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Grinding gears: mineral processing challenges

Trying market conditions have continued to affect mining companies during 2014, causing many to turn to processing solutions that will help them to cut costs, become more efficient and, in some cases, improve on grade quality.

In the titanium dioxide (TiO₂) industry, low demand and prices coupled with market consolidation have forced many producers to look closely at their processing methods.

At the TiO₂ World Summit 2014 in Montreal, Canada, held in October, delegates were told that only the innovative would survive in the present tough market, as modernisation in TiO₂ pigment production has stalled outside China (pp22-23).

Within China, however, both national and local governments are focusing on greener technology and producers for the most part have been willing to comply with processing updates, finds Kasia Patel, deputy editor.

Waste not
Recycling has also become a hot topic in the mining industry as end users look for new, and often cheaper, ways to source materials.

A United Nations Environment Programme (UNEP) report, “Recycling Rates of Metals”, published in 2011, found that recycling rates for minerals at the end of their usable lives, including rare earth elements, lithium, boron and zirconium, are less than 1% of their volume in waste streams.

Laura Syrett, prices editor, speaks to Finland-based processing group Outotec about why sustainability is becoming more important and why fresh sources of raw materials are becoming scarcer and more expensive to exploit (pp10-11).

Following the recycling theme, increasing demand for rare earths in Europe has led companies to explore the potential of recycling rare earths and magnets from e-waste.

In his article on pp24-25, Antonio Torrisi, reporter, writes that there is growing potential for urban mines in Europe to supply rare earths within 10 years by developing recycling projects.

Importance of analysis
This year’s IM Processing Supplement also highlights the importance of mineral analysis results, which are an integral part of an industrial mineral producer’s journey to completing a feasibility study.

On p7, American Metallurgical Lab explains that in some cases, analysis results can be delayed by up to six weeks due to local assay laboratories not being readily available.

According to the company, the difference between the results from the developmental test work and actual full-scale production can mean the difference between success and failure, stressing the need for sound, reliable analysis solutions.

Challenges ahead
According to a new report by Transparency Market Research, the global mining equipment industry is expected to reach $117bn by 2018, up from around $71.5bn in 2012.

Forecasts of a compound annual growth rate (CAGR) of 8.5% contained in the “Mining Equipment Market – Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2012-2018” notwithstanding, the mining services business is braced for challenges.

At an October meeting in London as part of a series of events held for the 2014 London Metal Exchange (LME) Week, Ken Hoffman, global head of metals and mining at Bloomberg Intelligence warned that capex numbers were likely to “fall off a cliff” in the next few years as mining companies were forced onto “starvation diets” by lower mineral prices and weaker demand.

Signs that these predictions are already coming to fruition began to emerge in mining services companies’ third quarter earnings, when at the end of October, Outotec began negotiations to cut 100 employees from its workforce in a bid to save around €45m ($56.7m*).

The company posted losses before tax of more than €3m for the third quarter of 2014, although CEO Pertti Korhonen stressed that there exist good opportunities for Outotec’s process and plant solutions and services in specific market pockets.

More positive news came from Peoria, Illinois, US-based Caterpillar Inc., meanwhile, which reported a surprise increase in third quarter 2014 earnings to $1.02bn from $946m a year ago and forecast sales of $55bn for 2014.

The company said that the positive earnings were largely achieved through cost savings, rather than organic growth, however, and warned of persistent uncertainties in the global mining equipment market.

Emma Hughes
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*Conversion made November 2014
China’s Proppants Market
Raw Material • Supply • Consumption

IM Research announces China’s Proppants Market, the first definitive report on China’s oil and gas proppants market, covering frac sand and ceramic proppants.

An exciting new era of exploration and development of China’s vast unconventional shale gas resources is imminent, with an anticipated rise in demand for proppants.

This will have a direct impact on China’s domestic proppant supply sector and the global proppant supply market, already reliant on Chinese ceramic proppants.

- What is the status and outlook of China’s proppant supply sector?
- Who’s who and which grades are they producing?
- Which capacity expansions are progressing?
- How will China’s shale gas development impact proppant exports?
- How will global proppant producers compete with China?

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Analysis solutions for industrial minerals

Mineral analysis results can often be delayed due to a local assay laboratory not being readily available. This is a problem that many junior mining companies face in North America, according to American Metallurgical Lab (AM Lab), which told IM that delays can often be upwards of 4-6 weeks due to assay turnaround times.

"Most of the testing in the US is done by individual equipment manufacturers, which typically do not have an on-site assay lab," explained AM Lab's metallurgical lab manager, Jason Beale.

AM Lab is a third-party laboratory that has bench top and pilot-scale equipment to conduct wet gravity separation, low and high intensity magnetic separation (wet and dry), electrostatic separation, crushing and attrition scrubbing testwork. The improved efficiency of having the on-site analytical lab provides test results in days instead of weeks, saving the client time and money.

"We also have a pilot plant capable of running up to 10tph through a feed prep circuit that includes a scrubber trommel with a two-stage de-sliming cyclone circuit and a five-stage spiral circuit that can be reconfigured to meet client needs," Beale told IM.

"The ISO-17025 accredited assay capabilities include wet screening and de-sliming of ores, heavy mineral analysis (TBE), lithium borate fusion-XRF, aqua-regia digest, ICPOES, particle size analysis and turbidity," explained John Rockwell, AM Lab’s analytical lab manager.

AM Lab conducts the majority of its analysis on mineral sands such as ilmenite, zircon, and chromite, but also evaluates other industrial minerals including silica sand, feldspar and manganese.

"We can conduct analysis on any of these minerals as well as base metals such as copper, zinc, lead, tungsten and low levels of gold and silver using ICP," Beale said.

Demand drivers
Demand for analytical and metallurgical services like those supplied by AM Lab has slowed since 2012, but has now leveled off. When the world market slows, companies tend to reduce funding for the exploration of greenfield projects and focus on streamlining existing operations to maximise efficiency.

"ICP-OES and XRF are proven assay methods, which are used in exploration as well as process optimisation, and have been used to assay geologic materials since the 1970s," Rockwell explained.

Beale also notes that demand is high in the frac sand industry, which has seen tremendous growth in the US over the past five years, while other mineral markets seem to have stabilised since the slowdown in 2012.

"Producers in those markets are instead looking to maximise efficiency and recovery in existing plants while waiting for indicators in the market to show stronger economic improvement before making large investments in greenfield projects," Beale said.

