According to a new report by Global Industry Analysts (GIA), “the world market for mining chemicals is projected to surpass $25.7 billion by the year 2017. Growth in the future will be driven largely by revival of a large number of feasibility studies that were stalled by mining companies during the heat of the recession and waxing demand for mineral resources from developing countries to fuel their rapidly growing economies.”

Mining chemicals play a vital role in enhancing the productivity and efficiency of mining processes such as the recovery and extraction of minerals and target materials from ore. “Presently,” GIA reports, Asia-Pacific and the USA dominate the world mining chemicals market. Explosives & drilling application [to be examined in detail in September’s Fragmentation article] represents the largest and fastest growing market for mining chemicals worldwide, with impetus for the segment expected to be provided primarily by the coal industry, which is presently the largest end user of explosives. On the other hand, market for mineral processing is expected to be dominated by precious metals (sic) industry such as copper, due to the importance of leaching and flotation in these markets. In upcoming years, legal and regulatory laws regarding environment and safety concerns are expected to propel investments in developing chemicals which are safer and environmentally friendly.”

The importance of mining chemical in the value chain is likely to grow in coming years as the industry strives for efficient recoveries from ever lower grade ores. It could be also that mining chemicals come to have greater influence on the profitability of mining operation. GIA also suggests that “increased R&D and investments in developing and commercialising newer, more sophisticated chemicals will gradually push currently cheaper yet less efficient and environmentally hazardous alternatives out of the market.”

The Clean Mining Alliance announced its birth in mid-May and is sure to have some influence in mining chemicals. This new industry association is aimed at supporting and advocating technological advancements to make the mining industry cleaner and more environmentally responsible.

Frameworks exist to increase social responsibility in mining, but despite advancements in exploration, extraction, production and reclamation technology, the industry has struggled to present itself as having grown beyond the mining days of old,” says Dallas Kachan, Executive Director of the alliance. “The Clean Mining Alliance exists to help promote new and emerging technology developments that are making mining more environmentally responsible.”

It is an international non-profit organisation based in Vancouver, British Columbia, Canada. It was introduced during British Columbia Mining week, a time when the province celebrates the contributions the mining industry brings to the province, its communities and businesses.

Members include companies on the forefront of innovative breakthroughs in the mining industry, as well as leading research organisations. “We’re thrilled to be able to showcase case studies from industry, and world-leading research members like CERM³ (The University of British Columbia’s Centre for Environmental Research in Minerals, Metals and Materials), which has proven through its work at the local Britannia mine site that innovation can vastly improve mine reclamation. It’s these types of innovations that are leading towards a cleaner mining industry.”

Founding members of the Clean Mining Alliance include American Manganese, CERM³, Kemetco Research and Nevada Clean.
Cytec’s newly acquired Nagpur, India facility

Magnesium. Each one is introducing new processes or technologies aimed at making mining safer, cleaner and less expensive. Clean technologies, or “cleantech,” employed by member organisations include membrane-based water filtration, hydrometallurgical processes, biologic remediation, carbon capture, near-zero emissions processes, closed-loop systems and other innovation. More information on each company and the technologies it is employing at http://www.cleanmining.org.

Kemetco Research, for example, is developing a means of recovering gold without the use of cyanide leaching, as well as treating acid rock drainage (ARD) with biologically safe materials. It is developing a cyanide-free extraction method that would remove the harmful chemical compound from gold processing, thereby creating a safer and more environmentally friendly process for gold extraction and processing. Kemetco Research is also developing anaerobic biological processes relying on the activity of sulphate reducing bacteria for the treatment of ARD and other heavy metal containing effluents. This biological process aims to be an environmentally viable option for current and past mine sites for the treatment of ARD.

Sensing reagent efficacy

Frank Cappuccitti, Flottec’s President always has interesting, insightful contributions for articles on reagents and flotation. His opinion is that “we have a lot of new information on reagents and we know how we can use it to operate flotation. But we don’t have the available sensor technology that will allow us to measure certain parameters in the cell so that we can control it. There is lots of work being done in this area and more needs to be done. But this is what needs to be done to provide the next big step in improving flotation from an operational perspective.

“Based on the continuing work done at McGill University to develop new measurement techniques and sensors for measuring gas dispersion parameters, many companies and universities are conducting work on developing more specific sensors for direct measurement of the operating variables for the flotation cell. Specifically, new robust industrial strength systems are required to generate on line real time measurement of pulp parameters such as gas hold up, superficial gas velocity and bubble size. But this information alone does not give a complete picture of what is needed to provide control of flotation. Measurement of froth parameters are also required. Sensors do exist for providing measurement of froth speed and level, but sensors that can provide water content, density and froth loading would also be extremely valuable in understanding and controlling the mass and water flows in a system.”

