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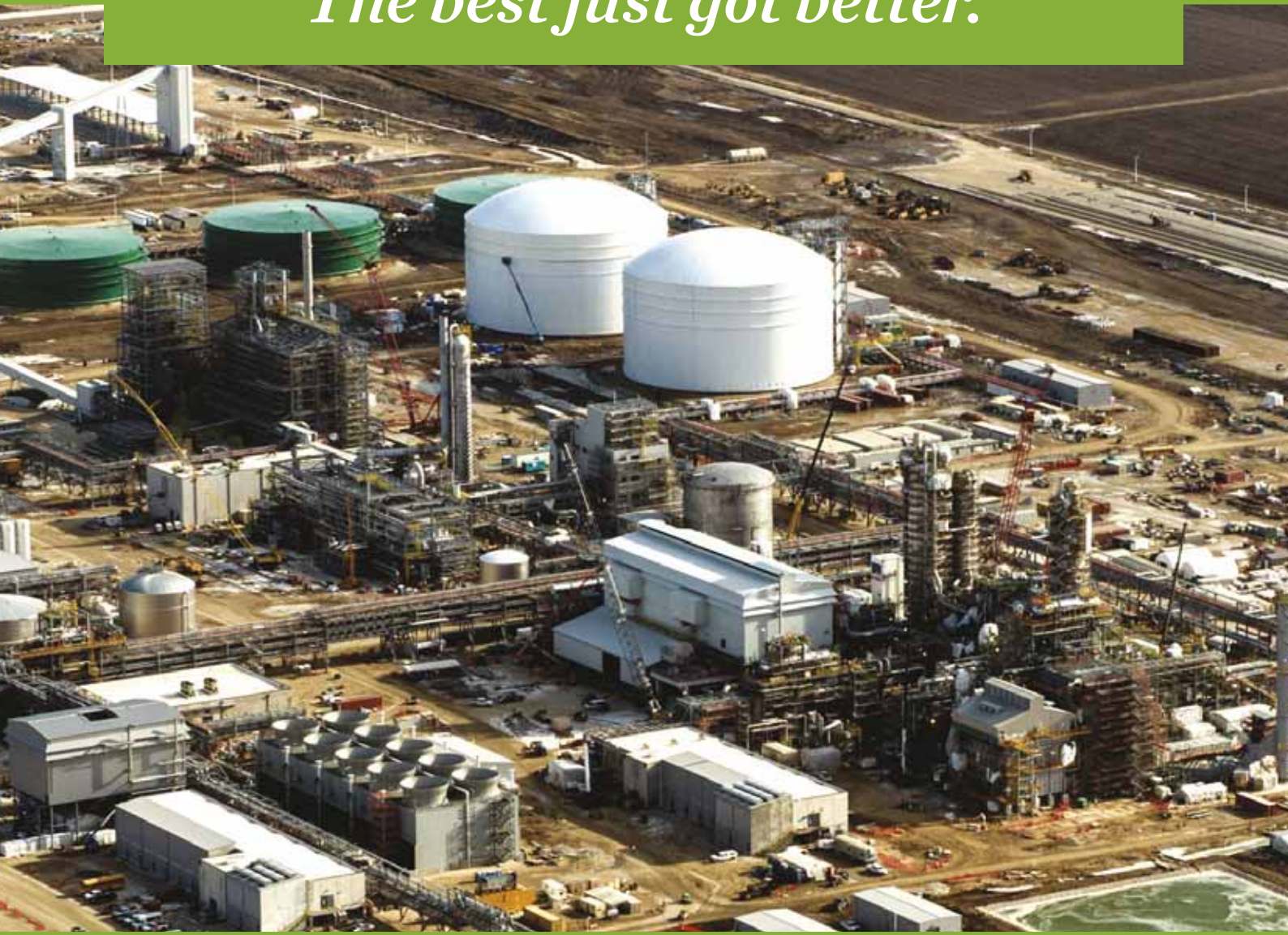
MAGAZINE | MAY/JUNE 2017

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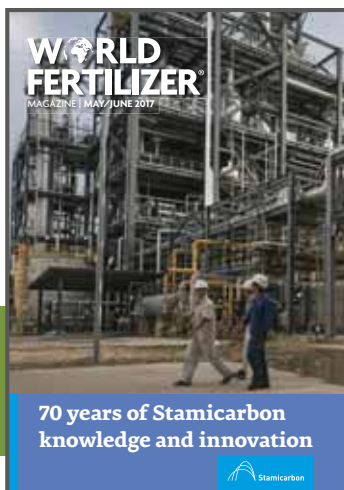
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ON THE COVER

Stamicarbon, a world class technology licensor, is celebrating their 70th anniversary. An overview of their history and innovative track record is described on p. 51. Their Full Life Cycle support offers technologies, products and services for new urea plants as well as for optimising and upgrading existing facilities.