Pitfalls and potential
While demand remains steady in the testing and analysis sector, companies working in this industry still face certain challenges.

"The challenge is to be prepared to make necessary process changes to maintain product quality and recovery as the feed quality changes over the life-cycle of the deposit," Beale explained.

Meanwhile, in the development stage of a new operation, the tendency is to not take the time to thoroughly evaluate the ore to understand all of the potential issues that may be encountered so the process has the capacity to deal with potential pitfalls.

"It is better to be proactive and spend the capital on the front end of the project and be prepared for possible issues rather than spend exponentially more trying to resolve the problems once the plant has been engineered and built," Beale outlined.

"Financial models are generated from reserve estimates and reliable process data. These models are only as accurate as the sampling and testing protocol used. Hence, the vital importance of accurate, expedited data analysis and testing. The difference between the results from the developmental testwork and actual full scale production can mean the difference between success and failure," Beale added.
Advances in magnetic separation technology have resulted in a variety of separators specifically developed for mineral processing applications. The relatively high strength of the rare earth separator coupled with its low cost has provided new applications in mineral processing and secondary recovery.

The advent of rare earth permanent magnets more than 30 years ago provided a magnetic product with an order of magnitude stronger than that of conventional ferrite magnets. This allowed for the design of high-intensity permanent magnetic circuits that operated with no electricity and drastically improved separation efficiencies of magnetic separators.

Historical perspective

The advancement of permanent magnet technology was shattered in the 1960s with the development of samarium-cobalt (rare earth) magnets. Since that time, the advent of neodymium-boron-iron (Nd$_2$Fe$_{14}$B) magnets provided such an increase in energy product that new design concepts were considered.

Rare earth elements were originally termed “rare” because they were thought to be quite scarce. However, geological studies conducted over the decades have shown them to be relatively abundant. The discovery and identification of rare earth elements is complicated by the inherent difficulties in separating them from each other.

The rare earth elements comprise the 15 transition elements of Group IIIB, Period 6 of the periodic table. These elements extend from lanthanum to lutetium and are commonly called the lanthanide series.

Commercial grade rare earth magnets

There are only a few common types of rare earth magnets that are considered for circuit design for magnetic separators. Early rare earth magnets of commercial significance consisted of the first generation of sintered samarium-cobalt magnet alloys (SmCo5). The energy produced from these magnets ranged up to 23 megagauss-oersteds (MGOe), which provided the initial impetus to the field of high-energy permanent magnets.

Although these magnets did not produce the extremely high magnetic field strengths of current rare earth magnets, they were relatively temperature stable. Containing 66% cobalt (Co), they were the most expensive of the basic commercial rare earth permanent magnets.

Second generation rare earth magnets were introduced when transition metals such as iron (Fe), copper (Cu), and zirconium (Zr) were added to the Sm-Co based magnets. The energy product ranged up to 30 MGOe with higher temperature stability and both the Sm and Co was partially replaced with the less expensive transition metals.

The intermetallic compound Nd$_2$Fe$_{14}$B received attention when it was introduced in the mid-1980s, and the third generation of rare earth magnets was initiated. This magnet offered properties equivalent, and in many respects superior, to the best Sm-Co magnets. Much of the growth was attributed to the economics of using a much more abundant rare earth (neodymium, or Nd, is 10 times more abundant than Sm) coupled with the inexpensive Fe and boron (B).

Eriez took the third generation rare earth magnets a step further with its own research and testing. This led to the introduction of the company’s proprietary Xtreme Rare Earth which generates magnetic fields up to 25 times stronger than conventional ceramic or alnico magnets.

Several specialised techniques are used in the manufacture of rare earth magnets. The first process is induction melting of all the metallic components and then chill casting. The second method is reduction-diffusion. The alloys are typically processed into magnets by powder metallurgy.

Rare earth magnetic separators

The evolution of high strength permanent rare earth magnets has led to the development of high intensity separators that operate virtually energy free. The rare earth roll, for example, generates magnetic field intensities up to 21,000 gauss and is effective in either concentrating or removing weakly magnetic minerals from a process stream. Another example is the rare earth drum at slightly lower field strength.
Rare earth drum

The rare earth drum magnetic separator consists of a stationary, shaft-mounted magnetic circuit completely enclosed by a rotating drum. The magnetic circuit has segments of alternating rare earth magnets and steel pole pieces that span an arc of 120 degrees. The steel poles are induced and project a high-intensity, high-gradient magnetic field. The non-magnetic material discharges in a natural trajectory when material is introduced to the revolving drum shell. The magnetic material is attracted to the drum shell by the magnetic circuit and is rotated out of the non-magnetic particle stream.

The rare earth drum separator treats relatively coarse (3 inches to +75 micron) material in a high capacity, severe duty application. The separator is effective in treating ilmenite, specularite, zircon, quartzite, kyanite, feldspar and combined glass batch, materials as well as the demanding application of crushed cullet (broken glass).

In most of these applications, unit capacity ranges from 2 to 5 tph per foot of drum width. Coarse minerals such as a mafic rock ore with a 3-inch top size are treated at a rate up to 25 tph per foot of drum width. Eriez manufactures rare earth drum separators in diameters up to 48 inches and widths up to 120 inches.

Rare earth roll

The rare earth roll separator was designed to provide peak separation efficiency and is typically used when a high level of product purity is required. The roll is constructed with Xtreme Rare Earth permanent magnetic discs alternating with thin steel pole pieces along a shaft. The steel poles are saturated with magnetic flux and produce a magnetic field in excess of 21,000 gauss.

The rare earth roll is used as a head pulley and a thin belt connects the roll to a tail pulley. The standard belt is Teflon coated, graphite-filled KEVLAR with thickness of 10 and 17mm. Other belt thicknesses are available for specific applications.

The belt conveys material to the magnetic field or separation zone. When material enters the magnetic field, the magnetic and/or paramagnetic particles are attracted to the roll while the non-magnetic material follows the natural discharge trajectory. A splitter arrangement is used to segregate the two streams.

Other components of the rare earth roll separator include a vibratory feeder or a roll feeder with a mounted hopper; stainless steel product discharge; TEFC gear motor and controls. The rare earth roll separators from Eriez are available in single, double and triple stage versions with either non-magnetic or magnetic rerun.