Over the last few years, Flottec and McGill have done extensive research on how reagents can affect flotation cell hydrodynamics. This has resulted in a new appreciation of how significant reagents such as frother can affect the performance of the cell at different air rates and cell levels. More importantly, these developments have lead to a better understanding of how flotation cells and circuit operation could be optimised using different reagents and mass removal strategies. In order to take advantage of this knowledge, what is lacking in industry is the sensor technology to provide dependable real time on line measurement of the hydrodynamics of the cell. Flottec continues to support the work of universities such as McGill and University of Chile and companies such as Cidra to develop the new sensor technologies that are needed to take full advantage of all the available chemical technology for the optimisation of flotation.”

Reagent developments

Cytec Industries says it “has become the largest specialty reagent supplier to the mining industry with three businesses: Alumina Processing, Metal Extractant Products and Mineral Processing. It offers technologies that can: decrease the cost of operations, provide better recovery and selectivity, help better manage hard to process ores, prevent or limit employee's exposure to hazards, optimise the use of natural resources, and minimise waste.”

Rafael Mier, Global Marketing Manager for Cytec’s Mineral Processing business notes “the necessity for the development of novel mineral processing reagents capable of enhancing value metal recoveries. Flotation requires new, stronger, more selective and versatile flotation collectors like MAXGOLD™ and XD5002®. These chemistries were created using its proprietary Flotation Matrix 100™ process for mineral flotation.” This is an approach that combines an expert system, proprietary blends and expertise to customise a tailored solution. MAXGOLD is a novel family of collectors designed for the flotation recovery of precious and base metals from primary and secondary ores. MAXGOLD chemistry is a sustainable alternative to the traditionally used sulphide collectors such as xanthates that are more effective and reduce the safety, health and environmental concerns. This new chemistry is offered under the AERO® MX series which contains mineral specific formulations for improved flotation recovery of:

- Gold values from primary gold ores (free gold, auriferous pyrite, auriferous arsenopyrite and other gold-bearing sulphides)
- Gold and copper values from copper/gold ores
- Nickel values from massive sulphides and ultramafic ores and PGM values from a variety of ores.

In addition, AERO XD 5002 promoter was recently developed to improve the safety, health and environmental (SHE) characteristics of the industry while enhancing metallurgical results for Cu and Mo in lower pH flotation.
Cytec Industries has also been active in developing technologies beyond the collector business, addressing needs in electrostatic separation, magnetic separation and scale control in phosphoric acid production. These bolt-on technologies are aimed at providing a means to improve overall unit operations without the need for large amounts of capital investment.

Several issues in electrostatic separation, such as finer particles and contaminant surface coating can cause issues with separation efficiency resulting in lower production rates and product purity issues. Cytec has developed AERO™ EZ 1000 and EZ 2000 for electrostatic separation of differing minerals that have increased separation efficacy by 8-11% compared to a control, especially at first pass. In addition, there are substantial energy savings as the separation process can now be conducted at ambient temperature. An added benefit is the reduced capital expenditure due to the bolt-on nature of the electrostatic process. Application of these products can lead to the ability to produce comparable product in quality with cost effectiveness compared to incumbent technologies, separation of minerals over wide size range, reducing the recirculation load and providing an overall more efficient and robust process.

The AERO® NSK product line was developed to improve magnetic separation, and application of these products has demonstrated the capability to obtain higher purity finished products, process mineral slurries of a wider particle size range, and even separate two non magnetic materials.

The Phosflow® series of anti-scalants is novel scale inhibition technology developed to address scaling issues in the production of phosphoric acid. These reagents are added to the process streams to minimise or even eliminate scale in inter-stage piping and evaporators. Benefits of using these products include increased production, increased energy efficiency, and process stability.

Steve Paulson, Lead Marketing Manager – N. & S. America with Nalco’s Global Mining & Mineral Processing Group explains that “for many applications, the site-specific ore composition and the chemistry of the process solution will have a very strong influence on the type of product used. Subtle differences in mineralogy or water chemistry can have a very significant impact on product selection and performance. For example, a flotation collector that works very well at Plant A may not work at all at Plant B – even though both plants are floating copper sulphide minerals. For this reason, product selection frequently involves ore-specific and/or site-specific testing of numerous products and perhaps customisation of products in order to implement the most effective program for that specific operation. While some products do have applications over a wide range of conditions (such as some flocculants and handling aids), it is usually not a case that ‘one size fits all.’