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COMMENT

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With a current population of 1.242 billion, Africa is the second most populated continent after Asia (4.473 billion). However, whilst Asia has benefitted from a so called 'Green Revolution' that by systematically improving harvest yields has led directly to reduced poverty, Africa in contrast, lags somewhat behind from an agricultural perspective, in many instances utilising techniques and practices that have not changed for centuries.

This is a continent that therefore represents an untapped market and a tremendous opportunity for the fertilizer industry. BMI Research notes in its recent 'Africa Fertiliser Outlook' that Africa and the Middle East, as a whole, account for just 3.9% of world fertilizer consumption. In Africa, just five countries (Egypt, Kenya, Nigeria, South Africa and Zambia) account for two-thirds of fertilizer consumption. However, recent efforts have shown that improving the lot of African farmers is no easy task.

Although it is urbanising faster than anywhere else on the planet, fundamentally Africa remains a rural continent – 60% of the population live in non-urban environments. Compare that to Europe where the population is 74.5% urban or North America where the figure rises to 82.8%. As a result, vast tracts of Africa are engaged in agricultural cultivation but by and large this is small-scale subsistence farming. Yields are low because soils have become severely nutrient depleted and are not being adequately replenished. An estimated US\$4 billion of soil nutrients are lost across the continent each year. Where fertilizers are available, poor infrastructure (roads, ports and storage), weak currency (most fertilizer is imported to African nations) and politics (and in some instances corruption) make it an expensive commodity well beyond the means of most small-scale farmers. As a consequence, Africa is forced to import approximately US\$40 billion of food each year. This need not be the case. Certainly Africa is all too often afflicted with headline grabbing humanitarian disasters (droughts, famines, etc.) but on balance and, with the correct investment, incentives and overall political will, it can not only meet its own needs but be a major exporter of food and produce.

In 2006, the African Union of Ministers of Agriculture met in Abuja, Nigeria, to adopt a framework, entitled the Abuja Declaration, aimed at kick starting the 'Green Revolution' in Africa. A key tenet of this accord was to increase fertilizer usage across Africa from an average of 8 kg per hectare, a mere 10% of the world's average, to 50 kg per hectare by 2015. Commitment was made to invest in making fertilizer readily available to farmers as it was recognised that food production rates could not be sufficiently enhanced without increased fertilizer use. Today, over ten years on from this landmark agreement, it is fair to say that no country has yet met their 2015 target. Africa currently averages just 12 kg per hectare whilst conversely Asian countries, such as Malaysia and Hong Kong, average 1570 kg and 1297 kg respectively.

However, there are encouraging signs that steady progress is being made. Nigeria's Vice President, Yemi Osinbajo, recently reported that better seeds, equipment and huge improvements in fertilizer supply had led to a tripling of rice production to 5 million tpy. Where the country had imported 580 000 t in 2015, it only imported 58 000 t in 2016. Improvements have also been made to the country's grain production to the point that Nigeria is today a net exporter of grains. Elsewhere, between 2005 – 2015, Ethiopia recorded an increase of fertilizer usage from 11 kg per hectare to 24 kg per hectare and similarly usage in Ghana and Kenya increased from 20 kg to 35 kg and 33 kg to 44 kg respectively. Each of these countries saw corresponding hikes in agricultural yields.

What is also encouraging are a number of significant ongoing and planned fertilizer projects in locations across Africa. Indeed, *World Fertilizer* Assistant Editor Harleigh Hobbs discusses just such a project in Eritrea with Punkaj Gupta, Chief Executive of the Essel Group, on p. 24 of this issue.

With fertilizer usage predicted to hit an average of 17 kg per hectare in Africa in 2018, twice the level of 2005, perhaps there are finally signs that the continent is beginning to embrace the 'Green Revolution' that has long been recognised as the key to its sustained economic development.

SUBSCRIPTIONS

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WORLD NEWS

OMAN EPC contract awarded for ammonia plant

SNC-Lavalin has been awarded a contract by Salalah Methanol Co. LLC (SMC) for the engineering, procurement and construction (EPC) of an anhydrous liquid ammonia plant, including its utilities and offsite infrastructure, in the city of Salalah, located in the Sultanate of Oman.

The project was expected to begin in March 2017 with SNC-Lavalin initially performing the early works programme. Upon closing of financing by SMC, expected to occur in June 2017, SNC-Lavalin will continue with the engineering, procurement of equipment, construction and commissioning of the facility, which will produce anhydrous liquid ammonia using a technology provided by Linde Group.