The rare earth roll separator treats a variety of industrial minerals. It is the separator of choice in treating glass batch materials such as silica, quartzite, feldspar and fluor spar in the -20 to +140 mesh size range. The separator can treat 200 to 500 lb/hr per inch of roll width of -20 to +200 mesh material. This separator is also used in many specialty and value-added type applications, such as high purity quartz and many ceramic feedstocks like alumina, kyanite, mullite and zircon.

Typically, a double-stage separation is required for the magnetic cleaning of industrial minerals. The non-magnetic product from the first-stage separation is passed to a second stage to further remove any residual iron-bearing components. Generally, between 60-75% of the magnetics removed in a two-stage separation are removed in the first separation stage.

Rare earth magnets fill the void

The gap between high-intensity electromagnets and the low-intensity conventional ferrite and alnico magnets left a void in the medium-intensity range. Rare earth magnets now fill this void and allow economically feasible solutions to ferrous contamination problems that are too tough for low-intensity separation but for which high-intensity separation is overkill.

The improved performance of rare earth magnets over the years makes them ideally suited for certain minerals processing applications, including:

- Removal of fine iron, such as iron of abrasion, which is difficult to attract and hold because of its small mass
- Removal of weakly magnetic contaminants, such as iron oxide or rust, which do not respond well to conventional ferrite magnets
- Removal of some stainless steel particles which have been rendered paramagnetic through work hardening

In summary, rare earth magnets offer solutions to many fine or weakly magnetic iron contamination problems in mineral processing, solutions which were just not available before.

While rare earth materials have been available for a long time, their use has become more economically feasible in industrial applications through research and testing. Rare earth metals, combined with other elements, continue to produce a “new breed” of permanent magnets.
Recycling

Closing the loop: recycling for greater resource efficiency

Most of today’s high functioning consumer products contain complicated combinations of minerals, metals and other materials – many of which are innately and practically precious commodities.

Of the billions of tonnes of valuable minerals in circulation in appliances and devices across the world, a significant proportion ends up in landfill once the products containing them reach the end of their usable lives (EoL).

A United Nations Environment Programme (UNEP) report, “Recycling Rates of Metals”, published in 2011, found that EoL recycling rates for minerals including rare earth elements, lithium, boron and zirconium are less than 1% of their volume in waste streams.

At the other end of the scale, EoL recycling of metals like gold, silver, platinum and copper are all above 50%, but recovery rates still fall well short of technical potential, resulting in large tonnages being lost at a rapid rate.

According to Marcus Reuter, director of technology management at Finnish engineering group, Outotec Oyj, this wastage is due to the fact that the vast majority of supply chains are linear, rather than circular – a situation that is ultimately unsustainable in a world of finite resources.

“Sustainability is becoming so much more important; minerals and metals are part of the fabric of society, but fresh sources of these raw materials are becoming scarcer and more expensive to exploit,” Reuter told IM.

In order to boost historically low recycling rates, Reuter is championing a shift from a material-centric to a product-centric approach for salvaging these materials, in which recycling targets specific components of products at their EoL, and devises ways to separate and recover them.

“It’s about closing the loop; taking valuable minerals out of waste manufactured products and putting them back into the cycle,” he says.

In April 2013, Reuter published a report entitled “Metal recycling: opportunities, limits and infrastructure” – another UNEP-backed initiative that he describes as being “more of a free textbook than a report”.

“It’s more than just words,” he explains. “It contains figures, practical steps and real life examples to show that sustainability can be achieved.”

Opportunities and limits

Available to download for free, Reuter’s UNEP report provides a techno-economic, product design and physics basis for assessing the availability of mineral resources in society and addressing the challenges of recycling increasingly complex products.
One of the main challenges facing modern recycling is the fact that the "designed mineralogy," found in manufactured products, is often more complicated than the comparatively simple, primary mineralogy of geological deposits, meaning the valuable individual elements are harder to separate and recover.

A mobile phone containing a battery, for example, can contain more than 40 elements, including base metals and precious metals as well as critical industrial minerals like rare earths, graphite and lithium, that are intricately combined in alloys and compounds for reasons of functionality.

However, Reuter argues that waste manufactured items like phones, LEDs, batteries and LCD screens, should be considered as secondary resources, or "urban mines", which temporarily lock up minerals in the value chain and can be productively exploited by taking a product-centric approach.

"It comes down to creating systems that are more sustainable than the ones we have now — systems that incorporate efficient EoL collection of products, effective sorting and an optimum suite of physical separation, metallurgical technologies and infrastructure to recover metals from recyclates in an economically viable way," he explains.

Product-centric thinking therefore requires linking technology with product design by understanding the relevant separation physics, thermodynamics and metallurgy behind different product types, because "if you don’t understand complex minerals, you can’t recover them," Reuter says.

**Human challenges**

Aside from the technical challenges of designing recycling systems tailored to the complex composition of modern consumer products, Reuter says that there is also a need to change established ways of thinking about research and development in this field.

Reuter’s UNEP report was downloaded more than 5,000 times in the first year since its publication, but he says that even though the need to improve recycling is widely accepted, he faced resistance to his work from some within the mineral engineering community.

Part of the problem with making progress in this area, Reuter believes, is the unwillingness to share information.

"The way the mineral engineering industry, academia and research are set up encourages silo thinking. Everybody wants to win a Nobel Prize — it takes courage to step out of your area and share ideas," he explains.

Protecting rather than sharing information means that much of the funding allocated to resource efficiency is wasted through duplication of research.

"The breadth is there, but not the depth," Reuter says. "There is no need to reinvent the wheel with the digitalisation of existing technology and systems, knowledge can be more easily accessed shared.”

Reuter also believes that the mineral processing sector needs to attract more students into the industry to study process engineering and physics, which will add fresh brain power to the drive for greater efficiency and sustainability.

"We can revitalise the significance of these industries for sustainability with a suitably inspiring explanation of the sometimes dry and difficult physics underpinning recycling," his report states.

It also stresses the need for academic communities, as well as industry, to be adaptive to deal with the changing complexity of waste streams.

**Recommendations**

Reuter’s report makes a series of policy recommendations to legislators about improving sustainability and recycling rates, stressing that while a completely "circular economy" is an unattainable ideal, the notion offers a framework for systemic thinking about resource efficiency.

He calls for policy makers to take a wide view of recycling that takes into account the environmental, industrial and economic factors behind the industry, to create a level playing field in terms of the costs of recycling for businesses and to focus on promoting best available techniques (BATs) in recycling systems.

