculture training, health and safety training, and field support on crop fertigation. ■

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

PHOTO: ARGUS

More than 650 delegates from 326 companies and 56 countries gathered at the Hotel RIU Plaza España, Madrid, Spain, 17-19 October 2022, for the Argus Fertilizer Europe 2022 conference.

Deep transformation

Javier Goni, Fertiberia's CEO, placed Spain and the Spanish fertilizer industry centre stage in his impassioned opening keynote. Against a backdrop of unprecedented fertilizer market turmoil in Europe, Javier called for the "deepest transformation of our industry" in four priority areas – energy, sustainability, decarbonisation and nutrient use efficiency.

He admitted this was challenging given that, with huge market volatility currently, it was "difficult to say what happens next month".

This time last year, there was a view that, with the market still reeling from the aftereffects of the Covid-19 pandemic, the trading and operating environment could only improve during 2022. Then the Russia-Ukraine conflict began.

The impacts of this conflict on Europe over the last 11 months have been – to use one of 2022's most repeated words – unprecedented. By September last year, around 65-70 percent of European ammonia production capacity was down, due to rocketing natural gas costs and the loss of large-scale Russian gas imports (*Fertilizer International* 510, p8). Consequently, some 30-35 percent of the continent's downstream nitrogen fertilizer production capacity was also offline. Production is only now startling to resume again.

To some extent, Spain has been protected from this widespread European energy shock due to its low dependency on Russian natural gas. The country also benefits from having around 40 percent of the EU's regasification capacity. Spain has substantial and competitive solar and wind energy generation capacity too – this accounting for 40 percent of the country's electricity generation.

Spain's status as an agricultural powerhouse has helped make the country's fertilizer industry particularly pioneering and innovative, Goni suggested. Spain is "Europe's orchard" with favourable soils and climate conditions, he said, and some of the world's most advanced crop growing systems and ag tech practices. The country has the world's third largest agricultural area under drip irrigation, for example, after India and China.

Spain's advanced agriculture sector, in turn, has created a substantial market for speciality and added-value fertilizer products.

Fertiberia, as its name might suggest, is the largest fertilizer producer on the Iberian peninsular, with 14 production assets in Spain, Portugal and France. Speciality products already generate 55 percent of company revenues, up from 25 percent just five years ago. These include a portfolio of nitrates, water soluble and liquid fertilizers for drip irrigation, together with biostimulants, biofertilizers and nitrogen protection products.

The company is also a green ammonia pioneer operating one of the world's largest production systems at its Puertollano site in Spain. The green hydrogen plant at Puertollano comprises a 100 MW photovoltaic solar plant, a lithium-ion battery system with a storage capacity of 20 MWh, and a large-scale 20 MW capacity electrolyser.

Fertiberia's ultimate ambition, says Javier Goni, is to fully decarbonise its supply chain and offer the market low carbon fertilizers as an alternative to the energy intensive commodity fertilizers that currently predominate.

Market insights

This session outlined the macro-economic and geopolitical events shaping the fertilizer raw material and finished product markets. **Lawrence Templeton**, business development VP for European gas, power and LNG at Argus, kicked off by providing a detailed update on Europe's natural gas market – with a focus on drivers and trends for the leading Title Transfer Facility (TTF) price benchmark.

During the course of last year, forward TTF prices eventually rose above €200/Mwh as the European gas supply picture became increasingly tight and inflexible, a price hike that was linked to Russian supply dwindling to below 100 mcm/day from late 2021 onwards. This tight supply situation has prompted a reconfiguration of the European gas market towards liquid natural gas (LNG) imports. (Spain, as an LNG peninsular, has had a role to play in this by re-exporting LNG to France.)

The TTF price moved above the LNG price from May 2022 and, as a result, destination pricing for US LNG favoured Europe over the summer. Europe's growing hunger for LNG has since been accommodated by new import capacity in both the Netherlands and Germany.

Oliver Hatfield, VP for business development at Argus, followed up with an overview of the global fertilizer market situation. This was illustrated by a summary of recent price developments for three key f.o.b. fertilizer benchmarks – urea granular Middle East, MOP bulk Vancouver and DAP bulk Morocco.

Fertilizer demand growth moved ahead of supply, as the world economy restarted post-Covid, turbocharging fertilizer prices, Hatfield noted, although these increases still lagged crop price rises. More recently, however, prompted by the start of the Russia-Ukraine conflict, inflated fertilizer prices have raced ahead of crop prices to affect fertilizer affordability. This has led to demand destruction putting a brake on fertilizer consumption. "The cure for high prices is high prices – that old market adage," commented Hatfield.

Urea price volatility has been one notable consequence of the Russia-Ukraine conflict. Europe has been 'self-sanctioning' by absenting itself from the market for Russian product. Consequently, it has been paying higher prices than other buying regions and countries such as Brazil.

As a Baltic supplier with fewer destinations, Russia has discounted its urea prices. However, the volume of Russian urea supply has remained robust, contrary to initial expectations, and is actually up year-on-year. The export route for Russian urea has changed in response to the conflict with Ukraine, exiting via Black Sea ports rather than through EU ports.

At the time of the conference, European nitrogen fertilizer closures had removed about one third of production capacity. The shuttering of urea production plants was essentially a function of EU production costs exceeding urea import costs (e.g., for Egyptian sourced product). With the loss of Russian urea, Europe has a supply gap to fill or around one million tonnes per month. We should therefore expect to see some demand destruction in Europe, Hatfield suggested, as the market would not be able to replace all of this supply shortfall.

Corporate buyers panel discussion

In this moderated session Oliver Hatfield, sat down to discuss commodity procurement challenges with **Hugo Carrasaco**, the head of Europe at Sulphur Mills Ltd, and **Marc Ostwald**, chief economist and global strategist at ADM Investor Services.

Sulphur Mills has a dual perspective on procurement being both a sulphur buyer and an Indian-based sulphur producer, while ADM Investor Services is the clearing and execution arm of Archer Daniels Midland, the Chicago-headquartered commodities trading giant.

Energy makes up big part of the production costs for a low-cost commodity like sulphur, Hugo Carrasco said, while purchasing power has also decreased due to interest rate rises. Freight cost volatility is another major variable in sulphur trading. "Freight can really upset price when it's up to 20 percent of cost," Carrasaco said.

Marc Ostwald highlighted what he called the "misallocation of investment in productive oil and gas capacity". This has however left opportunities for digitalisation and automation of the petrochemicals industry.

Underinvestment in [oil and gas] capacity is an additional problem linked to the unfavourable financing conditions created by central banks, suggested Ostwald. "Central banks don't understand supply chains. The post-crash era of low interest rates is now at an end – we're entering a more volatile era instead," he said.

There has been a change of behaviour by Gulf Cooperation Council (GCC) countries though. Oil and gas companies in the region are "going upstream and downstream to capture margins", according to Ostwald. This should stabilise sector margins in the longer term in his view.

When asked how long commodity market turmoil would last, Marc Ostwald replied: "At least another 18 months, although that may need to be extended." Hugo Carrasco agreed, saying commodities would take "at least another 1-2 years to stabilise".

Renewable energy in fertilizer production

Participating in this panel discussion were:

- **Marco Van Doorn**, Fertiberia's head of green developments in hydrogen, ammonia and fertilizer
- **Jacob Hansen**, the director general of Fertilizers Europe
- **Cleiton De Sequira**, the director of business development for the US start-up Nitricity
- **Prashant Chaubey**, the president of Indian-headquartered Avaada Energy.

Fertiberia is the first fertilizer producer in the world producing green ammonia at scale, said Van Doorn. This has been manufactured since May 2022. The company is currently developing two other world-scale green ammonia projects and is targeting full decarbonisation of production by 2035.

Avaada is an integrated energy group benefiting from India's conducive policy for green ammonia, said Chaubey. The company currently has a four million tonne capacity green ammonia project pipeline – with one million tonnes of this capacity already being executed.

Nitricity is introducing disruptive technology to the fertilizer industry that is capable of electrifying and distributing nitrogen production, explained De Sequira. Its on-farm fertilizer production systems, which generate nitrates from a plasma reactor powered by renewable electricity, should help cut production emissions by eliminating fossil fuels, and improve global food security and food equity, in his view.

Europe has decided it wants a green hydrogen economy, commented Hansen. "It's exciting that ammonia will be the workhouse and carrier for that," he said. "Yet it is not realistic for Europe to be self sufficient in green ammonia currently – imports and trading will be necessary."

He added: "The political message is clear – Europe will have to import 10 million tonnes of green hydrogen [annually] by 2030. That will have to be imported as green ammonia."

To this end, Fertilizers Europe is currently working on a certification scheme for low carbon ammonia. "Flexibility is needed as grey, blue and green ammonia will be produced initially," commented Hansen.

The lesson of the Russian-Ukraine conflict, in Hansen's view, was Europe's need for strategic autonomy and therefore its own green hydrogen production base.

CONFERENCE REPORT

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PHOTO: ARGUS

C-Suites from leading global fertilizer producers meet with Argus SVP, Tim Cheyne.

The Rhinefert Alliance

This presentation was jointly made by the three partners in the Rhinefert Alliance, a new European fertilizer distribution partnership:

- **Simon Rudiger**, business director at Triferto
- **Luuk Haagting**, product manager at Agrifirm
- **Christoph Leufen**, head of plant products at RWZ.

Netherlands-based Triferto trades 1.5 million tonnes of fertilizers annually. Agrifirm, in contrast, is a Dutch agricultural cooperative with more than 10,000 members and an annual turnover of €2.4 billion. It made sales of almost six million tonnes in 2021. RWZ (Raiffeisen Waren-Zentrale Rhein-Main eG), meanwhile, is Germany's third largest agricultural cooperative.

The Rhinefert Alliance was established in response to the following challenges and pressures faced by European fertilizer wholesalers:

- Concentration of supply
- Dropping sales
- New legislation and regulations
- Demand for new and innovative fertilizers
- Demand for sustainability projects
- Internationalisation of fertilizer supply
- The shift to integrated supply chains.

The Alliance began at the start of 2022. It enables Agrifirm to secure fertilizers from Triferto for its 10,000 members using shared logistics and warehouses. RWZ's distribution infrastructure in Germany and Luxembourg also complements and adds to Triferto's warehouse network in France, Belgium and the Netherlands.

The Alliance's three partners, by pooling their intelligence, can now gain a much wider and more holistic understanding of the European fertilizer market. As well as sharing useful information, the partners also benefit from a collective business strategy, access to joint warehouse locations and other shared assets as part of the Alliance.

Better fertilizer distribution planning is another key advantage of the Rhinefert Alliance. This is valuable as – for the first time – this properly joins up upstream fertilizer production volume plans (anticipated supply) with planning for the field application of fertilizers downstream (anticipated demand).

Fertilizer industry sustainability

In a session moderated by Oliver Hatfield, the industry's need for leadership on sustainability was discussed by:

- **David Herrero**, COO, Fertiberia
- **Brian Wade**, head of crop nutrients, Anglo-American
- **Naoufal Mahdar**, vice president, climate action & decarbonisation, OCP Group.

According to David Herrero, leadership on sustainability offers: "New opportunities to bring talent to the company and gain higher sales. Yes, being first movers is not without risk. But we believe in green ammonia as a long-term sustainable option for nitrogen. Securing partnerships also guarantees a staged approach to reduce risk."

"The climate emergency means there's no place for those born to be second: that's too much risk for the planet and business," said Naoufal Mahdar "We need to promote innovation from the start – offering fair and sustainable options for farmers."

Anglo American's under-construction Woodsmith project in the UK will generate a polyhalite product (POLY4) with the lowest per tonne carbon footprint of any fertilizer product, suggested Brian Wade. POLY4 would also be a zero waste, zero water product.

Anglo American, a company with a $40 billion turnover and more than 90,000 employees globally, is aiming to become carbon neutral by 2040. Eight mine sites are already on track to achieve this target by 2030 under the company's 'FutureSmart Mining' sustainability initiative. The company's flagship $5 billion Quellaveco copper mine in Peru, for example, is already fully electrified and digitised.

"With crop nutrients, Anglo is starting with a clean slate," said Wade, and given the company's targets and track record on carbon neutrality: "To put sustainability in place we don't need to reconfigure."

Oliver Hatfield asked the panel if decarbonisation would be costly and, if so, should the cost penalties be passed on to farmers. Would farmers be prepared to pay a premium for low carbon fertilizers, for example?

"It's more about business models than extra costs," said Mahdar. Carbon farming, for example, can generate extra revenues for farmers. OCP was already pursuing this by working with 1.5 million African small-scale farmers on carbon certification and soil mapping.

"I'd reframe the question – what's the cost of inaction not the cost of action?," said Wade, adding: "Agriculture is responsible for 30 percent of global emissions, so business-as-usual would use up the entire carbon budget to keep to 1.5 degrees of warming. Inaction therefore imposes costs on our customers – and our customers' customers."

Herrero agreed: "There's a need to change and act on climate change to secure food production and, as first movers, a huge investment effort [to decarbonise nitrogen production] is necessary. The lowest cost business model requires working with the whole value chain."