SNC-Lavalin's Abu Dhabi office will be responsible for

the project delivery, supported by local and international resources, while maximising the use of in-country expertise and local workforce during the construction phase.

"SNC-Lavalin has gained direct and relevant experience across our four sectors of activity over the past 40 years in United Arab Emirates and the greater Middle East region," said José J. Suarez, President, Mining & Metallurgy, SNC-Lavalin. "This new contract is testament of our continued commitment to the region and strong expertise in delivering world-class industrial facilities, while integrating a wide range of technologies in our projects," he added. "We are proud to work with SMC in developing this new exciting project."

CANADA New potash mine officially opens

At the start of May, K+S celebrated the opening of its new potash mine in Canada with 700 guests, including the Honourable Brad Wall, Premier of Saskatchewan, and numerous local government dignitaries, representatives from suppliers and employees.

The five-year construction phase has been successfully completed and the first tonne of marketable potash is expected to be produced in June as planned.

During the opening, the new potash mine, which ran under the project name Legacy, received its new name "Bethune". K+S upheld the Saskatchewan potash mining tradition of naming its facility after the closest neighbouring town.

"With our new location, we are making a huge

step forward in the internationalisation of our potash business," said Norbert Steiner, Chairman of the Board of Management of K+S Aktiengesellschaft. "Bethune enables us to participate in future market growth, reduce our average production costs and strengthen our international competitiveness, which will benefit the entire K+S Group."

K+S projects the mine will produce its first marketable tonne of potash at the end of June. In the course of the year, the first potash transport by freight train will take place from the site in southern Saskatchewan to the new K+S port facility in Vancouver, from where the potash will be shipped to customers mainly in South America and Asia. K+S also expects to achieve the desired production capacity of 2 million t by the end of 2017.

USA New urea plant commissioned in Texas

In April, Canadian potash company Agrium Inc. announced it had successfully commissioned its new urea plant with its first run of urea production at the Borger Nitrogen Operations facility in Texas.

The company has said that it continues to ramp up production and expects to reach full operational capacity by the end of the second quarter of 2017.

The new urea facility has a capacity of 610 000 t of urea, of which 100 000 t of urea equivalent will be Diesel Exhaust

Fluid (DEF).

"The successful completion of our first run of urea production from our Borger nitrogen expansion project continues to emphasise our commitment to operational excellence and creating shareholder value at Agrium. We look forward to bringing our reliable and high-quality urea and DEF products to existing and new customers in this key agricultural region of the US," commented Agrium's President and CEO, Chuck Magro.



WORLD NEWS

IN BRIEF

Morocco

FLSmidth has won a five-year contract from OCP S.A. (formerly known as Office Chérifien des Phosphates) to operate port equipment for handling phosphate, fertilizer and sulfur at a port located in Jorf Lasfar, El Jadida, 100 km south of Casablanca. The contract marks FLSmidth's first operation and maintenance contract in Morocco.

Mali

Great Quest Fertilizer Ltd has entered into a partnership with Salam Mineau SARL to create a jointly owned and managed Malian mining and trucking company for the development of the Tilemsi phosphate deposit.

Salam Mineau and Great Quest will jointly create a Malian company (NewCo) to complete mining tasks on the Tilemsi mining permits, transport mine material to the planned beneficiation plant and transport enriched phosphate rock to the planned blending and granulation facility.

Ethiopia

Circum Minerals Ltd have been advised that their application for a mining licence for the Danakil potash project located in the Danakil region of northeastern Ethiopia has been approved by the Council of Ministers of the Federal Democratic Republic of Ethiopia.

The mining agreement provides exclusive access over the 4.9 billion t NI 43-101 compliant potassium resource contained within the 365 km² license area for an initial period of 20 years and is renewable indefinitely for further 10 year periods, provided that financial viability continues to be demonstrated.

USA Iowa plant inaugurated

Iowa Fertilizer Co. (IFCo) and its parent company, OCI N.V., has officially started production at its plant in Wever in southeast Iowa.

The Governor of Iowa, Terry Branstad, Lt. Governor Kim Reynolds, the Lee County Board of Supervisors and others joined OCI in an event to inaugurate one of the largest private sector construction projects in the state's history and the first world-scale, greenfield nitrogen fertilizer facility built in the US in more than 25 years.

IFCo has commenced production and sales. The plant will produce approximately 1.5 – 2 million tpy of nitrogen fertilizer products and can alternate between products at short notice, depending on market demand.