Reuter also suggests laying down carrot and stick incentives to meet recycling targets, such as economic rewards for meeting recycling targets and the implementation of "producer responsibility laws" that require manufacturers to make their products more amenable to recycling.

Perhaps even more controversially, he advocates cross-border transportation agreements allowing waste to be transported to international recycling centres in order to achieve economies of scale for recycling minor or "spice" metals, present in small quantities in manufactured products.

**Private enterprise**

Although Reuter acknowledges that the UN is a "great platform to spread the message" about the need for improving sustainability and ways to achieve it, he cautions that political backing for such initiatives does not always translate into meaningful action.

"There is lots of talking and hand waving, but often very little gets done. There is too much fluff surrounding this issue; the words are there but the actions are not," he says.

The role of private technology companies is therefore vital in driving innovation and bringing solutions into the recycling industry.

Outotec, the Espoo, Finland-headquartered mineral processing company where Reuter works as an in-house expert in recycling and sustainable technology, describes sustainability as its "core value", influencing both its thinking and its behaviour.

Recent Outotec initiatives include hosting seminars on rare earth sustainability in China and sustainable mining and metals processing in Mongolia in 2013. In 2014, the company was contracted to provide beneficiation technology for Tata Steel’s chromite tailings and was ranked third in the World Economic Forum’s Global 100 list of the most sustainable companies.

The company also awards sustainability prizes to young engineering students in an effort to encourage excellence in this area.

Since 2010, Outotec has published an annual sustainability report, detailing its corporate strategy, interaction with stakeholders, spending on research and development and assessing the "ecological footprint" of its operations.

"The aim should always be to minimise our footprint and maximise our handprint," says Reuter.
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Long-term investment in resilient mills

Due to excessive wear and tear, the chemicals group Yara has replaced its existing mills with NEA PM 30 pendulum mills and achieved a considerable increase in production.

After experiencing significant mill wear and tear, Norwegian fertiliser, urea, nitrate and ammonia manufacturer, Yara International, was left searching for a new pendulum mill provider.

After working with pendulum mills from a French manufacturer at its fertiliser works in Poppendorf, close to Rostock in Germany, Yara International approached Neuman & Esser, part of the NEA Group, which produces wear resistant pendulum mills, with components that are easy to exchange.

Large quantities of dolomite are pulverised at the Rostock works to be used as fertiliser carriers. The previous mills displayed massive wear and tear on both the base of the mill housing and on the main vertical shaft. The shovel shaft and the shovels were only designed as a welded sheet steel construction.

A further weakness in the highly abrasive environment was that the pendulum purge air was fed using rubber hoses.

Wear resistant mills for top requirements

NEA pendulum mills incorporate 80 years' experience, both in construction materials and design. For example, the four-part ground wear plate can be replaced quickly. The shovel shaft and shovel carrier are made of robust cast steel and the shovels themselves are made of high strength sheet steel.

In contrast to the current mill, the PM 30 does not use any rubber tubes for the purge air. The pendulum purge air is fed through the rotor and the spigot trunnion. It is a well-designed, long-term, non-wearing solution.

Wolfgang Palm, sales manager after sales at Neuman & Esser Mahl- und Sichtsysteme, was responsible for the new installation of the PM 30 mills at Yara.

“The special feature of this project was its many ambitious specifications. For example, it involved a very tight time frame. We had to conclude all of the assembly work within only three weeks,” he explained.

This is precisely the period of time which Yara schedules for the annual servicing of the entire fertiliser works. Also, the space available for the 42-tonne heavy lower mill housing was extremely tight.

For the installation of the cast housing with the dimensions $4,900 \times 4,400 \times 1,100\text{mm}$, the access space was very limited.

“To the left and right of the housing, we had no more than a hand’s width of space,” Palm said.

Yara stipulated that the mill gear, mill drive and upper mill housing including the feeder from the existing pendulum mill, had to be reused. NEA incorporated all of these components into the complete system design.

Ambitious project mastered with routine

Following the successful mill assembly, the NEA experts installed a new inverted cone classifier and incorporated the product and hot gas ducts into the system design. The pulverising system was operable again within the specified period of only three weeks.

“YARA is now perfectly equipped for dolomite grinding. Apart from the very tight space available, this is really a routine project for us. The dolomite has very little wear effect on the lower mill housing and the vertical main shaft any longer. The mill now consists of very solid components,” Palm said.

Yara Rostock project manager, Wolfgang Wolff, added: “The newly installed pendulum mills mean a huge improvement for me and not only with regard to their wear and tear behaviour. The new mills are considerably quieter and enable higher throughput. The first PM 30 installed by Neuman & Esser already improved throughput by 15% to 34,500kg/h. We now even manage 37,500kg/h with the new filter. Moreover, we can adapt the fineness better to our requirements.”

After the installation of the first PM 30 and its reliable functioning since then, Yara has also replaced the second mill with a PM 30 from Neuman & Esser. It was installed in September last year and has been grinding kieserite and anhydrite since the beginning of October.

Although these are the first NEA mills for Yara, the companies have worked together in the past. Four MAFA Wurzen compressors have been in use at these works for over 30 years. MAFA was taken over by NEA Holding in 1991 and these compressors have been serviced since then by the company group service provider, NEAC Compressor Service.
Fillers are not just fillers

According to Beckum, Germany-based Christian Pfeiffer Maschinenfabrik GmbH (CPB), one of the main challenges processing companies face today is the production of functional additives to enhance the properties of end products.

Michael Halbur, project manager, Christian Pfeiffer

Developments in minerals industries and the demand for higher quality products, especially in the plastics and paint industry, have led filler suppliers to offer products that enhance the properties of end product applications. Christian Pfeiffer Maschinenfabrik GmbH (CPB) believes fillers can now be classified as high-tech products as companies have transitioned from offering filler-only products to producing functional additives. For example, compound producers are now less focused on characteristics like filler fineness, and more on the behaviour of fillers.

Equally, the required properties for the reinforcement of plastics for optimising impact resistance or the addition of flame retardants or stabilisers to extend the ultra-violet resistance, need to come in a great variety.

Depending on the application, shape, size and surface of particles, the aspect ratio or a combination of these factors, are the main targets for the producers of mineral powders in the filler industry.