“There are some classes of chemicals that have been used for many years in mineral processing applications. These include Neptune Chemical Pump designed its 500-D Series (Duplex) diaphragm metering pumps for frother applications in coal mine prep plants. The EZE-CLEAN™ valve cartridges can be removed from the pump heads without having to disturb the pump’s piping. Neptune’s Variable Oil By-pass™ stroke adjustment provides better valve performance than variable-linkage designs, the company says. Other standard features of Neptune pumps include double ball-check valves, internal relief valve, and a hydraulically balanced Teflon diaphragm for extended life. Optional features available are automatic flow rate adjustment using an electronic stroke controller and variable frequency drives.
New chemistries which will deliver improved
International Mining
Automation systems – monitoring
Scale inhibitors – improved
New chemistries that reduce or eliminate
Completely new applications for existing
products are equivalent and function the same
It’s a common mistake to assume that all
dosage or even change to a different product.
change, it may be necessary to modify the
optimum performance and that customers ‘hold
regular basis to ensure that it is operating at
dosage, and then monitor the program on a
apply it at the best location(s) at the right
customer, and then to select the right product,
New chemistries that reduce or eliminate
environmental impacts.
“As among the main areas of progress and
innovation that Nalco has focused on in mineral
processing are:
■ Coal flotation collectors –
alternatives to diesel fuel that
reduce environmental impacts;
NALFLOTE® collectors increase fine
coal recovery
■ Scale inhibitors – improved
performance on sulphate scale
control
■ Automation systems – monitoring
system performance and chemical
program control
■ Sulphide flotation collectors – improved
selectivity against Fe minerals and increased
molybdenum recovery; Pinnacle® sulphide
flotation collectors – improved Cu and Mo
recoveries and better selectivity
■ Flocculant technology – products that
enhance the settling of red mud and products
that invert more rapidly; POL-E-Z® liquid
flocculants–quick inverting flocculant
technology, and RRA® (Rigid Rod
Architecture) flocculants – increased red mud
underflow densities, improved overflow liquor
filterability and reduced scaling.”
Paulson also points out that a key
consideration for specialty chemical programs
“is what will deliver the lowest total cost of
operation (TCO). This involves the cost
performance for the entire program, and not just
the chemical cost. This includes the consultative
evaluation by the service engineer to
understand the process and objectives of the
customer, and then to select the right product,
apply it at the best location(s) at the right
dosage, and then monitor the program on a
regular basis to ensure that it is operating at
optimum performance and that customers ‘hold the gains’.
“As ore characteristics or process conditions change,
it may be necessary to modify the
dosage or even change to a different product.
It’s a common mistake to assume that all
products are equivalent and function the same
in a process application. With specialty
chemistries, the customer is paying for an end
result, and it is our job to ensure that we have
the best total program (chemical + feed system +
monitoring program + on-site service) to
deliver that result.”
Axis House has successfully developed
copper oxide flotation chemistries that use
combinations of patented hydroxamates and
modified fatty acid amines in conjunction with
traditional sulphidisation chemicals. The
reagent suites are now successfully being used
across the globe – and can be found on plants in
the DRC, Namibia, Botswana, Morocco, Russia
and Canada. The roll-out of this technology has
been sped up by the availability of the Axis
House Flotation Laboratory, where specially
trained chemists and metallurgists work with
am very glad to move forward in this direction;”
said Steffen Kudis, Head of the Global Oilfield
and Mining Solutions business.
The Regional Mining Solutions organisations
will be strengthened by shifting business
responsibilities into the strongest regional and
local markets. Regional Business Management
Asia Pacific will move from Hong Kong, China to
Melbourne, Australia, while those Santiago,
Chile; Houston, Texas and Ludwigshafen,
Germany will remain located where they are
today.
BASF Mining Solutions offers an extensive
range of mineral processing reagents. It is a
global business and currently the strengths are
in solid/liquid separation and solvent
extraction; however it also offers reagents for
flotation, dispersing, agglomerating and others.
At the end of last year, BASF signed a
long-term agreement with the
Commonwealth Scientific and Industrial
Research Organisation (CSIRO) to lease
laboratory and office space at the
Australian Minerals Research Centre in
Perth. There BASF is establishing a
global R&D and technology centre,
employing six researchers and
developers by the end of 2012.
In first projects, scientists will be
studying mineral processing specific innovation
needs such as advanced rheology modifiers for
the improvement of the thickening process for
valuables and tailings or modification of the
crystallisation process in alumina production.
The company also agreed to sponsor research
undertaken by the Parker Centre starting from
July 2012. For five years, BASF will make a
substantial financial contribution to participate
in collaborative research in the areas of
breakthrough technologies and process
fundamentals primarily focused on alumina,
base metals (particularly cobalt, copper, nickel
and zinc), gold and uranium.
The Parker Centre is a collaborative research
organisation focused on hydrometallurgy R&D,
involving three research institutions (CSIRO,
Curtin University and Murdoch University) and
strongly supported by 20 mineral processing
companies.
“Our vision is to become the leading chemical
solutions provider to the mining industry by
investing in existing and innovative technologies
for mineral processing and metal production of
ores. To be successful, we are increasing our
R&D spending and strengthening our market
focused organisation. The agreement with
CSIRO is an important step towards building
technology and innovation leadership and
demonstrates our global commitment to the
mining industry,” said Kudis.
With the participation at the Parker Centre in
Perth and the agreement with CSIRO, BASF intends to strengthen its R&D capabilities in proximity to industrial research centres and key customers. This creates the opportunity to connect BASF technologies and research and development platforms with opinion leaders in academia and industry and thereby jointly address new developments for mineral processing. “Our research will greatly benefit from the intellectual property generated from the Parker Centre and from our interactions with the participant research groups,” explained Gregor Brodt, Global Development, Oilfield and Mining Chemicals.