CEO roundtable

A conference highlight was the c-level roundtable on the event's first day. This generated an engaging and wide-ranging discussion on the sustainable production, trade and application of fertilizers – and how this can positively impact global food security. Argus Media would like to thank the following individuals for their fruitful participation: Javier Goni, CEO, Fertiberia; Motti Levin, CEO, Haifa; Marouane Amezaine, Managing Director Specialty Products, OCP; Sergio Atarés, Chief R&D and Planning Officer, Fertinagro; Antonio Sancho, CEO, Incro SA; Alexander Schmitt, CMO, Anglo-American; Tim Cheyne, SVP – Global Head of Fertilizers, Energy Transition.

Argus Fertilizer Europe 2023

Building on the success of Madrid's 2022 event, Argus Fertilizer Europe will be returning to Lisbon, Portugal, on the 17-19 October 2023 – dates to keep for your diary!

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Scrubbing technology: meeting the low emissions challenge

Fertilizer plant owners are installing highly efficient and reliable scrubbing equipment to satisfy increasingly strict emissions regulations globally. We highlight recent advances in scrubbing performance and technology.

STAMICARBON

Advanced scrubbing systems enter operation

Wilfried Dirkx, licensing manager

PHOTO: STAMICARBON

The granulator, quench vessel and advanced MicroMist™ Venturi (MMV) scrubbing system installed at DCG's Beulah urea plant in North Dakota.

Stamicarbon, the innovation and license company of Maire Tecnimont Group, offers advanced scrubbing technologies for fertilizer granulation plants and prilling towers. This case study describes the performance of the MicroMist™ Venturi (MMV) scrubber installed at the large-scale urea granulation plant operated by the Dakota Gasification Company (DGC) at Beulah, North Dakota.

Emissions regulations – particularly those regulating fine particulate emissions – are becoming increasingly strict globally. This has created a need for new scrubbing systems able to capture and remove sub-micron dust particles.

In response to this challenge, Stamicarbon and its partner EnviroCare International have jointly developed the MMV scrubber for granulation plants and the Jet Venturi (JV) scrubber for prilling towers. Both wet scrubbers have been shown to effectively remove sub-micron particulates and soluble gases. Advantageously, they operate at very high efficiencies with low energy input and reduce liquid waste generation.

Two of Stamicarbon's MMV scrubbers are currently in operation at urea granulation plants, with a further three at the construction and start-up phase currently.

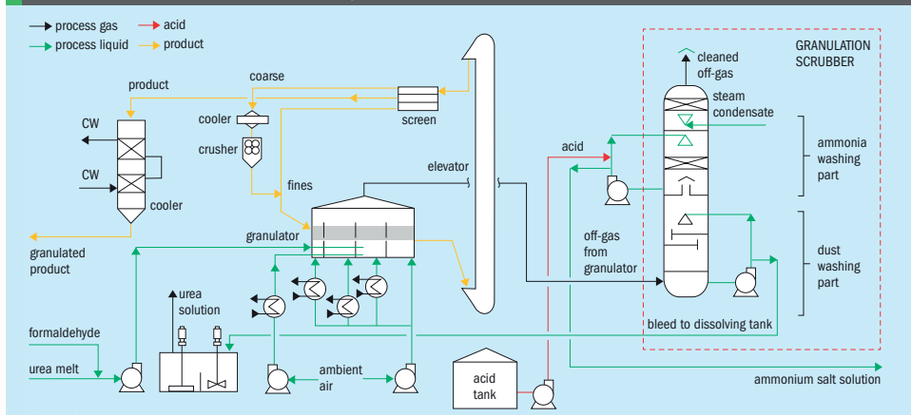
DGC's urea granulation plant

Stamicarbon signed a license agreement with the Dakota Gasification Company covering the construction of a brownfield urea melt, granulation, and diesel exhaust fluid (DEF) plant near Beulah, North Dakota, in the United States. The 1,000 tons/day capacity urea plant employs Stamicarbon's state-of-the-art Launch Melt™ Pool Reactor technology and optimised Launch Finish™ Fluid Bed Granulation technology.

The granulation plant installed for DGC (Figure 1) was designed to minimise the number of equipment items while maintaining its original high-performance specification. At the plant, solid products generated by the granulator are screened, cooled, crushed and stored as follows:

- The complete solid product flows through the main screens under gravity.
- The coarse product is fed to the crusher after cooling to a temperature of 70°C.

Fig. 1: **Process schematic of the granulation plant installed for the Dakota Gasification Company at Beulah, North Dakota, with the MMV scrubber shown on hte right**



Source: Stamicarbon

- The crushed product and the fine recycle flow are combined and recycled back into the granulator as so-called seeds.
- At the outlet of the main screen, the final on-specification product is cooled in a water-cooled Solex cooler and directed to storage.
- The dust-loaded fluidisation air is collected, together with cooling air from the bulk flow cooler and all the dedusting points, and fed to a single MMV scrubber.
- The clean air eventually exits the scrubber and is vented to the atmosphere via the off-gas fan.

A water injection system installed after the fluidisation air fan can reduce the consumption of fluidisation air and cooling air. This reduces total air consumption by raising the relative humidity and is only operated on exceptionally hot days.

Modular design concept

The MMV scrubber system for the DGC granulation plant consists of the following equipment:

- A quench scrubber vessel
- A cross over duct
- MMV scrubber vessel
- Several pump stations
- An acid recycle tank
- Associated field instrumentation.

The MMV scrubber is 12 ft x 20 ft x 75 ft (3.7 m x 6.3 m x 22.9 m) in size and consists of eight box sections. These were remotely fabricated from 316L stainless steel plate in a shop – ready to be delivered and assembled onsite. Each box, being 12 ft wide and approximately 9 ft tall, was easily shipped to the site on a common carrier and then offloaded and stacked.

The scrubber installed at DGC's granulation plant generates two separate blowdown streams: one generating concentrated urea solution and the other generating concentrated ammonium sulphate (AS) solution (Figure 1).

Test results

Official compliance testing for stack emissions was carried out following the successful commissioning of the granulation plant and after the MMV scrubber had been running stably under normal conditions for several weeks.

The following stack tests for particulate emissions were carried out:

- Filterable particulate matter (FPM) measured using EPA Method 5
- Condensable particulate matter (CPM) measured using EPA Method 202
- Total particulate matter (TPM) – simply the sum of CPM and FPM
- Opacity measured using EPA Method 9.

The purpose of these tests was to measure the emissions rates for particulate matter during normal operating conditions.

The compliance test programme was conducted on the urea granulation stack by an independent company in accordance with procedures set out by the Air Quality Division of the North Dakota Department of Health. Emission testing was carried out using the methods specified in 40CFR, Part 60 (Appendix A) and 40 CFR51 (Appendix M).

The results of the test programme showed that – without any additional fine tuning of the scrubber – the total particulate matter was <10 mg/Nm³ and that visible emissions were zero (i.e. a measured opacity of zero percent using EPA Method 9).

Operational observations

DGC staff optimised the process and fine-tuned equipment during the granulation plant's first year of operation. Smoother operating conditions were achieved after one year with no process upsets. The granulation unit often performed above its original design capacity during this initial period, with output reaching 115 percent of production capacity briefly, and 105 percent for a sustained period.

However, from routine lab tests, DGC did notice that the concentration of ammonium sulphate (AS) in the quench urea solution was higher than expected. The presence of AS, although constant, was not a particular cause for concern as levels remained minimal and did not lead to any product quality issues.

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The most logical explanation for the presence of AS in the quench loop was that some AS solution was leaking through the chimney hat and flowing down into the lower MMV stages (see Figure 2). It was thought that any splashing in the chimney hat stage could allow AS solution to migrate downwards through the chimney hat openings and into the lower stages.

Consequently, to prevent splashing, the diaphragm of the lower chimney hats was modified during the first scheduled maintenance stop for the DGC plant (5th October to 10th November 2019). This modification was successful as, when restarted, the AS concentration in the quench urea solution decreased dramatically (from 0.28% to 0.002%).

Four additional venturi tubes were also installed during the maintenance shutdown, increasing the total number of tubes to 32. The purpose of this was to lower the venturi stage pressure drop. It also improved control by allowing the venturi throat pumps to operate at mid-range, rather than at the bottom of their range, without affecting scrubbing performance.

DGC also thoroughly inspected the quench and MMV scrubber internals during the scheduled shutdown, checking for anything out of the ordinary such as shifted or displaced equipment (mist eliminator sections, DOI trays, venturi tubes etc.). This visual inspection confirmed that the spray nozzle plumes were all still uniform and that scrubber components such as flex hoses, gaskets and nozzles were in good condition.

Envirocare MMV scrubbing

The EnviroCare MMV scrubber installed at the DGC plant is shown in Figure 2. This consists of the following stages, from base to top:

The quench vessel, installed downstream of the urea granulator (see main photo), is designed to remove large particulates while saturating the incoming process gases.

The primary function of **the venturi stage** (Figure 3) is to capture any residual sub-micron particulates – including condensable constituents and aerosols – that have carried over from the quench stage. It is the first section of the MMV scrubber vessel that treats granulator exhaust gasses as they exit the cross over duct. The venturi stage consists of:

- A solid diaphragm with mounting locations for 32 venturi tube assemblies – with 28 venturi tubes initially installed at the DGC plant
- Eight factory installed throat spray manifolds
- Four venturi throat spray bars.

The venturi tubes – which are mounted in parallel – are highly efficient at particulate collection. They function by creating a large velocity differential between the water (injected by sprayers) and the particulate laden gas stream. The exits to these tubes, by recovering the velocity pressure, are also designed to minimise fan energy requirements.

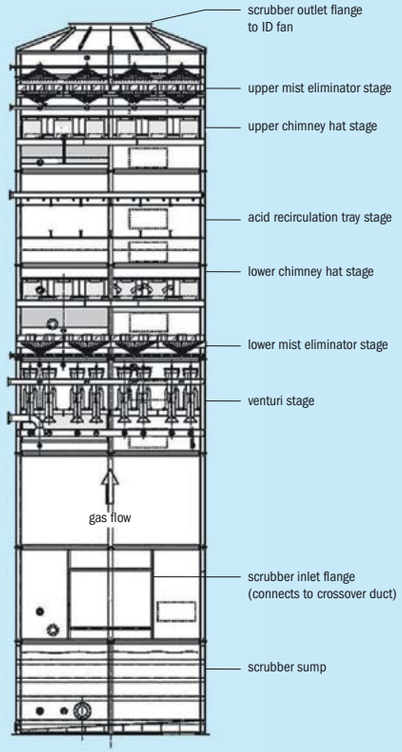
Each venturi tube assembly consists of a:

- Mounting plate
- Inlet cone
- Throat
- Low energy loss outlet diffusion cone assembly
- Throat spray nozzle connection
- Outlet deflector plate.

A spray of water is introduced into the centre of the throat of each venturi tube – in a counter direction to the gas flow – from a factory-installed throat spray bar. Water supply is modulated via a throat spray pump using a variable frequency drive (VFD). This maintains the pressure drop across the venturi stage – thereby ensuring high scrubbing efficiency – under varying operating conditions. Generally, pressure drop across the venturi stage will fall if gas flow decreases, unless more water is added.

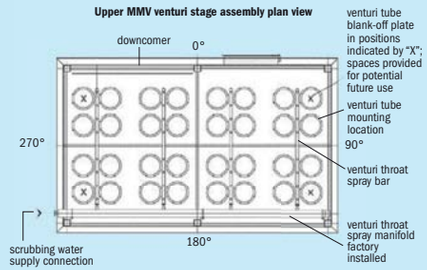
The **lower mist eliminator (ME) stage** is located above the venturi stage. Its main function is to keep the water in the venturi stage and prevent its carryover to downstream stages. The bottom (upstream) side of the ME chevrons are continually rinsed using irrigator sprays to help stop urea build-up.

Fig. 2: **Side view of the EnviroCare MMV scrubber installed at DGC plant**



Source: Stamicarbon

Fig. 3: **MMV venturi diaphragm**



Source: Stamicarbon

The **lower chimney hat stage** is located above the lower ME stage. The chimney hat stage prevents the acidic solution recirculated in the upper stages from draining into the recirculated dilute urea solution in the lower stages.

Above this is the **acidic recirculation tray stage**. Gas phase ammonia, not captured in the previous stages, is scrubbed in this stage and converted to ammonium sulphate (AS) using sulphuric acid solution. This stage consists of dual orifice impingement trays arranged in two levels. Scrubbing water dosed with sulphuric acid is continually recirculated over the top of these trays via the AS solution vessel. Process gasses are forced to pass through recirculated AS solution via small perforations in these trays. The AS solution is concentrated and bled off to storage where it is collected for resale by an AS crystallisation unit.

The **upper chimney hat stage**, installed above the acid recirculation trays, has two functions. Firstly, it prevents AS droplets from entering the next stage and, secondly, it prevents recirculated demister water (ME spray water) in the upper stages from draining into the recirculated AS solution in the lower stage.

The **upper chevron mist eliminator (ME)** forms the uppermost stage. This array stops any water entrained in the gas stream during the acid recycle scrubbing stage from carrying over to the ID fan and stack. Irrigator sprays rinse the bottom (upstream) side of the chevrons to prevent particle build-up. These are controlled with an on/off block valve. The chevrons are also backwashed intermittently from above using the ME backwash spray bars. Washing ensures the proper drainage of captured particle-laden droplets under all operating conditions.