Higher product fineness, an exact cut size and optimisation of the functional properties are also among the challenges filler producers face.

Cement

In the cement industry, the most important aspect for producers is the increase of production and simultaneous reduction of energy consumption.

Due to the high cost of clinker production, the grinding of clinker substitutes such as very abrasive products like slag is important.

In grinding minerals, an energy efficient grinding process is also necessary and depending on the basic raw material, grinding of abrasive materials is also quite common.

But more important is the enhancement of the best properties of each mineral powder. Producers must focus on what the customer needs.

CPB provides solutions to enhance not only fineness but also functional properties of different minerals, such as the enhancement of lamellar characteristics or very steep particle size distribution curves.

Conversely, CPB also focuses on very flat particle size distribution depending on the necessary behaviour of the ground minerals products.

Solutions

This change in the requirements of ground mineral products has taken place during the last 30 years or so, where the high in-
vestment costs of complex grinding plants have led to a need for more flexible grinding systems.

One of the best solutions for this is a ball mill in a closed grinding circuit with a classifier and a filter or, alternatively, with cyclones for the collection of fines.

Depending on the product that needs to be ground, this mill can be constructed as an air swept mill or as a ball mill with a discharge diaphragm.

If a higher reduction ratio is required, the tube mill can be executed with two compartments, the first one for the coarse grinding and the second one for the fine grinding.

A CPB grinding circuit, comprised of a tube mill with classifier, can be equipped with ceramic liners, ceramic grinding media and ceramic wear protection to avoid any kind of metal contamination during the grinding process.

Further advantages are the easy operation and a high level of reliability. A typical tube ball mill has an annual availability of 96-98%. Just 2-4% is necessary for maintenance.

Depending on the retention time of the minerals to be ground within such a grinding system, a wide range of different product fineness is possible.

The achievable aspect ratio compared with other grinding systems is in the middle range. Only spiral jet mills achieve better results of aspect ratio.

CPB

CPB's product quality, delivery services, and market-orientated management have made the company a well-known and established partner for the cement, coal, lime, minerals and mining industry.

Today, CPB is acknowledged as a specialist for offering grinding and classifying processes up to complete grinding plants. Either complete turnkey grinding plants or partial equipment for such plants are supplied.

CPB offers services for mill optimisations, tube ball mills with complete mill internals and classifiers produced in Europe (Germany and Austria) for the minerals industry.

The classifiers are suitable for classifying particles down to 10 µm. In close cooperation with Austrian partners, CPB is also able to provide solutions for the ultrafine grinding and classifying down to 1 µm.
Europe claims number one spot in ceramic machinery exports

Europe has traditionally been the largest ceramic tile producing region, however growing production in Asia and the Middle East has created export opportunities for ceramic processing providers.

Kasia Patel

Although the ceramics industry and the minerals used within it are seeing a revival, this increase in demand has been largely geographically varied and has been seen mainly in developing or emerging markets where urbanisation is taking place.

As the housing and construction sectors continue to grow in Brazil, the Middle East and China, it stands to reason that the location of ceramic processing companies would also follow this trend. Though traditionally Europe has been the largest ceramic tile producing region, with output mainly from Italy and Spain, China has now surpassed Europe in tile production.

Ceramic production has also grown in Middle Eastern countries along with demand in the whiteware ceramics industry, which includes tiles, sanitaryware and tableware.

EU ceramic machinery exports rise

Figures from the Association of Italian Manufacturers of Machinery and Equipment for Ceramics (ACIMAC) indicate that the increasing demand in regions outside Europe represents an area of opportunity for ceramic machinery providers, as exports remained the driving force behind revenue for the industry.

In 2012, the European Union once again returned to the number one spot after two years in terms of regional exports of ceramic machinery, accounting for 17.2% of total export turnover, or €221.5m ($281.94m*), ACIMAC said in its 21st Statistical Survey.

This was a 6% decrease in exports from 2011; however it reflects the general global decline in ceramic machinery in which global exports fell 7.4% to €1.3bn.

Much of this growth was led by the Italian ceramics machinery industry, which has seen a growth of 7.3% from 2011.

“This continued the previous year’s growth trend to attain a total turnover of €379.2m,” ACIMAC said.

“However, the Italian market is still a long way from the values reached in 2008 (-22.6%),” it added.

Mixed results for global exports

Asia, the second largest export area, was down 1.5% on 2011 figures. Including India, Thailand, Indonesia and Vietnam, exports accounted for 16.5% of the global total, or €212.5m.

Machinery supply from the Middle East also saw a decline of 29.9%, falling to third place in global rankings and accounting for 16.2% of total export turnover. Despite this drop, both ceramic tile consumption and production has increased in the Middle East, with Saudi Arabia remaining the world’s leading tile importer in 2012.

Unsurprisingly though, as the housing and construction industry has been seeing a revival, brick and roof tile machinery producers saw an increase of 12.9%, ACIMAC said, although it added that “these were still far short of the record pre-crisis figures, 42.3% lower than in 2008”.

Despite exports from various geographical regions fluctuating quite drastically in recent years, the shares of turnover generated by different types of ceramic machinery has remained largely stable.

Figures from ACIMAC indicate that processing equipment for the shaping of ceramic materials accounted for 19.8% of turnover in 2012, glazing and decoration machinery for 18.8% of global revenue, firing machinery for 12%, earth preparation machinery for 18.8% of global revenue, firing machinery for 12%, earth preparation machinery for 11.4%, storage and handling for 11.2%, finishing technologies for 6.7% and moulds for 5.6%.

*Conversion made October 2014
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Innovation with Integrity
German technology company Xproducts Deutschland GmbH has developed two innovative processes, one utilising waste streams such as municipal or commercial solid waste to produce a range of industrial products and another which converts sewage sludge into fertiliser. Both technologies produce market-ready products and reduce the volume of waste sent to landfill or incineration to an absolute minimum. This means customers who buy from Xproducts have the opportunity to significantly reduce their use of natural resources such as sand or wood.

An alternative to waste incineration

Ecocycling has been designed as an alternative process to waste incineration – currently the main method of municipal waste disposal in Germany – and landfill, the world’s most common waste disposal solution. Ecocycling does not replace traditional recycling; instead, it complements and enhances this. In traditional recycling, significant volumes of residue are still sent to landfill or for incineration. Ecocycling makes use of recycling residues thereby sending almost nothing to landfill.