The event in Wever marks the culmination of a five-year collaboration between state and local economic development leaders, Republican and Democrat officials in southeast Iowa, the agricultural community, IFCo, and state leaders led by the Branstad-Reynolds Administration.

CHINA Sulfuric acid plant development underway

Yidu Xingfa Chemical Co. Ltd (Xingfa) has awarded DuPont Clean Technologies contracts for the engineering and technology licence for a 3600 tpd MECS[®] MAX3[™] sulfuric acid plant. This project will make the Xingfa sulfuric acid plant one of the largest in China.

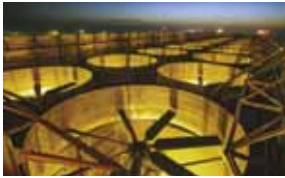
Xingfa is expanding its existing fertilizer site, located in the Hubei province near Yichang city, with the aim of roughly doubling the phosphate fertilizer capacity.

The new MECS MAX3 sulfuric acid plant will process 1.2 million tpy of sulfuric acid, as well as support the production of an additional 400 000 tpy of phosphoric acid, 400 000 tpy DAP and 35 000 tpy of potassium phosphate monobasic.

"DuPont Clean Technologies is very pleased to be providing its proprietary MECS[®] MAX3[™] technology for Xingfa's expansion project to enable the company to become one of the most efficient fertilizer producers in China. This MAX3[™] sulfuric acid plant is not only a significant step for both DuPont and Xingfa, but also for the sulfuric acid industry," said Eli Ben-Shoshan, President of DuPont Clean Technologies, "Never before has sulfuric acid technology delivered more value to the end-user. MAX3 not only offers sulfuric acid plants savings in water usage, time and money, but it also allows them to recover more energy while achieving best-in-class emission levels."

The MAX3 sulfuric acid plant for Xingfa's expansion project will have both high pressure and intermediate pressure steam generation that will be used to produce electricity and provide heat to the plant. The MAX3 sulfuric acid plant combines a suite of technologies, including two recent technology breakthroughs – SolvR[®] and SteaMax[™] heat recovery – in a revolutionary simplified sulfuric acid flow scheme.

The Xingfa configuration will produce more than 1.5 t of high pressure steam per tonne of acid, which is an increase of more than 25% over conventional acid plant technologies. SolvR[®] is the second-generation regenerative technology which demonstrated best in class SO₂ emission abatement at the first commercial installation.



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WORLD NEWS

IN BRIEF

Algeria

SAMSON Materials Handling has received an order from Sorfert in Algeria for two identical Samson® material feeder units designed to receive bulk prilled urea from 30 t tipping trucks. These new Samson® feeders will discharge into the existing SAMSON shiploaders, which have been operational on site at the Aznew Industrial complex since 2010.

These material feeders are of a rubber belted apron design mounted onto a pneumatic wheeled axle under gear. They will convey the prilled urea on a 3 m wide oil and fat resistant belt and discharge via an integral centralising head chute to the shiploader.

India

Bharat Heavy Electricals Ltd (BHEL) has won an order for a steam and power generation package from Ramagundam Fertilizers and Chemicals Ltd (RFCL) for its fertilizer plant at Ramagundam in Telangana. BHEL's scope of work includes design, engineering, manufacture, supply, erection, testing and commissioning of a 32.5 MW gas turbine, 125 tph heat recovery steam generator, 85 tph utility boiler and balance of plant (BoP) package along with associated auxiliaries on a lump sum turnkey (LSTK) basis, including mandatory spares.

Europe and the Middle East

Toyo and Koch-Glitsch have formed a new partnership to distribute Toyo's innovative energy-saving distillation system, SUPERHIDIC®, to new global markets in Europe and the Middle East.

GERMANY Urea and elemental sulfur fertilizer successfully granulated

Shell and Sandvik have successfully granulated urea and elemental sulfur fertilizer produced with Shell Urea-ES technology, using Sandvik's Rotoform granulation system.

Building on years of joint experience in the field of sulfur granulation, the companies joined forces and successfully demonstrated the integration of the Shell Thiogro Urea-ES technology and Sandvik Rotoform equipment during a series of continuous plant trials at Sandvik's productivity centre in Fellbach, Germany. Shell's technology and the versatility of the Sandvik equipment enabled the production of Shell Urea-ES granules containing up to 70% of finely dispersed elemental sulfur in a urea matrix.

In the Sandvik Rotoform system, the homogeneous Shell Urea-ES emulsion is fed to the unit and deposited in the form of drops (diameter of 2 – 4 mm) across a steel belt cooler. Water is sprayed against the underside of the solid steel belt (ensuring no cross contamination either to product or to water. As the product moves along the steel belt, the liquid droplets are converted into solid pastilles. The final solid product is collected at the end of the belt and sent to the downstream handling system (conveying, storage silo, bagging, etc.).