The MMV scrubber system incorporates **six pump stations** to circulate the various scrubber water sources. Each station consists of an operational pump and a standby pump. Pumps are needed to ensure that the spray nozzle design pressures and flows are being met. They are installed in parallel with common inlet and discharge piping. Each pump train consists of an inlet simplex strainer, discharge check valve and pressure gauge, plus inlet/outlet isolation valves for equipment maintenance.

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THYSSENKRUPP

Urea plant revamping for cost savings and energy optimisation

Dr Harald Franzrahe and Dr Matthias Potthoff, thyssenkrupp Fertilizer Technology (tkFT)

Success factors

A successful revamp involves close coordination between the plant owner, the technology provider, and engineering and construction companies. This makes plant modernisation a major task.

In many ways, the modernisation of an existing urea plant is much more challenging than building a new plant – especially in terms of the design and subsequent project implementation. In most cases, construction space is limited and other plants found in close proximity must remain operational. The shutdown period for the urea plant itself must also be minimised and the timing of the revamp chosen carefully due to operational integration with other units. Modernisation projects therefore need to be kept on a short time schedule with no overruns if they are to avoid incurring excessive costs.

Case study

A recent revamp project at an ammonia-urea production plant in the Middle East and North Africa (MENA) region faced many of the above challenges. The three main objectives of the project object were to:

- Increase plant operating capacity by 25 percent
- improve product quality
- Reduce gaseous and liquid emissions to meet with new environmental regulations.

Background

The original plant was commissioned in 1998 and employs Uhde, Stamicarbon and Hydro Agri technologies – for ammonia synthesis, urea synthesis and urea granulation, respectively. The urea plant has a nameplate capacity of 1,700 tonnes/day and a design capacity of 1,925 t/d. The optimisation of equipment and operating practices has enabled the plant to achieve capacities of up to 2,000 t/d under optimal climate conditions.

When the plant was designed, statutory requirements allowed the granulation unit to operate without an emissions reduction system for ammonia, and therefore only impingement-type dust scrubbers were installed.

Increasing plant operating capacity to 2,500 t/d was first proposed to the owner in 2009 by thyssenkrupp Fertilizer Technology (tkFT) and Uhde. The proposed project was, however, not pursued at that time due to the unfavourable economic situation.

More recently, a change in environmental regulations has required the enforcement of a new emissions limit for both ammonia (NH_3) and dust of 50 mg/Nm³ at the plant. Because of this, the owner decided to look again at the revamp project for the plant and explore the options. Recent urea price increases and urea supply shortages were also deciding factors.

On behalf of the owner, tkFT developed a new revamp concept to increase the capacity of the urea fluid bed granulation plant. This updated the original revamp option by incorporating experience gained since 2009 as well as new developments in equipment capacity and design. The basic design data for the revamp is shown in Table 1.

This new up-to-date concept is designed to make the plant future proof. It reduces investment costs and significantly decreases the plant down time required for project implementation. Additionally, the new concept introduces reduction measures for dust and NH_3 emissions which were not part of the original 2009 concept. The main differences between the two revamp concepts are shown in Table 2.

Table 1: **Basic design data**

Design conditions			
Nameplate capacity	2,000 t/d		
Revamp capacity	2,500 t/d		
	Emissions	**Dust**	**Ammonia**
Original design	@ 2,000 t/d	< 50 mg/Nm³ dust	-
Revamp	@ 2,500 t/d	< 50 mg/Nm³ dust	<50mg/Nm³ NH_3
Product quality	Better than or equal to the original design		

Source: tkFT

Revamp concept for a UFT® fluid bed urea granulation plant

Increasing capacity as part of the revamp inevitably raises heat input into the granulator. Additional cooling for fluidised bed granulation must therefore be provided to maintain the heat balance and temperature profile. This in turn increases the required ambient air flow to the granulator.

Significant improvement to the existing off-gas scrubbing system were therefore necessary to accommodate the higher air flow and the new, more stringent emissions limits. These changes were needed because the granulator's existing dust scrubber was not able to clean the combined air stream from the granulator and the newly fitted granulator extension to the new, more stringent limits. The installation of a new granulator scrubber that could satisfactorily reduce dust *and* ammonia emissions was therefore needed. Importantly, this new scrubbing system had to be able to fit into the available space on site!

Emissions reduction

tkFT designed a two-stage horizontal scrubbing system for the revamp project, based on its recent experience in other granulation plants[1, 2, 3]. This new type of low pressure drop scrubbing system is capable of reducing both dust and ammonia emissions from the granulator and the granulator extension to the required limits (Table 1).

Valuably, the new scrubber is also able to process waste gas streams from the urea synthesis unit – these containing ammonia – and reduce the load of the water treatment section by using ammonia-contaminated process water from other units. The routing of ammonia off-gases to the new scrubber is shown in Figure 1.

Table 1: **Comparison of conventional vs new revamp concept**

	Original 2009 conventional revamp concept	**New revamp concept with additional emissions reductions**
Cooling concept	Granulator extension and bulk flow cooler	Granulator extension
Emissions	Dust scrubber for extension only	Dust and ammonia scrubber for granulator and extension
Specific power consumption, %*	97**	94
Impact on installation cost, %	100	80
Number of new equipment items	15	12 + 3 (for ammonia scrubbing)
Estimated Shutdown time, %	100	85

** Current power consumption = 100% **additional cooling water capacity ~800kW* *Source: tkFT*

Another key feature of the new tkFT scrubber is that it can fit into the space occupied by the original dust scrubber. This is despite it having to:

- Firstly, process a much higher airflow
- Secondly, reduce both dust and ammonia emissions.

Remarkably, this scrubber does not require any significant modifications to the existing steel support structure!

tkFT's horizontal scrubber is highly cost efficient. For a 2,500 t/d capacity plant, the cross-sectional area is 50 percent less than the area of a standard tray-type scrubber for the same plant. This is possible because the scrubber's internal configuration and mechanical design can be easily adapted to match actual needs. By consisting of fewer items of simplified equipment, it also cuts equipment costs. The pressure drop across this type of horizontal scrubber is also far lower than a comparable tray-type scrubber – even with the resulting higher gas velocity. The acidic scrubbing stage does, however, require additional circulation pumps and an intermediate tank.

Optimised emissions control within the plant complex requires proper handling of:

- Off-gas from urea synthesis or other units (Figure 1)
- Waste streams containing ammonia water.

Off-gas from urea synthesis

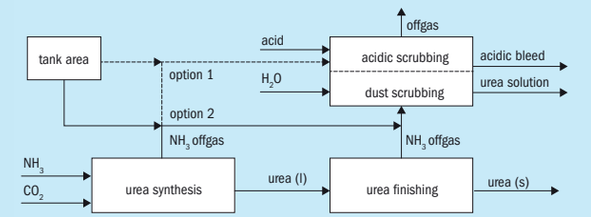
The synthesis unit of the urea plant emits gaseous ammonia which needs to be treated. This is in addition to the urea dust and ammonia vapour emissions typically associated with the granulation unit.

The ammonia present in synthesis unit off-gas can be removed by fitting a standalone acidic scrubbing system. This typically consists of: a scrubber installed in the steel structure of the synthesis unit, pumps located at ground level, associated instrumentation and piping. However, the installation of a separate, dedicated scrubbing system (and related equipment) is not necessarily required – if the plant also includes a granulation unit with an ammonia scrubbing system.

Although the characteristics of synthesis unit off-gas and the granulation unit off-gas differ, both gas streams can be routed to the granulation unit's ammonia scrubber for treatment. While the synthesis unit off-gas has a much lower flowrate, compared to the granulation unit, its ammonia concentration is much higher. Ammonia flows can also be discontinuous, depending on the design of the synthesis plant.

In principle, there is the option to treat all the ammonia containing off-gas streams from the synthesis unit in the granulator ammonia scrubber – from the ammonia water tank or the urea solution tank, for example.

Fig. 1: **Routing of ammonia off-gases to the new scrubber**



Source: tkIS

Waste streams

The wastewater treatment section is often another limiting factor during plant revamps. This is because additional ammonia-containing wastewater streams usually require the installation of extra, new treatment equipment to avoid problems with environmental permits.

This ammoniated water can, however, be treated in the granulator ammonia scrubber, as long as it is not contaminated with other components, as ammonia will be stripped by the high air flow and captured in the acidic section. The addition of water also reduces the amount of clean make-up normally required by the scrubbing system.

How much ammoniated water can be processed largely depends on the amount of ammonium salt generated via the ammonia-acid reaction within the scrubber. The use of nitric acid is ideal as this produces ammonium nitrate. This can then be combined with urea to generate the valuable liquid fertilizer urea ammonium nitrate (UAN) to supplement the volume already being produced at the plant.

In contrast, ammonium sulphate solution is created if sulphuric acid is used to capture ammonia instead. Low amounts of ammonium sulphate can be incorporated within urea fertilizer using tkFT's Ammonia Convert Technology (ACT) system. However, ammonium sulphate must be exported if generated in larger amounts. This can then

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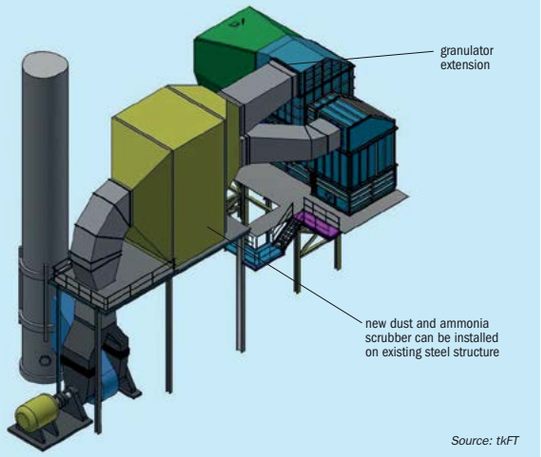
Fig. 2: **Detail of granulator extension and new scrubber**



Source: tkFT

be used as feed for an NPK or ammonium sulphate (AS) plant. Alternatively, it can be crystallised and sold as fertilizer.

All of the above are interesting water treatment options which can significantly reduce the cost and operating complexity of a revamped plant.

Capacity increases

Increasing granulation plant capacity requires the installation of additional urea solution injection systems in the cooling section of the original granulator. These extra injection systems increase the heat input into the granulator, while reducing the available cooling area in the existing granulator.

To compensate for this loss of cooling area and increased heat input, an additional cooling section is necessary. This was achieved in the earlier revamp concept by positioning a bulk flow cooler between the granulator and the existing cooling system. This required a significant modification to the plant building.

In the new concept, the extra cooling section is instead added as an extension to the granulator that incorporates its own dedicated air fluidisation system (Figure 2). This design achieves the maximum cooling possible by using all the available building area. These integrated granulator-coolers are already in operation at a number of tkFT plants.

Granulator extensions normally require an additional solid transport system to return the product from the new granulator outlet (via the safety screen) back to the existing fluid bed cooler inlet. However, for this project, novel product routing inside the granulator extension reduced the gap between the new granulator outlet and the existing equipment inlets from 10 metres to below two metres. This distance can be bridged by a simple chute, so avoiding the need for additional solid transport equipment.

The granulator extension design reduces the inlet temperature of granules entering the first fluid bed cooler. This then cools the product to the optimal temperature for screening and crushing operations without any modification. The product also exits the final fluid bed cooler at the required temperature – as its inlet temperature is also reduced. Overall, the new design means no additional product cooling is required (e.g., by the addition of a bulk flow cooler or an additional ammonia chiller) even through the granulator is operating at the new higher throughput and capacity.

The ability to reduce solid recycle temperature as part of the revamp had three added benefits by:

- Increasing product hardness. This significantly extends the operating intervals between cleaning by reducing scaling on product screens and roller crushers.
- Reducing bed temperatures in the granulation section.
- Ensuring spare operational cooling capacity is available during high temperature ambient air conditions.

Screening capacity was also raised by replacing the original screens with four high capacity screens of the latest design. These fit into the existing building due to their compact size – whereas the previous concept required two additional screens supported by an extra platform.

Even with the new scrubber, the new revamp concept with a granulator cooling extension, as shown in Table 2, requires less equipment than a conventional cooling solution with an intermediate bulk flow cooler.

Summary

tkFT's revamp concept for urea granulation plants is based on an optimised redesign of the existing granulator. In many cases, this significantly reduces the cost and time of the revamp by eliminating the need for additional cooling outside of the granulator.

Revamp projects now need to deliver much greater emissions reductions than in the past due to environmental regulations getting more and more stringent. Cost efficient revamp options are also required if plant modernisation projects are to remain economically viable.

tkFT's proprietary scrubber design – by integrating the granulation scrubbing system into the overall plant concept – makes both investment and operating cost reductions possible. The installation of less equipment during the revamp project also reduces plant shutdown time, avoiding substantial and costly production losses. ■

Authors' note: tkFT has been the licensor for Hydro Agri urea fluid bed granulation technology since 2006.