Ecocycling cannot process radioactive materials as current technology does not provide effective solutions. Neither can it be used to treat ammunition, explosives or hazardous medical waste as these provide significant risks for employees. Tyres, metal and reinforced concrete are generally also removed from the waste input stream, as these cause significant wear and tear on machinery.

The process

Waste processing methods generally handle a specific type of waste: metal, PET, glass (white or coloured) or other forms of homogenous input, while the Ecocycling process treats mixed waste basing the treatment process on the chemical composition of the mixed waste overall. Specific chemical recipes are created, tailored to the chemical composition of the input waste, the type and quantity of additives and the required properties of the desired end product determined by the target application.

Ecocycling does not require extensive pre-sorting of waste, the use of pressure or external heat inputs. It produces no CO₂ or other exhaust gas. It is a zero-waste technology, with no by-products. If raw waste is selected as the input, the process commences by sorting the waste stream (optional but recommended). Sorting is tailored to the specific needs of Ecocycling selecting the appropriate ‘ingredients’ to produce the desired end product and removing contaminants.

This technology does not extract heavy metals from waste, but it locks and ‘immobilises’ them. Other contaminants are either destroyed or chemically altered and detoxified. The constituents of the input material are preserved in the end-products. No substances are released into the environment during processing and none leach from the end product.

Sorting is tailored to the specific needs of Ecocycling selecting the appropriate ‘ingredients’ to produce the desired end product and removing contaminants.
The technological process itself involves grinding the input material to a very small grain size, maximising surface area to facilitate the chemical reactions required to manufacture the end products. This is achieved using ‘Cross-Flow’ grinding technology, developed by an affiliated company. The system is extremely robust and cost efficient. The small grain size serves to homogenise the material as necessitated by the process.

Quality control is effected via two independent quality cycles: one integrated online system (independent of the system operator) and one operated manually. The most important sensors used are X-Ray fluorescent analytic (XFA) devices (one online and one off-line). The online system gives readings every 20 seconds of up to 1 ppm. The off-line, manually operated, XFA delivers results with the same precision at 10 minute intervals. All results are fed back into process control, analysed and used to calculate any real-time adjustments needed. Process adjustments, calculated and implemented by process control, are effected by altering the discharge of the additives.

There are two types of plant design. One, designed to process solid domestic and/or commercial waste producing three different products: Xaggregate, Xboard and/or Xsoil; the other, designed to process sewage sludge producing Xfertilizer. Waste composition and target product determine the chemical additive recipe used. This recipe determines all process control parameters and thereby the system configuration.

Xaggregate – for construction use

Xaggregate is a raw material used to replace aggregates in concrete production, either in part or in full. It is employed in the concrete production process in the same way as a traditional aggregate. This new material also introduces new desirable properties. Products manufactured using Xaggregate benefit significantly higher insulation properties than traditional concrete, they are lighter and extremely fire resistant. The production process allows the material’s traits to be specifically tailored according to desired end use.

Xfertilizer, a fertiliser with specific properties (NPK-PK), can be manufactured utilising sewage sludge. This process offers a sustainable usage path for this increasingly expensive waste stream disposal. The technology used to produce Xfertilizer differs in that the sludge needs to be first dried as it contains up to 80% water and as sludge is handled differently to solid waste.

Xboard – for wood chip industry

Xboard product is a filler for wood-fiber board industry (LDF, MDF, HDF and particle board) and reduces use of the primary material wood.

Commercial production

Xproducts has been operating a pilot plant in Würzburg, Germany for a number of years. Here, it tests and develops all the different additive recipes and processes for industrial-scale product trials.

A full commercial-scale plant is currently under construction on the Isle of Wight, UK, with the sorting system already in operation. The grinding technology ‘Cross-Flow Grinders’ is currently being installed and refuse-derived fuel/solid recovered fuel RDF/SRF will initially be produced. The Ecocycling specific equipment and software will be installed later this year.

Xproducts plans to build its own plants across Europe and in developed markets. In frontier markets, the company prefers to licence its technology, including the machinery, and provide technical assistance to implement the process on-site through selected local partners.

A typical Ecocycling plant, including pre-sorting technology, of 300 tpd, based on a 20 hour workday, can be built at a cost of €12-15m ($15-19m*), while a plant of 500 tpd costs around €20-22m.

With appropriate maintenance, the plant life is expected to be 15-20 years.

Xproducts has also signed a contract to sell turnkey plants into Russia, is considering projects in Asia and is negotiating a partnership agreement with a Saudi Arabian company.

*Conversion made October 2014
Effective control or optimisation in mining can be used to prevent equipment damage during processing; however, it’s important to begin at the mine face or in the pit. This allows mine geologists to identify valuable and problematic mineralogy in ores early in the process.

For example, an iron ore sample might contain clay minerals such as actinolite, calcite, montmorillonite, and kaolinite, which can often result in difficulties associated with the geotechnical stability of high walls, comminution and flotation and leaching circuits.

The iron ore sample may also contain abrasive minerals like garnet and epidote, which increase wear on the comminution equipment.

Knowledge of the composition early in the process not only allows mine geologists to identify valuable and problematic mineralogy in ores for processing, stockpiling or avoidance/disposal, but also enables them to provide information to downstream technical personnel regarding changes in composition that may affect crushing, grinding, gravity separation, flotation, leaching and environmental parameters.

This reduces the amount of risk to equipment and ensures that only viable grades of ore are processed, leading to reduced costs and increased profits.

**TerraSpec Halo**

The TerraSpec Halo is PANalytical’s handheld, non-destructive, full-range, near-infrared (NIR) spectrometer, which incorporates on-board, state-of-the-art mineral identification software, an extensive reference library, which can be customised according to the deposit or deposit type, and a robust display screen for instantaneous point-shoot-identify functionality.

The integrated global positioning system (GPS) allows for sophisticated and accurate mineral mapping and ore body delineation. The TerraSpec Halo is 100% safe for the operator and nearby colleagues, unlike similar X-ray-based handheld systems.

In the majority of mining applications, mineralogy is supported by elemental analysis, which can be executed using a number of different techniques, depending on the application and required detection or quantification limits.

Some of the more familiar terms in elemental analysis might include ICP (inductively coupled plasma), usually coupled with AES (atomic emission spectrometry) or MS (mass spectrometry), flame AAS (atomic absorption spectrometry) and XRF (X-ray fluorescence spectrometry).