To support industrial deployment, Sandvik and Shell are finalising their combined design to support installation in greenfield and brownfield projects, which will allow current and new Rotoform owners to expand their product portfolio by enabling the production of Shell Urea-ES fertilizer.

RUSSIA Ammonia plant contracts awarded

KBR Inc. has been awarded Operator Training Simulator (OTS) and Reliability Based Maintenance (RBM) services contracts by JSC EuroChem Northwest for their ammonia plant under construction in Kingisepp.

The OTS will provide a cost-effective solution for training operators for a safe and efficient plant start-up and continued ongoing operational training. The RBM will enable proactive monitoring of assets and formulation of appropriate reliability strategies, which will lead to continuous improvement of performance, improved safety and higher productivity.

Under the terms of the contracts, KBR will provide turnkey delivery of the OTS and RBM solutions and services for the Kingisepp ammonia plant with design capacity of 2700/2890 tpd (1 million tpy). The new plant uses KBR's highly efficient Purifier™ ammonia technology.

"KBR is pleased to have the opportunity to provide OTS and RBM for JSC EuroChem Northwest," said John Derbyshire, President, KBR Technology and Consulting (T&C). "KBR is committed to providing state-of-the-art solutions for safe plant start-up and operations and providing an environment to achieve preventative and predictive maintenance activities of the ammonia plant."

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WORLD NEWS

DIARY DATES

2017 AIChE Clearwater Convention
9 – 10 June 2017
Clearwater, USA
www.aiche-cf.org

IFS Technical Conference 2017
29 – 30 June 2017
London, UK
www.fertiliser-society.org/event.aspx

North American Fertilizer Transportation Forum
20 – 22 August 2017
www.fertilizercanada.ca/about-fertilizer-canada/events/north-american-fertilizer-transportation-forum

Fertilizer Canada 72nd Annual Conference
21 – 23 August 2017
Banff, Canada
www.fertilizercanada.ca/about-fertilizer-canada/events/fertilizer-canada-72nd-annual-conference

62nd Annual Safety in Ammonia Plants and Related Facilities Symposium
10 – 14 September 2017
New York, USA
www.aiche.org/conferences/annual-safety-ammonia-plants-and-related-facilities-symposium/2017

TFI World Fertilizer Conference
17 – 19 September 2017
San Francisco, USA
www.tfi.org/conferences

ANNA Conference 2017
1 – 6 October 2017
Austin, USA
www.an-na.org/2017-anna-conference

Sulphur 2017
6 – 9 November 2017
Atlanta, USA
www.crugroup.com/events/sulphur

NORWAY World's first fully electric and autonomous cargo ship

Yara has announced that it is building a battery-powered ship that will be able to drive itself by 2020 – the world's first fully electric and autonomous container ship, with zero emissions.

The new ship, named “Yara Birkeland” after Yara's founder, the famous scientist and innovator Kristian Birkeland, will be the world's first fully electric container feeder. Yara's new vessel will reduce NO_x and CO₂ emissions and improve road safety by removing up to 40 000 truck journeys in populated urban areas.

Operation is planned to start in the latter half of 2018, shipping products from Yara's Porsgrunn production plant to Brevik and Larvik in Norway.

Birkeland will initially operate as a manned vessel, moving to remote Yara operation in 2019, and is expected to be capable of performing fully autonomous operations from 2020. The new zero-emission vessel will be a game-changer for global maritime transport, contributing to meet the UN sustainability goals.

“As a leading global fertilizer company with a mission to feed the world and protect the planet, investing in this zero emission vessel to transport our crop nutrition solutions fits our strategy well. We are proud to work with KONGSBERG to realise the world's first autonomous, all-electric vessel to enter commercial operation,” said Svein Tore Holsether, President and CEO of Yara.

RUSSIA Technology selected for VolgaKaliy mine

EuroChem Group AG has selected Veolia Water Technologies' proven HPD® crystallisation technology for its VolgaKaliy mine expansion project in Russia's Volgograd region.

The HPD PIC™ crystalliser system will be used for the production of 2 million tpy of high purity (98.5%) potassium chloride fertilizer from brine produced from conventionally mined sylvinitite ore. Veolia designed the system such that process heat will be optimally reused to maximise the temperature of the spent brine back to the ore leaching process.

Clark Bailey, Heading of Mining at EuroChem, commented: “With their proven experience and talented team, EuroChem is pleased to be working with such a strong partner as Veolia. The expansion phase of our VolgaKaliy project will increase the plant's capacity to 4.3 million tpy of potassium in grades suitable for both agricultural and industrial applications to better diversify our portfolio and markets. Our first phase continues to be on track to begin production in mid-2018.”