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January-February 2023

phosphates & potash INSIGHT

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CRU Phosphates welcomes you to Istanbul!

CRU Events will convene the 2023 Phosphates International Conference & Exhibition in Istanbul at the Hilton Bomonti Hotel, 27 February to 1 March.

The 15th CRU Phosphates Conference returns this year as a live, in-person event in Istanbul, Turkey. Located at the crossroads of Europe and Asia, Istanbul 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, supply constraints and demand destruction.

What to expect – the 2023 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 keynote presentation. A senior OCP representative will then provide a producer view of market dynamics in the other conference keynote. Additional industry perspectives will be offered by executives from other major producers, including Mosaic, Itafos, Toros Agri, and ICL.

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 Brazil, China, India, Jordan, North America, Saudi Arabia and Turkey.

Global market forces will also be covered and discussed – including supply chain and logistics challenges, specialty markets and the energy transition. Major production investments and emerging junior mining projects will also be featured.

Sustainability continues to be a driving force throughout the fertilizer industry, as producers balance the dual requirements of food security with their environmental, social, and governance (ESG) targets. This theme will be a particular focus of the technical agenda. Presentations on process and energy efficiency will highlight how sustainability goals are being achieved at production plant level. New innovations in phosphorous recovery will also be highlighted.

The event's strong technical programme will also explore advances in phosphoric acid production and the latest developments in beneficiation and fertilizer reagents.

The conference's commercial and market agenda will cover:

- Regional supply and demand insights
- Phosphate rock market updates
- The role of phosphates in the energy transition
- Specialty demand outlooks
- Supply chain and logistics.

While the technical agenda will cover:

- Phosphoric acid operations
- Advances in phosphate beneficiation
- Promoting sustainability in the phosphate industry
- Developments in fertilization and nutrient use efficiency
- Production efficiency improvements.

The full agenda for CRU Phosphates 2023 is online now. Register today for your place in Istanbul. For more information visit www.phosphatesconference.com ■

PHOSPHATE MARKET OVERVIEW

CRU's principal phosphate analyst, **Humphrey Knight**, sets the scene for the event with this personal take on the state of market:

"Global phosphate fertilizer prices largely continued to decline in early 2023 after hitting their highest nominal levels in nearly 15 years during 2022. Global demand contracted sharply last year as, despite persistently high crop prices, phosphate fertilizer affordability became highly unfavourable for consumers, causing many to reduce or defer purchases.

"This ultimately outweighed major supply disruptions to the industry, with Chinese DAP + MAP exports halving compared to a year prior, and key supplier Morocco continuing to manage output. Despite fears to the contrary, Russian suppliers were ultimately able to maintain phosphate fertilizer export volumes, helping to ease otherwise tight supply.

"In early 2023, previously wide regional pricing disparities have begun to narrow. After such a dramatic reduction in demand last year, some consumers have returned to the market to replenish drawn down inventories, pushing up some prices such as those in Brazil. However, this is not universally the case, with affordability in many regions still not at the levels which previously spurred significant increases in global demand.

"CRU expects supply to improve substantially in 2023. But it is the extent to which global consumption recovers this year that will determine price direction." ■

Technical programme highlights

A selection of Phosphates 2023 abstracts from the conference's technical and operational programme.

Case study for ScaleGuard™ technology

Rajesh Ritani & Steven Paulson, Nalco Water, and Eihab Abdel Samie, NCIC

A North African phosphate fertilizer plant suffered from serious scaling in heat exchanger tubes used in the concentration of phosphoric acid. This resulted in lost production time, plugged tubes and reduced productivity. Nalco Water performed a detailed investigation into the underlying problem and recommended the use of its ScaleGuard™ technology as a heat-exchanger and evaporator anti-scalant. An optimised dose of ScaleGuard™ in the phosphoric acid feed to the evaporators resulted in a 20 day increase in available production days annually, increasing P_2O_5 production by around 24,000 t/a. Moreover, the average number of tubes plugged with hard scale changed from 70 tubes to 14 tubes. These were also easily cleaned as the scale formed was softer. The use of ScaleGuard™ anti-scalant improved workplace safety at the plant while reducing overall maintenance costs.

Success with a new Andritz tilting pan filter at IMACID in Morocco

Farooq Ellahi, Andritz AG

Andritz has developed a new model 36-250 tilting pan filter that can filter 1,050 tonnes of P_2O_5 per day. This model can be adapted to all dihydrate and hemihydrate phosphoric acid processes. It can also be optimised for different phosphate rock types. The new Andritz tilting pan filter has been successfully installed and operated at IMACID, Jorf Lasfar, Morocco. The original reactor capacity at IMACID was 1,400 tonnes P_2O_5/day provided by two parallel reactors using the Prayon Mark 3 dihydrate process. A model 36-250 Andritz tilting pan filter was used to filter 750 tonnes P_2O_5/day up to a maximum filtration rate up of 950 tonnes P_2O_5/day. IMACID then upgraded their reactors to achieve 1,600 tonnes P_2O_5/day, using Andritz's model 36-250 to filter 1,050 tonnes P_2O_5/day. This achieves a dilution of zero percent. Residual acid in the gypsum cake coming off the filter is between 0.12-0.14 percent, achieving a water soluble P_2O_5 recovery of 99 percent.

Novel surfactants to enhance collectors for direct apatite flotation

Lucas Moore, Colonial Chemical, Inc.

This presentation focuses on a family of novel surfactants that are blended with the standard collector in relatively low concentration to enhance the grade/recovery balance during the first stage direct flotation of apatite. With the aim of maximising the amount of apatite recovered at a P_2O_5 grade of 25 percent, results suggest that an enhanced collector can achieve an increase in recovery of eight percentage points.

New reagent schemes for processing US phosphate ores

Guoxin Wang and Zhengxing Gu, Arkema

The conventional Crago phosphate flotation process for beneficiating Florida phosphate ore involves conditioning the phosphate feed with a fatty acid type collector and fuel oil (or diesel) under alkaline pH conditions at a solids content above 70 percent. In a new reagent scheme recently developed by Arkema, the phosphate feed was conditioned using a combination of a fatty acid collector and a surfactant for rougher flotation. Compared with the incumbent process, the new reagent scheme achieves similar or better rougher flotation performance without pH control for conditioning. Importantly, the new reagent scheme eliminates the need for diesel or fuel oil. This makes the flotation process simpler and more sustainable/environmentally-friendly.

Ash2®Phos: closing the phosphorus cycle

Therese Åström and Michael Meyer, EasyMining

EasyMining has developed a process for the recovery of clean phosphate from sewage sludge ash (SSA). This is patented and registered under the brand Ash2Phos. This process is based on chemical treatment of sewage sludge ash from mono-incineration. P is initially recovered in the form of clean precipitated calcium phosphate (RevoCaP). The process has been validated in several pilots that have generated products for analysis and quality testing.

EasyMining plans to produce 15,000 t/a of RevoCaP from 2025/2026 and then gradually increase production output to 150,000 t/a by 2030. RevoCaP has several potential markets: it can replace apatite in fertilizer production, be granulated and used directly as a fertilizer, or used as a feed phosphate.

Phosphogypsum – Closing the Gap?

Agnes von Garnier; Collin Bartlett & Hannes Storch, Metso Outotec

The energy transition will affect all global commodities including sulphuric acid. Today, approximately 70 percent of sulphur used in the production of sulphuric acid stems from oil and gas processing. Decreased fossil fuel use in coming decades will therefore lead to a reduction in sulphur availability. This presentation will focus on the energy transition and how it will impact sulphuric acid production technologies. Emphasis will be given to a process for decomposing phosphogypsum from existing stockpiles (or directly from operations) into sulphuric acid.

Sustainability – the trademark of Prayon's processes

Hadrien Leruth, Prayon Technologies

How can we achieve food security if the amount of available phosphate resources is insufficient to meet demand? GetMoreP and Ecophos are two innovative processes able to upgrade secondary phosphorus sources or spent acids from the metal industry. The objective is to manufacture the high-value product DCP – a 'super-rock' with up to 41% P_2O_5 – from low-grade phosphates or phosphate beneficiation tailings. The profitability of this approach is based on the simplicity of the DCP production process and the use of 'zero cost' phosphate raw materials. The presentation will also discuss the management of water and the effluents at phosphoric acid plants.

Phosphate fertilizer cooling comes full circle

Igor Makarenko, Solex Thermal Science

Moving bed heat exchange (MBHE) technology is providing phosphate fertilizer producers with the ability to recover/re-use process heat and meet aggressive emissions reduction targets, while still allowing them to produce superior products. This presentation will cover two areas where MBHE technology is having the greatest impact on fertilizer operations. Firstly, the technology has a proven ability to stop dust from entering the cooling process by using a cascade aspirator. Additionally, a first-of-its kind energy recovery process is also providing phosphate producers with the ability to capture otherwise wasted process heat from the cooling stage. This can then be then used in other processes – such as pre-heating the combustion air used in fluid beds or rotary drum dryers, for example. ■

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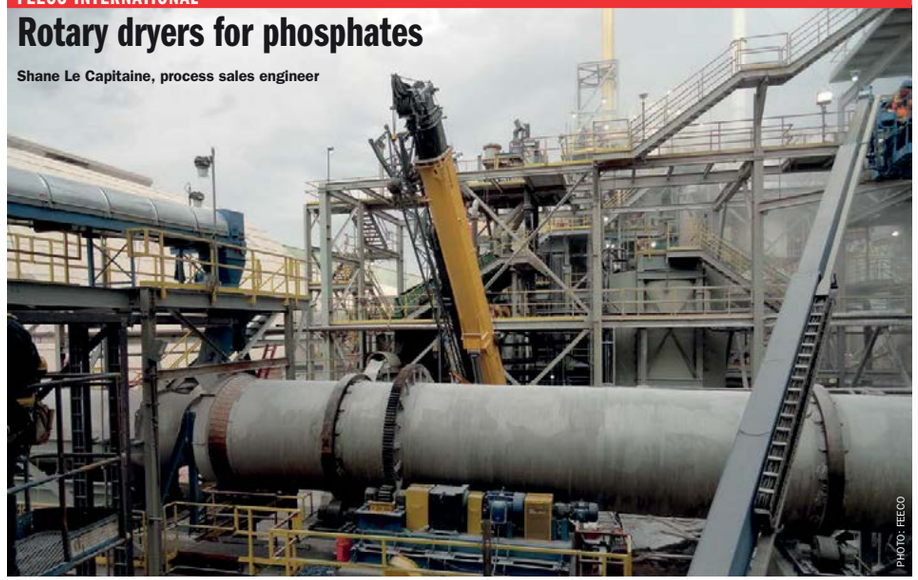
Phosphate process improvements

Advances in technology, equipment and reagents are enhancing phosphate fertilizer production. Optimisation of standard equipment is also vital for ensuring process efficiency.

FEECO INTERNATIONAL

Rotary dryers for phosphates

Shane Le Capitaine, process sales engineer



FEECO rotary dryer.

Rotary dryers have long been the standard option for drying bulk solids in industrial settings, whether at mine sites or production facilities. This certainly holds true when it comes to the phosphates industry. Miners rely on rotary dryers for drying phosphate rock, while fertilizer producers rely on them for finishing granular fertilizer products for market.

In this article, we outline how rotary dryers function, show why they are the equipment of choice for phosphate fertilizer producers, and describe individual phosphate industry applications. Unique considerations for plant managers when drying phosphate materials are also highlighted.

Phosphate rock applications

Rotary dryers are commonly found at phosphate mine sites where washing is used in ore beneficiation as this necessitates a drying step. In this application, drying is advantageous as it:

- Improves shipping economics
- Enhances handling and flowability
- Reduces the potential clogging of downstream equipment.

Rotary dryers are ideal for processing phosphate rock, thanks to their high throughput – more than 200 tonnes per hour – and durable design. They are also favoured for their tolerance to feedstock variations, which commonly occur at phosphate mining sites.

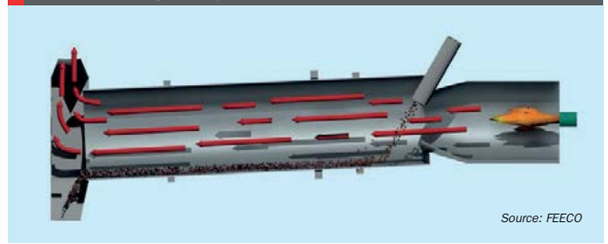
Finished phosphate applications

Rotary dryers frequently play a critical role in fertilizer finishing plants, particularly in wet granulation where a drying step is necessary to bring the final product to its target moisture content. In this application, drying is essential for meeting shipping, storage, and shelf life specifications.

As with phosphate rock processing, rotary dryers are often favoured in granulation processes because of their high throughput and durability. They also offer additional benefits during product granulation – as the tumbling action of rotating drums helps to polish granules, rounding and refining them into a premium end-product.

Interior view of a rotary dryer with flights.

Fig. 1: **Co-current dryer illustration: material, hot air, and combustion products all move through the dryer in the same direction**



Source: FEECO

Operating principles

Rotary dryers which extract moisture via convection are typically employed in phosphates processing. In these direct dryers, material passing through a rotating drum comes into direct contact with hot air and combustion products. (While indirect rotary dryers are also available – configured so that the heating medium and materials are kept separate – these are not generally used by phosphate producers.)