These techniques, with the exception of ICP-MS, involve the excitation of elements in the sample and the capture
of the elemental signatures, in the form of photons, they emit on relaxation. Of course all of these techniques have their own advantages and disadvantages, but they are all dependent on the quality of the sampling process and sample preparation procedures.

Effective process control is possible using these techniques, however, delivering the number of representative samples and analysing them fast enough to make process adjustments is not an insignificant task.

In order to circumvent this issue, many sites are turning towards the so-called online analysers or cross belt analysers which measure the elemental composition of the material on a moving conveyor belt. These analysers are often based on X-ray excitation (to generate XRFS-type results) or neutron excitation (to generate gamma emission results).

Neutron analysers are usually preferred due to superior sample penetration, which results in a more representative view of the sample than the very surface-specific X-ray analysers. These neutron analysers are most often powered by a radioactive isotope, such as californium-252 (Cf-252) or americium-241/beryllium (Am-241/Be), both of which are classified as highly toxic radionuclides under European regulations, making them difficult to import and handle.

These sources also suffer decreasing neutron emission over time (as per the half-life of the isotope), which necessitates continuous recalibration and, therefore, interruptions to production. These sources cannot be switched off and represent a significant risk of exposure to plant personnel if the proper precautions are not administered.

**Effective partnerships**

In 2010, PANalytical entered into an exclusive distribution and support agreement with SODERN, a Paris-based company that develops neutron-based cross belt analysers that adhere to PANalytical’s strict safety requirements. SODERN’s range of controlled neutron analyser (CNA) systems are unique due to the inclusion of pulsed electrical neutron sources. These electrically-powered sources have definitive advantages over isotope-based sources. Most importantly, these sources can be switched off at any time and are completely safe to handle by maintenance personnel. This functionality also allows these sources to be transported easily and stored as spare parts.

The generators that drive these sources are programmed to ensure a constant neutron flux over the entire lifetime of the source. This ensures stable and reliable analytical performance and minimises (if not eliminates) periodic recalibration. This functionality also allows replacement sources to be set to the same flux level, which again eliminates the need for recalibration and minimises interference with production.

The latest in the series of CNA systems is the CNA³, which was specifically designed for mineral/mining applications. The CNA³ can accommodate wide belt widths with variable loading and particle size ranges and, unlike other cross belt analysers, the CNA³ system is installed entirely below the conveyor belt, ensuring that oversize material passes harmlessly over the analyser, minimising damage and downtime due to unavoidable impacts.

Currently there are four CNA³ solutions available: CNA³ Coal, CNA³ Copper, CNA³ Iron and CNA³ Nickel. Coal quality can vary greatly depending on the source, hence the end use and price are highly dependent on the composition. Whether located at the mine, a processing plant, a metallurgical plant or a power plant the CNA³ delivers reliable, real-time information about the composition, calorific value, ash content, volatile matter and the moisture content as it travels on the belt.

Copper ores and concentrates are usually graded according to the concentration of copper (Cu), penalty elements, such as arsenic (As), bismuth (Bi), lead (Pb) and tungsten (W), and reward elements, such as gold (Au) and silver (Ag). The CNA³ delivers real-time analytical data that can be used to direct mining operations, sort material streams and provide feed-forward process control information.

With its large calibration range, the CNA³ Iron is capable of analysing a wide range of iron ores. The unit can be installed at ground level or deep underground and provides elemental information to guide mining operations and/or mix different ores to a target composition, minimising variability in downstream processes.

Whether installed at the mine or the processing plant, the CNA³ system delivers information that can be used to control nickel grade, Fe/Ni ratio, basicity index and other key process parameters. The CNA³ system can also be installed on shipping conveyors to deliver quantitative results that can be used for real-time grading and pricing.

PANalytical continues to strive towards delivering analytical solutions in process control that enable sample analysis to be both effective and safe.
The landscape of the titanium dioxide (TiO$_2$) industry has completely changed in the last few years. Stockpiled resources, bullish construction indicators and a lack of demand have kept prices low, causing the industry to evolve in various ways to overcome these challenges.

At the TiO$_2$ World Summit 2014, held at the beginning of October in Montreal, Canada, delegates were told that the industry was at the dawn of a new era, with changes underway at many of the world’s largest TiO$_2$ plants. These changes include the merger between Tronox and Exxaro, which was completed in 2012; DuPont’s decision last year to spin off its TiO$_2$ business by 2015; changes in ownership of shares following the death of Kronos’s former CEO, Harold Simmons, last December; the privatisation of plants in Eastern Europe; and, more recently, Irish mineral sands miner Kenmare Resources Plc confirming that it is still in discussions about a possible takeover by Australia’s Iluka Resources Ltd.

China’s increasing role in the TiO$_2$ industry is also likely to have a large impact on developments in the market, as the country now accounts for a third of global production, and industry consolidation, expanding production and the adoption of new processing routes mean that the country is emerging as a new source of high quality material that can compete with other global suppliers.

**Innovation is key**

One point that most conference attendees could agree on was that only the innovative in the industry would survive.

According to analysis from independent consultants TiPMC Solutions LLC, there are not many available solutions to expand the industry at present, as innovation in TiO$_2$ pigments has stalled.

Gerry Colamarino, TiPMC Solutions’ managing director, told delegates at the conference that, compared with previous activity in TiO$_2$ processing, the innovation pipeline is surprisingly bare. According to Colamarino, the goal for the industry is to focus on improving the production process to cut costs.

“We’ve pushed the boat out on grade development, so I don’t think that’s the answer: This is a production intensive industry, so that’s where we need to focus R&D to bring those costs down – I’m not talking about just cost cutting, but innovation along the supply chain to come up with something new,” he said.

Previous industry breakthroughs began with the sulphate process route, which was viewed as innovation in the initial pigment process. This was followed by another advancement in pigment production – the chloride process – which enabled both ilmenite and rutile to be used in production, as well as allowing for continuous process, higher capacity and higher quality grades.

Other historical breakthroughs in the industry include the discovery of large reserves in Western Australia and South Africa and developments in beneficiation.

**Notable new approaches**

However, not all innovation in the industry has stalled. In China, both national and local governments are focusing on greener technology and producers for the most part have been happy to comply with updating processing routes.

In order to compete with material from outside the country, companies like Xingli, Billions, Luohe, Jinzhou, Wanji and Panggang are investing in less wasteful and more environmentally friendly pigment production routes.