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POTASH: HI-TECH OPTIONS

GORDON COPE, WORLD FERTILIZER CONTRIBUTING EDITOR, OUTLINES THE WIDE SELECTION OF INNOVATIVE TECHNOLOGIES AVAILABLE TO POTASH COMPANIES IN ORDER TO GAIN A COMPETITIVE EDGE.

The potash sector is going through a rough patch. Supply is up, consumption is down, and prices are in the doldrums. Potash companies are reacting in traditional commodity-sector fashion; higher-cost mines are being closed, mergers and acquisitions are underway (such as the blockbuster PotashCorp/Agrium deal in 2016), and operations and maintenance are being squeezed for efficiencies and money saving.

But there is a unique avenue to explore: the wide spectrum of technological innovation. In 2015, Canada-based Agrium employed 100 staff and spent more than CAN\$30 million on R&D. Part of that effort was to make modifications to their production facilities to increase production rates and energy efficiency, as well as reduce greenhouse gas emissions. "Efforts in these areas positively impact the environment and our bottom line," it noted.

Automated vehicles

OEMs have been offering automated mining vehicles to the potash sector for well over a decade. Joy Global supplies a wide range of automated machinery, including continuous miners, shuttle cars and flexible conveyor trains. Over the last decade, software upgrades, sensor enhancements and multi-device communications have increased safety and productivity; Joy estimates that the productivity



on devices such as their continuous miners have more than tripled in the last decade.

Salzgitter Maschinenbau AG (SMAG) has a line of automated drilling vehicles specially designed for potash and salt mining. The GB 280 S vehicle can drill up to 12 x 280 mm holes to a depth of 7500 mm simultaneously.

Sandvik has developed an automated borer miner for the Saskatchewan potash sector. An intelligent control system steers the machine along the seam. Smart diagnostics improve reliability and utilisation.

Caterpillar and its subsidiary Bucyrus are major suppliers of equipment to the potash sector, including continuous miners and support vehicles and equipment. Its EL 3000 longwall shearer features a state-of-the-art communication system for advanced automation and monitoring.

The benefits of automation are readily illustrated by advances in the driverless load-haul-dump, or LHD (also known as a front-end loader). The first models, introduced almost 20 years ago for hard rock and coal mining, were termed line-of-sight remote, in which an operator was equipped with a chest-mounted console. Using the console, the LHD was guided to the ore face where it would scoop up as much as 25 t of load and back away to a safe distance. The operator then mounted the cab and manually drove the machine to a dump point. The main advantage of the system was removing the operator from the danger zone at the ore face; it reduced, but did not eliminate, accidents.

Subsequent generations of automated vehicles allowed two levels of control: co-pilot and auto-pilot. Co-pilot mode completely removes humans from the machine. The operator is located at a console at the surface, where they monitor the LHD's location on a mine map and choose its direction with a joystick. Onboard scanners and radio nodes mounted along the tunnel allow the machine to

self-drive. The system greatly improved safety and physical comfort for operators.

Auto-pilot is a further refinement, in which the operator selects a goal for the LHD and then initiates the machine's internal self-guidance system. A typical sequence involves the LHD piloting itself to the ore face, where the operator fills the bucket remotely. The LHD then drives itself to the dump site, offloads the ore, then returns to the mine face. Advantages of auto-pilot include the ability for one operator to supervise several machines, lower LHD damage due to sidewall impacts, and 24 hour operation.

Caterpillar has developed a line of automated LHDs and offers clients its MINEGEM LHD automation system. The equipment can visually scan and recognise the sidewalls. Because global positioning systems (GPS) are ineffective underground, the system employs a LADAR (laser-radar range sensing) system, which provides spatial information to the machine by comparing these profiles to an existing database provided from the mine map.

In addition to constant machine status and engine monitoring, the operator also receives audio feedback from the machine. Machine health status is also displayed on the remote operator's console. In all, Caterpillar estimates that the automated systems increase productivity by around 25%, at the same time collisions are reduced to zero. The system's ability to operate regardless of shift changes or blasting schedules increases the daily production period by up to six hours.

Continuous underground mining

Canada's province of Saskatchewan is one of the major potash producing regions in the world. The depth, geology and orientation of the deposits allow for a range of production techniques, from underground mining to solution cavitation. Although underground coal mining is common in western Canada, producers such as Agrium and

PotashCorp have worked with local engineering and manufacturing companies over the last several decades to design an efficient system uniquely suited to the potash deposits found in the province.