Flights pick up the material and drop it through a stream of hot air as the drum rotates (see photo). This creates a cascading curtain of material in the drum's cross section. (It is for this reason that rotary dryers are sometimes referred to as cascade dryers). The ideal curtain maximises heat transfer by matching the flight design and pattern to the material's specific characteristics.

The phosphates industry typically uses rotary dryers with a co-current design. This means that the material and combustion products flow through the unit in the same direction (Figure 1).

This configuration is used at both phosphate mine sites and phosphate granulation plants. At the mine, a co-current configuration helps to 'flash off' surface moisture and dry rock particles to their core as they move through the drum. At the granulation plant, a co-current configuration avoids the overheating of products when they reach their driest point and helps prevent product attrition, degradation and the generation of fines.

Predetermined air flow velocity, retention time, and temperature profiles all ensure that phosphate materials are dried according to specification.

In both ore processing and granulation plant applications, phosphate producers frequently incorporate a combustion chamber at the inlet end of the dryer. By stopping the burner flame from coming into direct contact with the material being dried, this helps prevent product degradation, discolouration, and attrition.

Phosphate materials can cause issues during drying due to several challenging characteristics. The following qualities must therefore be considered when working with phosphates:

Corrosion

Because of the incorporation of phosphoric acid, corrosion can be a concern when drying phosphate fertilizers. This is particularly true at the inlet of the dryer where the moisture content is high. Phosphate fertilizers are all corrosive to some extent, although the exact level of corrosion will vary depending on their composition.

When selecting drying equipment, phosphate producers should work with an experienced rotary dryer manufacturer to prevent corrosion. Constructing the dryer using corrosion-resistant alloys and reinforcing high-wear areas are both recommended.

Additionally, welds should be ground smooth in fabrication to eliminate potential catch points where material could begin to collect and corrode the unit. Internal flights should also be full welded on both sides to deter corrosion.

In existing units that are already operational, plant managers can also opt to replace or reinforce key sections with more corrosion-resistant alloys.

Abrasion

Abrasion can also be a concern during phosphate rock processing and phosphate fertilizer granulation. Particle size and impurities in process materials can increase abrasion potential in the dryer. Reinforcing high-wear areas with abrasion-resistant steels can therefore help to minimise wear.

Clumping & build-up

Phosphate materials are also prone to clumping and build-up – tendencies that can cause a range of problems for both product quality and consistency, as well as dryer longevity. Fortunately, producers

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A pneumatic hammer knocker mounted on the side of a rotary dryer.

Trommel screen ('grizzly') at the discharge end (right) of rotary dryer.

have the following options available for minimising build-up:

- Most often, producers incorporate some type of knocking system on the drum (see pneumatic hammer photo). This knocks the drum on a wear band to dislodge any potential build-up on the drum's interior as it rotates. Various knocker designs are available.
- A screw conveyor may also be employed at the inlet. This projects or 'flings' material into the unit, causing clumps to break apart as they enter the dryer.
- Materials of construction, such as stainless steel with a 2B finish, can also help to prevent build-up.
- On the discharge end, a circular trommel screen or 'grizzly' (see photo) can break up any clumps that may have formed (or not broken up) during the drying process, while also aiding size separation.

Dust

Excessive dust can be a problem during phosphate processing – primarily at the mine site – if the dryer is not designed properly. A cyclone can be added to deal with excess dust. This is installed prior to the baghouse or scrubber to capture the dust and return it to the process.

Feedstock variation

Although less of a concern during fertilizer granulation, feedstock variation can be a real issue for phosphate rock processing as physical properties and chemical composition can vary considerably. This makes familiarity with the specific characteristics of the individual phosphate rock source essential prior to processing.

Testing at a facility such as FEECO's Innovation Center may therefore be necessary to evaluate the material and establish key operating parameters. Results can then be used to establish a suitable and robust design for a commercial-scale dryer.

Inspections

The challenging characteristics of phosphate materials, along with their potential to cause damage, make regular inspections especially important for rotary dryers operating in the phosphate industry.

As well as ensuring operators and maintenance personnel are properly trained in dryer operation and maintenance, phosphate plant managers should also mandate routine external and internal inspection of their unit(s). This allows problems to be caught early before they have a chance to escalate into more serious damage.

FEECO also recommends having the dryer more thoroughly inspected on an annual basis by the original equipment manufacturer (OEM) or a third-party service provider. Catching and addressing potential issues at their onset can help to avoid unnecessary downtime and extra maintenance costs in the future.

Concluding remarks

Rotary dryers offer an effective and reliable solution at phosphate mine sites and phosphate fertilizer plants – being suitable for drying both phosphate rock and/or finished phosphate products. Their high throughput, longevity, tolerance to variation, and ability to polish granules have made them a favoured and reliable option for drying phosphates.

Nevertheless, phosphate-based materials do present unique challenges. Thoughtful design is therefore required to maximise dryer service life and ensure high product quality and consistency. Regular inspection and maintenance are also essential in keeping these dryers running at their best for years to come. ■

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PRAYON

Dicalcium phosphate: the versatile phosphorus source

Marc Sonveaux, HCl-based processes technology lead

Dicalcium phosphate offers a highly versatile source of phosphorus for animal feed and phosphate fertilizer production. In this article, Prayon outlines how DCP production can benefit product purity, increase resource availability and improve phosphate supply chains.

Why DCP?

Dicalcium phosphate (DCP) – in either its dihydrate or anhydrous form – is valued as a concentrated phosphorus source. DCP can be derived directly from phosphate rock or obtained by digesting phosphate rock (with hydrochloric acid or sulphuric acid) and then neutralising the solution generated (with calcium carbonate or calcium hydroxide). Prayon has developed and industrialised the acid digestion route to deliver two commercial processes:

- The HCl-based Ecophos process
- The H_2SO_4-based GetMoreP process.

Both processes can cope with different phosphate rock quality and can consume low- to high-grade rock types.

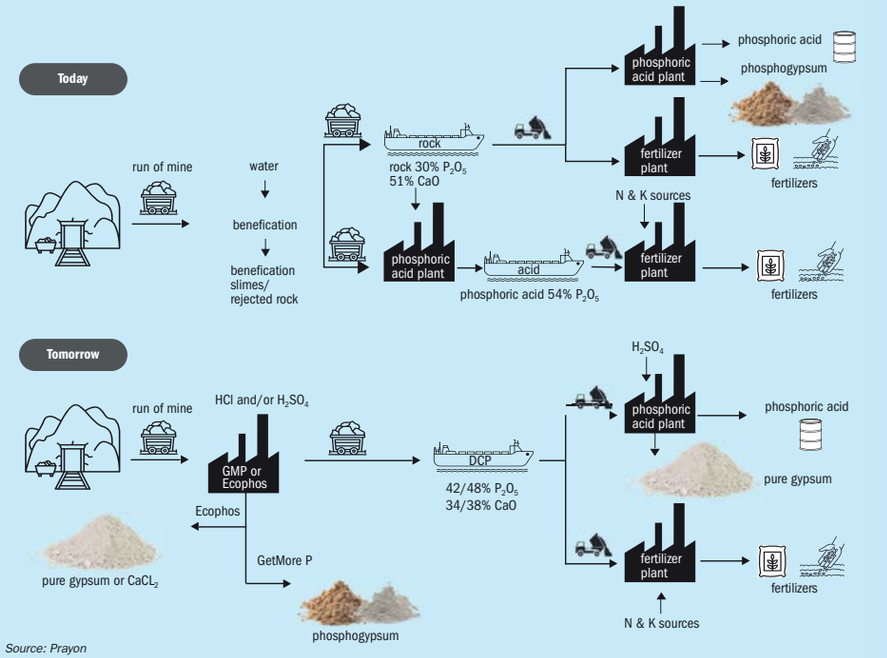
DCP is inherently versatile. As well as being a pure final product, DCP can be used as a concentrated intermediate to manufacture a range of different phosphates, as described in this article.

Imagining a new supply chain

Today, high quality phosphate rock mined at a limited number of global locations is used to produce phosphoric acid, fertilizers, and other derivative products. The phosphate rock extracted from these mines is typically beneficiated to concentrate phosphate and reduce impurities. However, beneficiation is expensive, consumes significant water and energy, and results in P_2O_5 losses by generating rejects such as tailings and slimes.

The beneficiated phosphate rock concentrates obtained are dried and then transported from mine sites to phosphoric acid or fertilizer plants (often located close to a port) or traded commercially. Massive quantities of phosphate rock concentrate, usually containing 30-33 percent P_2O_5, are exported to manufacturing plants all around the world. Liquid phosphoric acid, generated by plants located close to mining sites at a concentration of 52-54 percent P_2O_5, is also traded commercially. But shipping this acid across oceans is expensive and can be environmentally risky.

Fig. 1: **The phosphate supply chain of today and tomorrow**



Source: Prayon

Replacing current large-scale transportation of phosphate rock or phosphoric acid with DCP is one alternative – an option called the 'super rock' approach. DCP is attractive as it can produced either directly from run-of-mine phosphate rock or through limited chemical beneficiation. The DCP obtained is suitable for transport to different factories worldwide. It can also be transformed into fertilizers or higher quality phosphoric acid using existing or new production plants.

The DCP 'super rock' approach simplifies the supply chain (Figure 1) as it avoids the transport or phosphoric acid or the large amounts of unwanted and undesirable components (such as clays, sand, calcium fluoride, organic matter etc.) that are usually present in phosphate rock. Last but not least, the DCP produced by Prayon's two processes is a higher quality product that is free from the heavy metals (including cadmium) and radioactive elements that are present in the original phosphate rock.

Two processes, one product

As previously indicated, Prayon offers two process technologies for DCP production:

- The Ecophos process – based on hydrochloric acid (HCl)
- The GetMoreP (GMP) process – based on sulphuric acid (H_2SO_4).

Both technologies are built around the same concept, i.e., the partial digestion of phosphate rock that avoids dissolving most of the impurities. In both instances, the phosphate solution obtained, after filtration to remove residual insoluble materials, is neutralised using lime or limestone to produce DCP. In the final process step, solid DCP is separated from the mother solution by filtration and then dried (Figure 2). The DCP obtained can ultimately be granulated if necessary.

In the Ecophos process, the residue left after the digestion of the rock (this containing undigested impurities) is neutralised. These residues can be stored or converted into single superphosphate (SSP) in certain projects. A mother liquor of calcium chloride remains after the filtration of DCP. This can be dried or reacted with sulphuric acid. The latter converts the calcium chloride back to hydrochloric acid and generates an extremely pure gypsum by-product. This is free from radioactivity and suitable for use in the plaster and cement industry.

Fig. 2: Filtration of DCP at the Technophos demonstration plant.

The Ecophos process is normally selected when:

- Hydrochloric acid is available
- The phosphate rock contains high levels of magnesium
- The generation and storage of phosphogypsum is an issue.

The Ecophos process also generates the highest quality DCP suitable for animal feed applications.

In the GMP process, the phosphogypsum by-product left after digestion is potentially suitable for agronomic use. The mother liquor obtained is water. This can be returned to the process after an optional treatment step. The GMP process is normally selected when sulphuric acid is available and where there is storage space or a market for the phosphogypsum generated.

Is DCP production economic?

The key aspect of this new phosphate industry supply chain philosophy (Fig. 1) is the ability to produce DCP at the lowest possible cost.

There are six main operational principles for keeping DCP production costs low:

1. **Use low-grade phosphate rock:** Low-grade rock is much cheaper and widely available worldwide Typically, a run-of-mine grade of 10% P_2O_5 and above is suitable for both the Ecophos or GMP processes. The presence of high levels of impurities (e.g., magnesium, iron, aluminium, silicates, fluoride etc.) is generally not an issue.
2. **Avoid beneficiation:** The Ecophos and GMP processes both provide chemical beneficiation. Therefore, in most cases, DCP can be produced without the need for additional beneficiation. This boosts P_2O_5 recovery and avoids the need for large-scale investment in a beneficiation plant. Prayon's DCP processes typically deliver a P_2O_5 yield of 80-90 percent, compared to the 30-60 percent yield obtained using a conventional beneficiation approach. (Indeed, the waste generated by conventional beneficiation plants can sometimes be used as a raw material for DCP production.)
3. **Use secondary acid sources (spent acids):** These can be found at low cost in some locations. Sulphuric acid can be sourced as a smelter by product, while hydrochloric acid is generated as a co-product from the manufacture of potassium sulphate (SOP), caustic soda and polymers.
4. **Flexibility:** Each phosphate rock is compositionally different. It is therefore possible to adapt the DCP production process to match the phosphate rock source with the end-product. Project capex and opex can then be optimised by selecting the correct process or combination of processes.
5. **Capacity impact**: the use of a large DCP unit as a hub for downstream production processes helps optimise the overall capex of the phosphate production plant.
6. **Location selection**: The DCP plant can be located at either the phosphate mine or the shipping port. Co-location at the mine allows storage of the gypsum generated by the process (GMP) or the remaining part of the rock (Ecophos). Location at the port, meanwhile, helps reduce logistics costs.