“Mining has become a central focus for BASF globally, and particularly in Australia and New Zealand,” said Neil Fitzmaurice, Head of the recently established Asia Pacific Industry Target Group Mining. “We have built relationships with leading mining houses and industry-recognised academia, a sound market understanding, an attractive portfolio and the capability to translate market needs into chemical solutions. Our Asia Pacific Industry Target Group Mining looks to develop an even more comprehensive offering with the overall portfolio of BASF, also for market segments beyond mineral processing, metal production and construction. In this way we want to continue to provide major operational, environmental and economic benefits for the mining industry.”

In April Clariant Mining Solutions celebrated the opening of a new, state-of-the-art mineral processing lab at its location in Guangzhou, China. “The new Guangzhou mineral processing lab is further tangible evidence of Clariant’s commitment to mining business development in north Asia,” said Jason Wang, head of BL Mining, region North Asia Pacific. “The lab’s location will allow Clariant to share its global expertise with regional customers in China and will enhance our ability to provide excellent, customisable solutions to meet our customers’ needs.”

The lab meets Clariant’s rigorous safety standards, including the installation of a fume hood and dust control to foster a safe work environment for employees. The lab contains all equipment necessary to perform flotation trials, and will be further equipped with mineral analytical capability through planned new equipment installation later in 2012. The lab will also process mineral ores and coal samples to optimise recoveries and grade for Clarient Mining customers.

Also in April, AkzoNobel Surface Chemistry, a leading supplier of collectors and mineral coating agents for the industry, announced plans to invest in the growth and continued operational excellence of its fatty amines manufacturing plant in Saskatoon, Saskatchewan, Canada. This investment is being made to support the substantial growth by its potash-producing customers. AkzoNobel’s fatty amines and derivatives are used for the flotation of potash ores and anticaking of potash minerals during manufacturing.

“One of the Saskatoon plant is ideally suited to service the potash industry, particularly in the Saskatchewan basin, one of the largest permit areas for potash exploration in the world,” says Gerry Labelle, Business Director for Performance Applications at AkzoNobel Surface Chemistry.
A couple of months ago BioteQ Environmental Technologies commenced the 2012 operating season at the Minto mine in the Yukon, Canada, providing water treatment services. BioteQ’s operations staff commissioned the water treatment system on site. This is a fee-based contract where BioteQ earns revenue for labour provided and water treatment fees for volume of water treated. The company expects to treat some 500,000 m³ of water in the 2012 season, though that can vary with precipitation and snow melt at the site. BioteQ is an innovative clean technology leader in global industrial water treatment. The company’s proven technologies have been applied at sites around the world to recover dissolved metals and remove sulphate, producing clean water and eliminating residual waste.