"Saskatchewan has been a world leader in advancing the mining process using continuous mining, which requires overhauling the entire process from scratch," said Luke Mason, Business Development Manager for Prairie Machine Parts (PMP), located in Saskatoon, Saskatchewan. "If the province didn't already have the continuous mining technology in place, it would be difficult to compete with the current low price environment."

Working with potash mining firms, PMP developed the



Figure 1. Underground continuous mining machine. Courtesy of Prairie Machines and Parts Ltd (PMP).

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underground dual and four rotor continuous mining machine, which can cut through potash up to 12 ft high. It delivered its first complete borer in 2000, and the machine is still in operation, having mined almost 17 million t of potash.

In order to move the potash away from the wall face in a continuous manner, PMP developed the Flexiveyor, a flexible haulage system that replaces shuttle cars between the boring machine and the main belt conveyor. "It's very portable, and can go around bends in a tunnel," said Mason. "It allows you to achieve much higher hourly rates; instead of 400 tph, you can do 800 or 1000 tph."

Underground operators are also moving away from diesel-powered vehicles, to electric vehicles. "Health is the number one reason (diesel fumes contain harmful micro-particles), but it also saves a large amount of mine ventilation costs," said Mason. "Many underground vehicles have been refitted, but we developed a line of electric personnel vehicles from the ground up. We do our own manufacturing in-house, including batteries. We have the only real, 100%-designed underground electric vehicle in the world. They can operate for a full shift without a recharge."

PMP is now working on sensors and automation for its machinery. "The sensors monitor the ore face, the Flexiveyor and the main belts; it's all shown on a computer screen," explained Mason. "We are also working to develop software that will monitor wear and anticipate maintenance in order to reduce downtime."

Solution mining improvements

In a depressed commodity climate in which companies are shutting down existing operations (PotashCorp suspended operations at its CAN\$2.2 billion Picadilly mine in New Brunswick and Mosaic idled its 2.6 million tpy Colonsay mine in Saskatchewan), it might seem counter-intuitive to be promoting a brand new mine, but that is exactly what Western Potash Corp of Saskatchewan is proposing with its Milestone pilot plant project. "We are pleased to have completed all the engineering, which shows the technological and economic feasibility of applying innovative horizontal drilling methodology, selective solution mining and crystallisation pond techniques," said Geoffrey Chang, Chairman of the company. "We are very excited about the prospect of bringing this revolutionary new solution mining technology to Saskatchewan."

In the traditional solution mining process (in which the deposit is thick, relatively flat and extensive), vertical wells are drilled approximately 200 m apart. Hot water is injected into the base of the ore body in order to start development from the bottom (oil is also inserted to control cavern roof development). The hot water dissolves both KCl and NaCl, which is then pumped to the surface.

The process creates a pancake-shaped cavern around 300 m across. Each cavern is separated from adjacent caverns by a pillar region. Although this results in 40% areal extraction, the process allows for greater control of solution injection and removal, and avoids subsidence at the surface.

When the produced brine reaches the surface, the KCl is separated from the NaCl. Because the ore body is around 30% KCl, the separation produces two tonnes of unwanted salts per tonne of Potash ore. The salt is generally uneconomical to transport to market, and is normally stockpiled in a salt pile. The process uses large amounts of energy to separate the salts, and large volumes of water.

Western Potash Corp's Milestone project is unique on several levels. First, instead of vertical wells, it will use horizontal wells, which will have an ore body contact of up to 1000 m (compared to the 40 m thickness of the ore body in a vertical well). This will create a barrel-shaped cavern up to 1000 m long. Although a horizontal well is more expensive to drill than a vertical well, it takes far less time to reach initial production – months instead of years.

The second technology is known as 'selective solution mining'. The injection fluid will have more than 200 mg/L of dissolved NaCl, which will allow for removal of KCl without removing NaCl. As a result, the produced brine is simply placed in a crystal pond where the KCl precipitates. There is no complex processing to separate the NaCl, no salt pile and very little water usage as the near-saturated solution can be collected from the crystal pond and reinjected. Because most of the NaCl remains behind, there is little risk of subsidence.

By using the technologies, the time to production is significantly shortened, surface facility CAPEX is reduced by approximately half (because there is no need for separation crystalliser modules and other equipment), energy consumption is cut by about 40% (because the near saturated solution does not have to be reheated), and water consumption is diminished (to about half that of traditional solution methods).

Although variations of the horizontal selective mining method have been tried in other parts of the world, Western Potash is confident that the bed configuration, depth, geology and high temperature gradient of the ore body on their lease will allow economic production.