In addition, DCP has valuable technical characteristics compared to phosphate rock (e.g., its purity and P_2O_5 concentration) that can justify a price premium relative to phosphate rock.

A wide range of end products can be derived using DCP as an intermediate (Figure 3), for example:

- **Animal feed DCP.** This is characterised by its high purity with less than 5 ppm heavy metals, less than 0.2 percent fluoride and high phosphate concentration (up to 42 percent P_2O_5). DCP also has the desired high biodigestibility when produced in dihydrate form.

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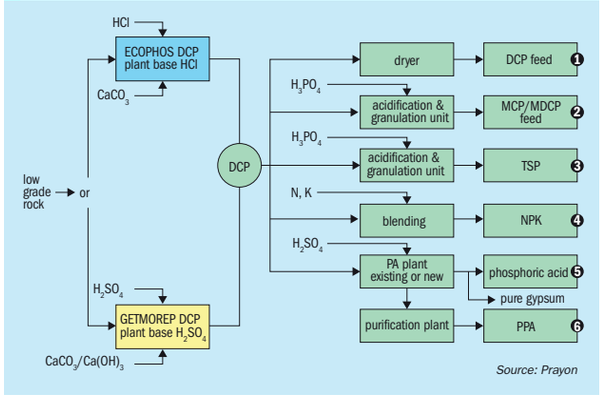
Fig. 3: **The multiple applications of DCP**



Source: Prayon

- **Monocalcium phosphate (MCP).** This can be produced directly from DCP by mixing with phosphoric acid – enabling 52 percent P_2O_5 content to be reached. The product is then granulated and dried.
- **Triple superphosphate (TSP).** This is conventionally produced by mixing phosphate rock and phosphoric acid followed by granulation and maturation. Using DCP as a phosphate source instead enables much purer TSP to be produced, with low cadmium, low radioactivity and low heavy metal content. This process also reduces industrial plant costs as no maturation step is needed. The sulphate content of TSP, which is produced in the same way as MCP, can be adjusted with sulphuric acid if required.
- **NPK fertilizers.** Various NPK grades can be produced from DCP by blending or chemical reaction with different raw materials (KCl, SOP, K_2CO_3, HNO_3, urea, nitrates etc.) The NPKs obtained will be highly pure, with low cadmium, low radioactivity and low heavy metal content. These can be granulated and acidified to ensure optimal phosphorus solubility in water.
- **Purified phosphoric acid (PPA).** This can be produced from DCP due to its lack of impurities. This is a simple way of purifying phosphoric acid to a technical- or food-grade standard.

Advantageously, DCP can also replace phosphate rock in phosphoric acid production (PAP). The major advantages include:

- Lowers transport cost and potentially lowers steam consumption in PAP due to the higher P_2O_5 of the DCP
- Generation of purer phosphoric acid with less impurities
- Less gypsum is produced and plant capacity increases because of the low calcium content of DCP
- Longer mine life thanks to the use of low-grade – and previously unexploitable – phosphate rock
- The pure gypsum by-product generated complies with plaster industry requirements
- The high purity of DCP simplifies the layout of the phosphoric acid plant and its maintenance programme
- The phosphoric acid produced from DCP is pure enough for downstream production of monoammonium phosphate (MAP) and other water-soluble fertilizers.

Circumstances that favour DCP use

There are plenty of industrial situations that favour the use of DCP. For example:

- DCP is suitable for companies wishing to produce clean phosphate fertilizers and who need to adjust phosphate solubility to suit the soil types of their farmers.
- Using DCP instead of phosphate rock is advantageous for phosphoric acid producers encountering environmental issues with phosphogypsum storage. The lower quantity of gypsum generated from DCP also increases production capacity at existing plants. The gypsum generated will be cleaner and therefore usable in the cement industry, agronomy and even for plaster in the construction market. The phosphoric acid obtained is also cleaner and less viscous.
- Companies using technologies that currently require the most expensive and highest quality phosphate rock can lower their costs by substituting DCP instead.
- Mining companies extracting highly impure phosphate rock, or facing decreasing ore quality and resource depletion, could blend its phosphate rock source with DCP to upgrade and standardise phosphate feed quality to the downstream phosphoric acid plant.

Conclusions

As high-grade phosphate rock resources become depleted, we will need to manufacture phosphate products – such as fertilizers and industrial, food and feed phosphates – using lower quality raw materials. Widely available low-grade phosphate rocks (and secondary phosphate sources) can be transformed into highly pure DCP using Prayon's Ecophos or GetMoreP technologies. This ability to exploit lower quality rock has the potential to greatly expand exploitable phosphate resources globally.

The DCP generated by Ecophos or GetMoreP processes can be used as a building block to produce many different types of phosphate products for animal feed, fertilizer, technical and food applications.

The construction of large capacity DCP plants close to existing phosphate mines could generate calcium phosphate in a highly pure and concentrated form suitable for export – before being converted into final products at its end destination.

DCP, being a solid product, offers important logistical advantages, as it is much easier to transport than phosphoric acid. It also has a much higher P_2O_5 content than phosphate rock concentrate. Widespread introduction of DCP production capacity could therefore improve the industry's sustainability – by creating a new phosphate supply chain that significantly reduces transport CO_2 emissions.

In addition to the company's well known and widely installed phosphoric acid production processes, Prayon Technologies can support the entire DCP plant concept. This includes projects to convert phosphate rock to DCP as well as projects that convert DCP into phosphoric acid and phosphate end-products. ■

WUHAN FERTCHEM TECHNOLOGY

A practical solution for reducing phosphoric acid impurities

Kevin Song

In recent years, with the continuing decline in ore grades, the proportion of various impurities present in phosphate rock has gradually increased – these including iron, magnesium, aluminium and acid insoluble substances. In the wet phosphoric process, almost all of these impurities enter solution. This means that the impurity content of phosphoric acid is also on the increase. This results in phosphoric acid with a relatively high minor element ratio (MER), thicker viscosity and containing more suspended solids. Unfortunately, when impurity levels are high, the utilisation value of phosphoric acid is correspondingly low.

Phosphoric acid production

During the concentration process, the impurities in phosphoric acid can cause blockages in the heat exchanger and increase scaling. This seriously affects the normal, continuous operation of the concentration unit due to the following undesirable consequences:

- The service life of the equipment is shortened
- The heat energy utilisation rate is reduced
- Steam consumption is increased
- The capacity of the concentration unit is sharply reduced.

As phosphoric acid becomes more concentrated, the solubility of impurities decreases and they precipitate out. The presence of impurities as dissolved metal ions also increases the viscosity of phosphoric acid, reduces settling rate and increases the clarification time. Other process problems associated with phosphoric acid impurities include large heat losses and a large increase in sludge discharge from the concentrated acid storage tank.

There are knock on effects too. Low-quality concentrated acid inevitably causes quality problems in the downstream production of phosphate products, and can even cause the shutdown of downstream processes. The presence of excess impurities within phosphoric acid also reduces the effective production capacity of the whole phosphates complex, increases production costs, and results in significant economic losses at phosphate production plants.

Downstream production

The presence of impurities in phosphoric acid has three main effects on the downstream production of phosphate fertilizers such as diammonium phosphate (DAP) and monoammonium phosphate (MAP).

Increases the viscosity of the ammoniated slurry. Ammonia can react with impurities in phosphoric acid (e.g., iron, magnesium and aluminium) to form various complex ammonium phosphate compounds. These have the following undesirable properties and behaviour:

- Raising the viscosity and specific gravity of ammonium phosphate slurry, negatively affecting its rheological properties
- Creates inconsistent local variations in ammonia content
- Causes production equipment blockages – and ultimately equipment failures that can result in shutdowns.

Lower DAP/MAP product quality. The presence of large amounts of iron, aluminium and magnesium in phosphoric acid reduce its pH value. This can lead to poor neutralisation if the quantity of liquid ammonia added is insufficient. This in turn can generate final products with lower-than-expected nitrogen content. Furthermore, the ammonium phosphate salts generated (iron, aluminium and magnesium types) are insoluble and therefore reduce the available P_2O_5 in the final product, especially water-soluble P_2O_5. This reduces the nutrients available for release by the fertilizer and typically results in poor quality products.

Undesirable colour and physical properties. The use of poor-quality phosphoric acid with high total impurity levels can alter the colour of the final phosphate product. It also generates irregular and poor strength product granules. The presence of magnesium phosphate salts (which are soluble in citric acid) also makes the final product prone to undesirable moisture absorption and caking.

Phosphoric acid impurities

Traditional flocculants and settling agents can only reduce impurities to certain levels and, consequently, the specification of weak/strong phosphoric acid may not satisfy downstream production requirements.

Wuhan Fertchem Technology Co., Ltd. has addressed this problem by modifying and optimising conventional flocculants and settling agents to produce a new and superior purifying agent (NPA100). This multifunctional phosphoric acid additive is designed to solve practical production problems to deliver the maximum benefit. It reacts well with dissolved impurities to allow their easy separation and removal. This reduces costs and improves the efficiency of subsequent purification steps.

NPA100 is an easy-to-handle liquid that contains chelating agents, settling agents, decolourants and surfactants. It functions by:

- Decreasing the surface tension and hence the viscosity of phosphoric acid
- Chelating with calcium, magnesium, iron, aluminium and other dissolved metal ions
- Forming low solubility chelates in phosphoric acid that settle as non-phosphate metal precipitates
- Allowing suspended solids to settle and be adsorbed more easily by altering their surface electrostatic repulsion
- Acting as a flocculant that captures and sweeps away suspended solid impurities
- Having a decolourisation effect via redox reactions.

NPA100 delivers significant benefits for different strength phosphoric acids (20-60% P_2O_5). It has the ability to:

- Reduce minor element ratio (MER) and P_2O_5 losses
- Improve settling rate by 50 percent
- Efficiently remove solids and dissolved metal ions
- Reduce phosphoric acid viscosity
- Deliver cleaner phosphoric acid with improved colour
- Improve the quality of downstream fertilizer end products
- Shorten the clarification time in the settling tank by 50 percent
- Increase the capacity of the phosphoric acid clarification unit
- Enable the utilisation of low quality phosphate ore. ■

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

TOMRA

Cutting the cost of phosphates processing

Jens-Michael Bergmann, TOMRA's area sales manager for Europe, MENA and India

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, over the last two years, 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 two 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. ■

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Phosphates project listing 2023

PHOTO: VERDANT MINERALS

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

Inspection of Ammaroo project phosphate core.

Phosphate rock*

Plant/project	Company	Location	capacity ('000 t)	Status	Start-up date
AUSTRALIA					
Ammaroo	Verdant Minerals	Northern Territory	2,000	FS	n.a.
Ardmore	Centrex	Mount Isa, Queensland	625	UC	2022/24
CANADA					
Lac-à-Paul	Arianne Phosphate	Quebec	3,000	FS	n.a.
Sept-Îles	Mine Arnaud/Yara	Quebec	1,300	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.
SENEGAL					
Baobab	Agrifos	Gadde Bissik	1,000	FS	n.a.
SOUTH AFRICA					
Elandsfontein	Kropz	Elandsfontein	1,000	UC	2022

**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 Khouribga 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.*

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

Plant/project	Company	Location	Product	capacity ('000 t)	Status	Start-up date
BRAZIL						
Santana	Itafos	Para State	Phosphoric acid (P_2O_5)	200	PL	2026
Serra do Salitre	EuroChem	Patrocinio, Minas Gerais	Phosphoric acid (P_2O_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_2O_5)	500	UC	2024
El Wadi	WAPHCO	Abu Tartur	DAP/MAP	800	UC	2024
El Wadi	WAPHCO	Abu Tartur	TSP	600	UC	2024
INDIA						
Orissa expansion	Paradeep Phosphates	Paradeep	Phosphoric acid (P_2O_5)	120	UC	2024
Orissa expansion	Paradeep Phosphates	Paradeep	DAP/NPK	690	UC	2024
Tuticorin expansion	Greenstar Fertilizer	Tuticorin	Phosphoric acid (P_2O_5)	320	UC	2023
Tuticorin expansion	Greenstar Fertilizer	Tuticorin	DAP	680	UC	2024
KAZAKHSTAN						
Taraz	Kazphosphate	Taraz	PPA (P_2O_5)	220	UC	2022
Taraz	Kazphosphate	Taraz	DAP/MAP	480	UC	2022
MOROCCO						
Phosphore 3&4	OCP Group	Jorf Lasfar	Phosphoric acid (P_2O_5)	520	UC	2022
Phosphore 3&4	OCP Group	Jorf Lasfar	TSP/SSP	1,170	UC	2022
Phosphore 3&4	OCP Group	Jorf Lasfar	TSP + S	590	UC	2023
Phosphore 3&4	OCP Group	Jorf Lasfar	NP + S	1,130	UC	2023
NIGERIA						
Lekki	OCP/Nigeria	Lekki	DAP/NPK	650	PL	2024
RUSSIA						
Dorogobuzh	Acron	Dorogobuzh	Phosphoric acid (P_2O_5)	400	PL	2024
Dorogobuzh	Acron	Dorogobuzh	DAP/MAP/NPK	1,000	PL	2024
Volkhov expansion	PhosAgro	Volkhov	Phosphoric acid (P_2O_5)	405	UC	2022
Volkhov expansion	PhosAgro	Volkhov	MAP	1,615	UC	2022
SAUDI ARABIA						
Third mega project	MWSPC	Ras al Khair	Phosphoric acid (P_2O_5)	1,500	PL	post-2024
Third mega project	MWSPC	Ras al Khair	Finished phosphates	3,260	PL	post-2024
TUNISIA						
M'dilla II	GCT	M'dilla	Phosphoric acid (P_2O_5)	180	PL	2026