Canada is the top potash-producing country in the world, followed by Russia, Belarus, Germany and the United States. “The new investment in our plant is part of our long-term commitment to support our customers’ growing development needs with the capabilities they have long relied upon: our consistent quality, responsiveness and on-time deliveries,” says Bob Margevich, Managing Director for AkzoNobel Surface Chemistry business unit. “We will maintain our leadership as a supplier to the potash industry by continuing to fulfill and exceed our customers’ expectations.” AkzoNobel’s fatty amines product lines include: Armeen®, Armoflote®, Atrac®, Berol®, Ethomeen® and Lilaflot®.

Cleaning up

Kemira says water is the connection in everything it does. “We use our chemistry and applications expertise to provide both in-process and effluent solutions for a wide range of water treatment issues found in mineral ore processing.

“Superfloc polymers are a cornerstone of our mining business. This brand has been trusted by the mining industry for over 50 years to meet tight performance requirements for multiple end-use applications from water clarification and filtration to thickening and tails management.”

Joseph Narciso, VP of Minerals & Metals at Kemira, “Water scarcity and mining in arid areas will continue to be challenges for the industry and the regulatory environment will keep the industry under increased pressure to reuse, conserve and treat water.”

Kemira is developing new products and solutions to meet new challenges that the industry is facing. The mining industry faces the dual challenge of declining ore quality and the need to save and recycle more water. This is changing the nature of many process circuits and is creating scaling conditions in mineral operations that had not previously experienced this kind of problem. Mineral scaling is prevalent in water systems that are saturated with ionic constituents. Calcium carbonate or calcium sulphate fouling is often associated with leaching processes.

Kemira’s comprehensive line of KemGuard scale control products can help. These allow selection from a wide range of options to address specific and the most difficult mineral deposition problems. In recommending a product, Kemira looks at the system as a whole and understands that chemical addition upstream can have major effects on downstream operations. Scale control is an essential tool in managing water quality. Kemira has an active R&D program to develop the KemGuard product line to solve scaling problems where solutions may not have yet been identified.

Mines’ ability to effectively deal with contaminants such as arsenic and selenium in waste waters will be key to ensure optimal and uninterrupted production.

Narciso adds, “We understand the important role technology and water treatment play in production efficiency and environmental compliance.

“Kemira’s unique position in offering both organic and inorganic coagulants means that the optimum program for wastewater treatment can be developed. Proven treatment regimens are used for arsenic, selenium and heavy metals removal.”

Mine water treatment products from Nalco aim at more efficient and selective removal of heavy metals. There is also OreBind® Tailings Management Technology – increased water recovery.

As noted in the emissions management article in the February issue, dust suppression is a continuous and costly activity because it impacts operational efficiency, impairs visibility, increases accident risk and may increase the detrimental effects present in the work environment. Quaker Chemical notes that local communities along with regulatory agencies have put increased pressure on companies to improve methods of dust suppression. In the US, “the Mine Safety and Health Administration (MSHA) has required mine operators to increase the total combustible content of the combined coal dust, rock dust and other dust; and has reduced the concentration limits for coal mine dust. Whereas, the Environmental Protection Agency (EPA) has mandated that facilities that generate dust minimise or mitigate the production of dust in their operation.

To alleviate industry-related issues and address MSHA and EPA concerns, Quaker Chemical has developed Dustgrip™, a dust suppression product line for various applications, including crushers and conveyor systems, rail cars, stockpiles, unpaved haul roads, pits and quarries, mine tailings and screening operations.

It says Dustgrip “not only suppresses dust but offers solutions for managing company resources and addressing environmental concerns such as:

■ Improving work environment and safety by increasing visibility and improving air quality
■ Creating a cumulative effect thereby, reducing water consumption
■ Reducing labour and equipment costs
■ Ability to use with existing spray equipment, and does not require post application rinsing of equipment
■ Non-corrosive
■ Ongoing field support from experienced and respected Quaker associates.

It is a liquid that absorbs moisture from the air and allows small dust particles to combine and increase in size, making them less prone to become airborne. Dustgrip Turbo, Quaker says, “changes the wetting characteristics of water making it excellent at penetrating and knocking down dust particles. It can be used on stockpiles to seal surfaces, prevent the erosion of valuable minerals, and stop air penetration.

Dustgrip oozes dries to a thin, flexible, continuous seal that that effectively suppresses dust for an extended period. It is effective on stockpiles, soil stabilisation, erosion control and suppression of dust caused by wind, vehicle and heavy equipment traffic.”

Nalco’s recent developments include DustFoam Plus and DustBind Plus technologies for in-plant and in-transit fugitive dust control. IM

References