Even though the pilot project is a fraction of the size of a traditional solution mine, because of CAPEX and OPEX savings, Western Potash calculates that the Milestone project is economically viable without the economy of scale, and can be scaled up through the repetition of horizontally-drilled caverns. "It is a good time to be building a mine, as there is low activity in the oil and gas sector, so your construction costs are less," said Matthew Wood, Project Director for the Milestone pilot plant project.

Wearable technology

Wearable technology is a term for computer-assisted devices that can be worn as clothing or an accessory. They can take a number of forms, from smart watches that strap around the wrist to eye frames that conform to the face (known as Heads Up Displays, or HUDs).

Wearable technology became headline news several years ago with the launch of Google Glass, a prototype HUD that attaches to a stylish pair of feather-light,

titanium frames. The device allowed the user to connect to the internet and download information that can be projected so that it appears as an image in front of the user.

As the technology became more robust and reliable, manufacturers began to devise wearables for industrial use. Daqri, based in Los Angeles, has developed a computer-equipped hard hat with applications in mining. The Daqri Smart Helmet resembles a bike helmet with a plastic protective eye screen. The screen acts as a display on which the user can superimpose instructions, diagrams, workflows and procedures. It can be equipped with safety sensors to monitor immediate surroundings, and is designed to be sufficiently robust to thrive in field environments. The hands-free device provides users with both augmented reality and head protection, enhancing worker safety.

The future

While high-powered computers, scanners and sensors have made automation possible for underground mining vehicles, the potential for further advances in automation, preventative maintenance and optimisation of assets is just beginning to dawn. Sensors are generating immense amounts of information in a number of industries, and the potential for 'big data' has only begun to be explored in the potash sector.

Caterpillar, for instance, is investigating the viability of self-learning, in which complex algorithms sift through

data from repeated runs and build a comprehensive guide for LHDs to understand and anticipate changing conditions, and adapt accordingly. The company envisions that it will be possible for 12 – 15 machines to work simultaneously.

What will the longer-term future bring? 'Code halo' is a term that is used to describe the digital information that surrounds people, organisations and devices. It is generated by clicks, swipes, views, interactions and transactions that generate a 'virtual self' made of code. Individuals have them as consumers; GE is now working to extend the concept to both machines and subject-matter-experts. "You could have a virtual best operator that helps you understand how to achieve better uptime for your assets, regardless of where they are," said Ashley Haynes-Gaspar, the General Manager for Software & Services at GE Measurement & Control. "It would be like a digital twin."

Most technologies will only be applicable to certain types of potash mining, and partnerships between mine operators and OEMs will also be necessary in order to optimise the benefits of new gadgets and practices. But there is still a rich choice of new machinery, automation and processes to allow most operations to benefit in terms of safety, efficiency and cost reductions. "We need to work with the mines to continue to develop new solutions," concluded PMP's Mason. "We need to increase productivity, reduce costs and increase productive working time." **WF**

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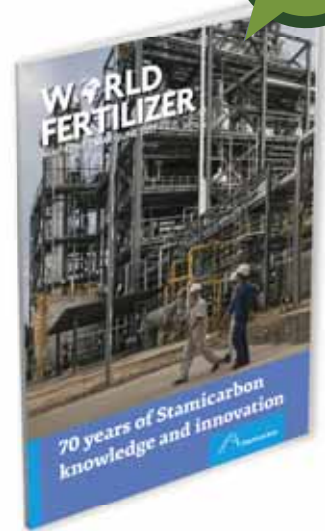
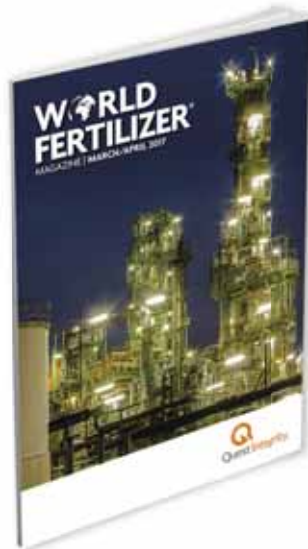
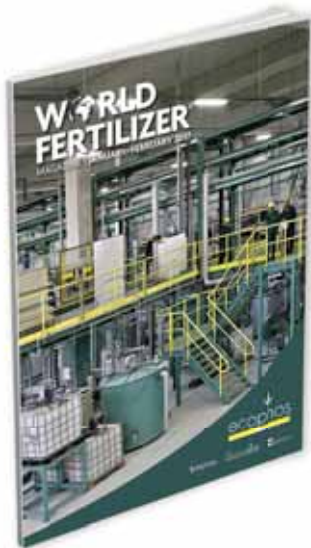
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