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 collectively add 2.9 million t/a to Morocco's finished phosphates capacity out to 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 in Brazil, which it bought from Yara last year. 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.*

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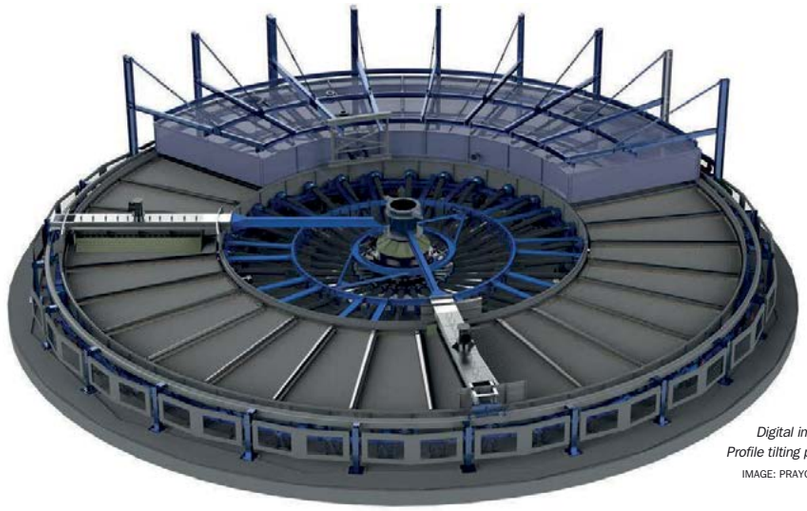
PROJECT TECHNOLOGY AND ENGINEERING PROVIDERS



Digital image of a Profile tilting pan filter.
IMAGE: PRAYON-PROFILE

Profile

When will the pendulum shift?

Paul-Henri Legros, general manager, Profile, a division of Prayon s.a. provides a personal update on latest phosphate industry developments: "It would be a lie to say that 2022 was a good year for the deployment of new production facilities and the development of new projects in the P_2O_5 industry. The unpredictable events in Eastern Europe in early 2022 have created turmoil in the fertilizer industry – and as a result we've seen prices for raw materials and utilities, such as oil, gas and electricity, rocket to levels never seen before.

"As a consequence, investors put their projects on hold and had second thoughts about the way to proceed. Yet now that prices are settling down to more acceptable levels, we're seeing these same investors coming back with their projects, finally thinking that we've all lost one year.

"Because of high P_2O_5 product prices, and demand from a growing world population looking for more and higher quality food, we're seeing a lot of high capacity projects being activated – or should I say re-activated. If all the projects Prayon-Profile are dealing with right now transform into firm construction orders then production worldwide would jump by around 10,000 tonnes P_2O_5 per day.

"That is, of course, a nice position to be in – for Profile and the engineering and the manufacturing world surrounding the P_2O_5 industry – and I strongly believe it will ensure a bright future for the next 4-5 years potentially. But then what?

"Well, we all know there's a need to think green and sustainability, protect nature, and shift to renewable energy sources in the very near future. 2030 is very close now and playing the ostrich by burying our heads in the sand is not an option.

"I strongly believe that these important matters, that will decide our mutual future, must be taken care of by industry professionals – it is time to let engineering define the practical way forward. I am deeply convinced that the technological solutions exist, or will soon exist, and globally we need to anticipate this pendulum shift.

"At Prayon-Profile, we express this succinctly in our vision statement : "Our technology will make the difference." We need to anticipate the future – not just to feel good about the planet's protection – but to ensure our survival, the survival of our partners, the survival of our customers, and the general survival of fertilizer production worldwide.

"Let's remember that fertilizers feed the world and we must be aware of that responsibility in our decision-making and actions.

"Profile, and all P_2O_5 engineering companies in general, are thinking about ways to improve their equipment. This is necessary to save energy, save on costly raw materials and to reimagine machinery where spare parts are more than just waste.

"Profile's decision to switch to 3D models for all of its design work really holds the key to these new developments and ideas. Yes, Prayon's widely installed tilting pan filter will remain a successful tilting pan filter – it will just get a lot more 'green' in the upcoming decade.

"Prayon-Profile's unique position, as a phosphates producer, technology-provider and an equipment supplier for other producers, gives us a clear market edge as it provides us with a life-size laboratory to design and test the future of this industry.

"Although challenging, I am convinced that there is an exciting 'green' future for our industry. On sustainability, the pendulum is moving in our direction fast now – so we need to be ready when it arrives." ■

Desmet Ballestra

Milan-headquartered Desmet 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 and purified phosphoric acid (MGA and PPA), single superphosphate (SSP), triple superphosphate (TSP), potassium sulphate and granulated NPK compound fertilizers.

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

- Feasibility studies
- Process design
- Detailed engineering
- Material supply
- Project implementation
- Plant start-up the phases.

Desmet 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, for example, plants are customised to accommodate different types of phosphate rock.

Under a long-standing agreement with technology licensor Prayon, the company 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 AlF_3 under a technology collaboration with Buss ChemTech. Alternatively, it can be neutralised for disposal.

Desmet Ballestra has offered a phosphoric acid purification option as part of its chemicals technology portfolio since 2015. The purification process involves a sequence of steps to remove impurities – typically arsenic, gypsum, heavy metals, fluorine and chlorine – and achieve the target quality at the required yield.

Desmet Ballestra is also an established supplier of SSP and TSP powder plants. These have been developed through a technology partnership with Italy's Industrie Chimiche Puccioni and incorporate proprietary Kuhlman-Den or Broadfield-Den type reactors. These production processes involve reacting phosphate rock with either sulphuric or phosphoric acid, respectively, to generate SSP or TSP.

Granulation plants for SSP/TSP, DAP/MAP and NPK are also available, based on in-house or Incro pipe-reactor technology. The company also offers plants for water-soluble MAP/DAP production via a strategic partnership with leading technology provider GEA. ■

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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 supervisions steps 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 production 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 H_2SO_4-based) including a phosphoric acid production process based on DCP
- Fluorine gas scrubbing
- Phosphoric acid concentration and fluosilicic acid recovery
- Acidic cooling tower design
- Gypsum 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).

DSAG also offers a comprehensive range of construction services for fertilizer granulation. These services covering the construction of granulation units for:

- Ammonium sulphate (AS)
- Monoammonium phosphate (MAP)
- Diammonium phosphate (DAP
- NPKs more generally.

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 a single point of contact with complete responsibility for the delivery of their fertilizer projects.

DSAG provides a complete range of services to fertilizer industry clients 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, front end engineering design (FEED), capex and opex estimates, including all on-site and off-site facilities
- Financial studies
- Overall project management
- 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

IMAGE: DE SMET AGRO

Client: Verdant Minerals Ltd
Location: Northern Territory, Australia
Project: Ammaroo phosphate project: di-hydrate (DH) phosphoric acid definitive feasibility study (DFS)

In 2022, DSAG completed a definitive feasibility study (DFS) with an AACE Class 2 capex estimate for Verdant Minerals, the developer of the Ammaroo project. This study examined the technical and economic feasibility of producing fertilizer-grade phosphoric acid from phosphate rock using Prayon's dihydrate (DH) process for subsequent MAP/DAP production. The proposed phosphoric acid plant had a design capacity of 1,580 t/d (P_2O_5).

Left: 3D model of the concentration section of the proposed phosphoric acid plant for the Ammaroo phosphate project.

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, SO_4, Mg. etc.) The PUMA process, which uses membrane technology, can also be applied when a larger purification step is required.

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.

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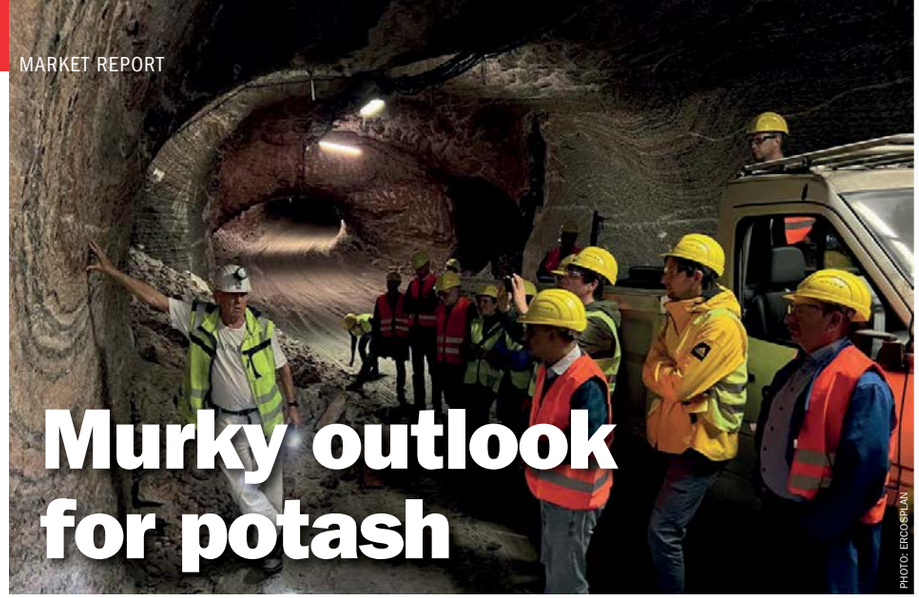

Murky outlook for potash

PHOTO: ERGOBRIAN

The global potash market has endured a tumultuous 18 months, says **Andy Hemphill**, senior editor for potash and sulphuric acid at ICIS Fertilizers. Export sanctions, high offer prices and buyer unrest persist as we enter 2023.

Above: Potash mine, Sondershausen, Germany.

Two key attributes

Being extracted, processed and sold on a massive scale, muriate of potash (MOP) has two remarkable attributes. Firstly, It's one of the world's largest fertilizer types by volume – with an annual global production capacity of around 90 million tonnes and a traded volume of circa 70 million tonnes. Secondly, the global MOP market is dominated by just a handful of large-volume producers.

These two attributes reflect the nature of the product: MOP is an umbrella term for potassium chloride (KCl) fertilizers, usually offered in the form of bulk granules or occasionally as a powder. These products are simple to bag and ship and can be used straight or blended. MOP is also relatively painless to mine, process and granulate – compared to the phosphate fertilizer production process and the chemical manufacturing of ammonia and urea.

What really marks out MOP, though, is the limited locations where potash is found and commercially extracted as a mineral fertilizer. These are restricted to approximately 18 countries around the globe.

Table 1: **The world's Top-five potash-exporting countries, 2018-2020 (tonnes)**

	2018	2019	2020
Canada	21,903,198	19,526,292	21,250,960
Belarus	10,959,677	10,323,956	11,758,388
Russia	8,752,870	9,354,119	9,524,784
United States	3,651,795	3,216,264	3,192,572
Spain	741,652	655,717	400,832

Source: TDM via ICIS

Pre-2021 market stability

Prior to 2021, the global potash market was relatively stable, with three large Canadian, Belarusian and Russian producers and exporters predominating (Table 1). State-run Belaruskali and its MOP marketing arm Belarus Potash Company (BPC) controlled Belarusian exports, while Uralkali marketed Russian potash mined from that nation's considerable deposits. In Canada, MOP marketing firm Canpotex handled exports for North America's two major potash producers, Mosaic and Nutrien (the world's largest fertilizer company).

Each year, key benchmark supply contracts for MOP – agreed between the large-volume producers and major buyers in China and India – offered the potash market price direction for the year ahead. Palm oil plantations in southeast Asia generally filled their warehouses with MOP with ease, while agricultural powerhouse Brazil regularly became a hotbed of import activity, thanks to its almost endless appetite for granular MOP.

May 2021 changes everything

The MOP trade has been a lucrative export earner for those countries where raw potash ore can be successfully extracted at scale, processed and sold commercially. Looking back, the market was enjoying a period of relatively calm – up until the moment when Belarus forced Ryanair Flight 4978 out of the skies. This catalytic event kicked-off a period of unprecedented change that, while still unfolding, has completely rerouted the potash market and its long-established supply/demand dynamics.

In May 2021, Minsk ordered the grounding of Flight 4978, ostensibly because of a bomb threat, before removing dissident blogger Roman Protasevich and his partner Sofia Sapega from the aircraft. The two are still in custody at the time of writing (December 2022).

Western countries quickly condemned the move and were fast to act. In a few short months, they imposed sanctions on the money-spinning Belarusian MOP export industry, as well as a wide variety of other export goods. Belarusian business leaders who had been profiting from president Aleksandr Lukashenko's regime were also sanctioned individually.

The largest repercussion of these sanctions was the ending of a longstanding agreement between Belarusian Potash Company (BPC, the country's state-run MOP marketing arm) and two key partners in Lithuania – the port of Klaipeda and Lithuanian Railways. Klaipeda was BPC's primary MOP export hub and distribution centre for its worldwide sales. BPC was also reliant on Lithuanian Railways for trans-shipment via this essential port.

In effect, sanctions at a stroke cut off the main MOP supply route from landlocked Belarus to the global marketplace – including the three key MOP-consuming nations, India, China and Brazil (Table 2).

While Minsk responded to its exclusion from the Baltic with talk of exporting MOP through overland routes via Russia, industry sources dismissed this option as unworkable, particularly as Russian ports are already busy shipping Russian MOP. Aleksandr Lukashenko's government subsequently suggested that Russia would build additional port capacity dedicated to Belarusian tonnages – a claim that has yet to be realised.

India's buyers, meanwhile, signalled their willingness to continue buying Belarusian MOP by talking-up the prospects or a rupee-denominated trade deal. This was, however, quickly dismissed as "posturing [by Indian buyers] to get [other] people to notice and close contracts", according to one trader in late 2021.

Unlikely or not, before such a deal could be put together, another disruptive jolt hit the global MOP market at the end of February 2022: Russia invaded Ukraine – with military forces crossing into its neighbour from Belarusian territory to do so.

Predictably, The Lukashenko regime's support for the invasion caused a fresh wave of sanctions to come crashing down on the Belarusian MOP industry, closing any remaining loopholes that were left. This time around, the EU effectively banned around 70 percent of its MOP imports from Belarus, closing down any overland road and rail supply routes which were still open.

The consequence was that, by mid-2022, Belarus was largely cut off from the global MOP market. The country's vast stockpiles of potash were left awaiting shipment through Russia and into China by railway, or for shipment to Russian ports for export to other destinations, albeit in far smaller volumes than normal.

By September 2022, the Belarus Potash Company was thought to have exported only 4-5 million tonnes of MOP in the year-to-date – less than one-third of its normal annual production capacity of circa 13 million tonnes. At that time, monthly Belarusian MOP production was heard to be languishing at around 300,000 tonnes. Since then, however, reliable MOP export information has been hard to come by, as Belarus ceased issuing customs data in late 2021.

The war in Ukraine

With Belarus potash supply largely blocked by sanctions, that left Canada and – briefly – Russia as the two largest suppliers of MOP to the global marketplace.

Table 2: **Top-five potash-importing nations, 2018-2020 (tonnes)**

	2018	2019	2020
United States	12,949,089	11,664,467	12,057,406
Brazil	10,656,538	10,668,138	11,510,427
China	7,668,587	9,382,479	9,051,946
India	4,783,426	4,322,803	5,176,922
Indonesia	3,534,512	2,834,921	2,884,922

Source: TDM via ICIS

Russia's invasion of Ukraine on 24th February 2022 was met with widespread and immediate condemnation of president Vladimir Putin and his regime, and soon after attracted a wave of Western sanctions on Russian exports, businesses, and oligarchs.

While Western sanctions did not specifically target Russia's potash exports, there were mounting concerns that these would be indirectly affected. Restrictions on bank transactions, for example, were making commodity trading with Russia increasingly difficult. Getting insurance for shipping to and from Russia was also becoming problematic. Additionally, there were drastic boardroom reshuffles at several major Russian and Russian-owned fertilizer producers due to sanctions aimed at specific Russian oligarchs. Unsurprisingly, Russian MOP exports declined steadily in response to these cumulative effects.

Fertilizer market impacts then worsened when the European Commission extended EU export sanctions to include a range of fertilizer products – including phosphate fertilizers, MOP, nitrates and NPK blends – in October 2022. Although these sanctions stopped short of entirely banning the import of Russian MOP into Europe, tonnages are thought to have declined in recent months, compared to the volumes seen in recent years (Table 3).

Across the global potash market, the result was that buyers spent late 2021 and much of 2022 wondering where their MOP tonnages were going to come from.

Offers skyrocket

During the first half of 2022, MOP import prices at most ports climbed rapidly as sanctions on Belarus and Russia spurred a wave of panic-buying.

Brazil – having little domestic potash production of its own – experienced the most pronounced price rises. By March 2022, potash import prices peaked at $1,250/t cfr (cost & freight) Brazil – the highest price ever recorded by ICIS. Supply concerns led buyers to stock-up, while producers granulated as much MOP as they could to ship to potash-hungry Brazil.

March's peak was then followed by a slow decline in MOP price offers during the rest of the year (Figure 1). This was due to a sluggish Brazilian market characterised by weakening potash demand and growing oversupply. Essentially, given ample availability, Brazilian buyers were reluctant to purchase potash at elevated prices they had not budgeted for.

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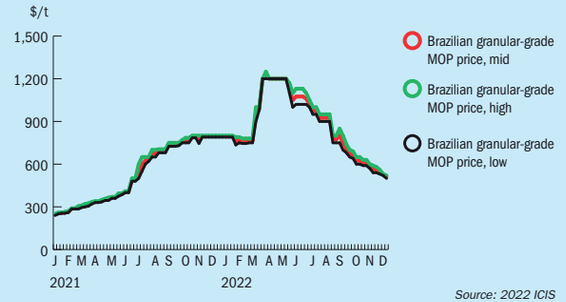
Table 3: **EU member states: top-nine Russian MOP importing countries, 2019-2021 (tonnes)**

Member state	2019	2020	2021
Estonia	437,051	836,783	760,135
Finland	381,965	386,711	423,387
Poland	226,034	189,163	207,959
Belgium	198,680	187,943	176,359
Romania	110,892	60,200	54,579
Netherlands	75,192	17,856	37,525
Latvia	23,422	24,494	15,666
Lithuania	20,457	62,601	61,161
Hungary	18,063	26,174	25,967
World total	**9,354,119**	**9,524,784**	**11,834,770**

Note: no data released for 2022 *Source: Russian customs via TDM*

Fig. 1: **Price range (cfr) for Brazilian granular-grade MOP (high, mid, low), January 2021-December 2022**



Source: 2022 ICIS

In Europe, the high price of standard- and granular-grade MOP led some farmers to delay their purchases. Russia's invasion of Ukraine also left Europe's sulphate of potash (SOP) producers reluctant to fire up their Mannheim furnaces – due to worries over the effects of high natural gas and power prices on their margins.

Having emerged as the world's largest undisputed MOP producer in recent months, Canadian producers responded to the supply shortfalls and all-time price highs in 2022 by upping their output. Indeed, Canada's Nutrien revealed plans to raise its potash production in 2022 by nearly one million tonnes to 15 million tonnes. Although substantial, this boost to global supplies still fell well short of the deficit left by the absence of Belarus from the global MOP market and the reduction in Russian tonnages.

Elsewhere, producers in Germany, Israel, Jordan, Chile, and other smaller enterprises, also stepped in to meet demand where they could.

In southeast Asia, offers for standard- and granular-grade MOP showed the same pattern of all-time highs followed by slow decline seen in Brazil. It was a similar story in China, where supply concerns saw the country's MOP import prices spike.

Chinese domestic MOP availability was already tight before the Russia-Ukraine conflict began, as importers had opted to sit on inventories rather than sell, in expectation of higher prices to come. This standoff forced Beijing to release product from national stockpiles to ensure MOP price offers remained at a reasonable level for buyers.

BUMPER PROFITS FOR POTASH PRODUCERS

Potash producers in Canada, Germany and Israel have been well placed to capitalise from the global potash market's supply shortfall. Companies such as Mosaic, K+S and ICL have stepped in to fill the deficit left by reduced Russian MOP exports and the increasing withdrawal of Belarus from key MOP import markets. As a result, these companies have raked in proceeds, as is shown by the leap in potash sales and earnings this year (Table 4).

Table 4: **Selected potash producer earnings, Q3 2022 vs Q3 2021**

	Third quarter 2022	Third quarter 2021
Mosaic, Canada		
Net sales ($, billion)	5.35	3.42
Operating earnings ($, billion)	1.2	0.70
Net earnings ($, million)	841.7	371.9
K+S, Germany		
Revenues (€, million)	1,469.9	746.3
EBITDA* (€, million)	633.3	120.7
ICL, Israel		
Sales ($, million)	2,519	1,790
Operating income ($, million)	935	321

**Earnings before interest, tax, depreciation and amortisation*
Note: Results are for potash business segments only.
Results for leading global potash producer Nutrien not included. *Source: ICIS/company results*

China typically imports around 60 percent of its annual MOP requirement. Russia is usually the country's second-largest supplier, thanks to well-established rail links. Belarusian supply is now also proving popular in China – this notably being the one route to market not curbed by Western sanctions.

What next for the potash market?

At the start of a new year, the foremost question in potash player's minds is always the same: "What happens next?" 2023 is no different.

Frankly, though, there is no clear path out of the disruption inflicted on the global MOP market over the last 18 months. In particular, the loss of a huge portion of the 12 million tonnes of annual exports from Belarus has left the global market with an immense supply shortfall, thanks to sanctions and export restrictions.

Yes, Russia is still exporting. But the volumes leaving Russian borders are well below expectations – a situation that is unlikely to change until the Ukraine invasion ends. Even then, some judge it very unlikely that borders will immediately open, given the attitude of the west to Russia's unprovoked attack on its neighbour to the west.

While MOP producers in Canada, Israel, Jordan and Germany have – where possible – all raised their output to help meet demand, these additional tonnages are mainly earmarked for high-return destinations such as Brazil, or being directed to existing contract customers to make up for lost tonnages from Belarus and Russia.

This situation has left large-volume standard-grade MOP buyers in China and India – two countries that traditionally set bellwether benchmarks for the whole industry – cripplingly short of tonnes. Then there is the question of the annual import contracts for both China and India – contracts for which Belarus is typically the first to secure a price settlement.

With Belarusian tonnes hard to come by, many players feel that Canpotex, Canada's MOP marketing giant, will now fill the role of market trendsetter. There are already signs that this is happening. In late September, Canpotex signed a memorandum of understanding with three long-time customers, Indian Potash Limited, Coromandel, and Chambal Fertilizers, for the supply of up to 500,000 tonnes of potash annually between 2023-2025.

While it is true that substantial additional potash production capacity is expected to emerge, this is not expected to come fully online for up to five years – doing little to ease the immediate shortfall. Essentially, the current global MOP shortfall cannot be filled tomorrow, next year, or the year after.

In the interim, a lack of potash availability could see some farmers opt to skip applications or swap potash for additional nitrogen or phosphorous fertilizer applications – decisions that might not affect some crops too badly for a couple of years. Other crops, however, will suffer quickly from a lack of potassium. The resulting yield reductions then risk a vicious circle of reduced fertilizer purchases and eventual demand destruction.

High potash prices are also here to stay in the short-to-medium term, although these are unlikely to climb to the highs seen in mid-2022 – mainly because of the reluctance (and/or inability) of farmers to pay for fertilizer inputs which are this expensive.

What is clear is that the supply/demand dynamics of the global potash market have already changed forever – and that these changes still have some way to go.

Laos potash pushes further into southeast Asian markets

MOP exports from Laos have enjoyed an increased presence in southeast Asian markets since the beginning of the Belarus/Russia supply squeeze, offering a lower-cost alternative to imports from Europe and North America.

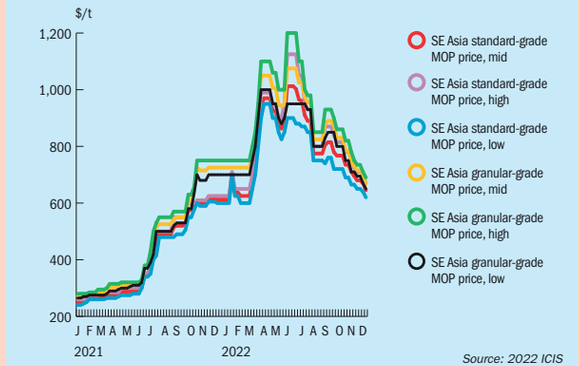
Standard-grade MOP product from Laos is primarily shipped in powdered form. This is typically priced at a discount relative to standard- and granular-grade MOP imported from Russia, Germany and Canada. Potash buyers in the region have therefore taken to supplementing Canadian and European MOP imports with tonnes from Laos to reduce overall expense.

There is expectation that investment by potash producers in Laos will soon improve the availability of standard-grade product in granular form from the country. Greater amounts of granular-grade MOP from Laos, which commands a premium over standard-grade MOP, will also become available.

The price of potash imports into southeast Asia climbed fast in 2022, driven upwards by supply concerns following sanctions placed on Belarus, and Russia's invasion of Ukraine, eventually hitting $1,200/t cfr (cost & freight) in June (Figure 2).

Price offers subsequently declined to around $600-700/t cfr by December 2022 for both standard- and granular-grades. While these price levels were at considerable discount from earlier in the year, offers are still more than double the $250-280/t price range seen in January 2021, before the first wave of sanctions were placed on Belarus.

Fig. 2: **Price ranges (cfr) for standard- and granular-grade MOP southeast Asia (high, mid, low), January 2021-December 2022**



Source: 2022 ICIS

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