As a result, these companies are shifting from older, polluting and less efficient sulphate production to the more efficient processing route.

There are only three plants in China using the chloride route process, but pressure to shift from the sulphate processing route means that around 95% of large state-owned companies now have newer equipment in place to mitigate waste and pollution, although this figure is more like 40% for privately-owned companies.

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**TiO$_2$ pigment properties – differences between processes**

<table>
<thead>
<tr>
<th>TiO$_2$ Properties</th>
<th>Sulphate</th>
<th>Chloride</th>
<th>Argex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>Less bright</td>
<td>More bright</td>
<td>More bright</td>
</tr>
<tr>
<td>Undertone</td>
<td>More yellow</td>
<td>Less yellow</td>
<td>Neutral</td>
</tr>
<tr>
<td>Dispersibility</td>
<td>More</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Abrasiveness</td>
<td>Less</td>
<td>More</td>
<td>Less</td>
</tr>
</tbody>
</table>

Source: Argex
Industry players in China are also placing a much stronger focus on R&D and more innovative technologies. According to Dr Wu Zhonghui, founder and managing director of market researchers CCM and KCOMBER Inc., the number of patents applied for in the last three years has doubled, with many relating to water treatment and processing technology, although he noted that it is hard to ascertain their quality.

Downstream industries in the pigment market are also tending to focus on performance and innovation instead of price competition.

“They are trying to change the image that people are looking for high end products,” Wu said.

“Future manufacturers will need to change their development focus to fit in with the focus of distributors and end users if they don’t want to be knocked out the market. Only those focusing on performance and quality will survive in the future market,” he added.

A third channel
While China wavers between the chloride and sulphate processing technology routes – despite a focus on cleaner technology there are still new sulphate processing plants coming online – another industry player is developing a third production channel.

Canadian junior Argex Titanium Inc. has been lauded as one of the current great innovators in the TiO₂ space, as the company plans to convert low cost ilmenite into high quality TiO₂ using its patented production method.

According to the company’s technology has significantly lower costs and is more environmentally friendly than traditional methods of TiO₂ production, with the uniqueness of the process lying in the way iron is removed. This is because 99% of iron is removed in one step, making the remaining material better than a slag, the company says.

As a result, only 1 ppm of iron goes into hydrolysis, making the process much like the sulphate process but cleaner owing to the very small amount of iron. As well as being environmentally friendly, the process will also produce marketable by-products and is what the company is calling a “disruptive technology”.

According to the company’s chief operating officer, Enrico di Cesare, the process is likely to make a difference in the industry, owing to the production of high quality material at lower costs than the chloride process.

Kasia Patel, deputy editor, hands out Industrial Minerals magazines at the TiO₂ World Summit in Montreal, Canada.
Recycling rare earths from e-waste in Europe

Owing to increasing rare earths demand in Europe, which has one of the largest markets of auto vehicles and mobile phones, companies have called for a concerted effort from all institutions and governments to explore the potential of recycling rare earths and magnets from e-waste.

Antonio Torrisi

The rare earths industry called for a concerted action to recycle rare earths from end-products in Europe at the ERECON 2014 conference, held in Milan, Italy, towards the end of October 2014.

Danilo Bonato, president of the Italian consortium ReMedia, said that there was growing potential for urban mines in Europe to supply rare earths within 10 years, owing to the large consumption of cars and mobile phones in the region.

“Italy alone consumes 300,000 tpa of electronic equipment,” Bonato explained. However, he added that this potential can be exploited only by developing major recycling projects, funded by companies and governments, and by setting new legislation in support of rare earth recovery from e-waste.

Bonato urged industries and universities to stop developing independent small projects and to form a consortium, which would have an industry-driven approach.

The main task given to the consortia is to re-design the whole hi-tech recycling value chain, moving from a material-centre to a product-centre approach, in order to recover the best value of each product, Bonato said.

“We do not need to recover all the individual rare earth elements, but to focus on the more economically-viable products,” he added.

ReMedia recently started the WEEE2020 project to recycle waste electrical and electronic equipment (WEEE). It involves 23 stakeholders worldwide including European technological and engineering companies Bosch, Outotec, Umicore and DigitalEurope.

Difficulties of recycling rare earths

The recycling rate for rare earths and critical metals is presently less than 1% due to the small fraction of rare earths used in the industry.

In addition, the economics of recycling are also hampered by rare earth price volatility and geopolitical risks, as well as by a limited experience in the industry, which still presents low collection rates, according to Bonato.

“It is time to define priorities, focusing on few markets - such as [lamp] phosphors or magnets - but in more efficient ways. Funding and directives to source rare earths from end products are also needed,” Bonato said at the conference.

He explained that European laws in WEEE recycling have been traditionally set to minimise volumes and not to recover valuable material in the most efficient way.

Allan Walton, senior science city research fellow at the University of Birmingham, said that tracking urban mines is one of the major challenges in rare earth recycling, as there is not a collection of targeted products.

“Separation of [EoL products] is a key step in recycling, as [their] reprocessing depends on composition and impurities,” Walton said.

In order to be economically viable, recycling must be cheaper than the cost of rare earths from China’s primary sources.

Advantages of recycling

Walton agreed with Bonato, saying that targeting products is critical, adding that recycling rare earths has several advantages over primary sources.

As exploitation of e-waste does not need the environmental permits required by new mining projects and do not have radioactive by-products, recycling may place rare earths in the market quicker than new mines, according to Walton.
The scientist, who designed a process in 2012 to separate neodymium-iron-boron (NdFeB) sintered magnets from hard disk drivers (HDDs) using hydrogen gas at atmospheric pressure, said that it is important to design different processes to recycle specific products.

He also recommended the development of new waste directives and mapping of urban mine waste procedures and urged funding research and development (R&D) projects and pilot plants in Europe.

**Conflicting laws**

Alex King, director of the US-based Critical Materials Institute (CMI), said that legislation in the US hampers the development of efficient recycling strategies.

In order to attain data security and protection, US legislations impose that end-of-life (EoL) HDDs must be completely destroyed through shredding.

Shredding is the less efficient process to recycle NdFeB magnets due to the difficulty of recovering small magnetic particles, which attach to remaining waste.

Bonato said that such legal concerns are not present in Europe and that this is a clear example that shows the necessity to involve authorities in recycling policies in order to address problems and design solutions.

**New pilot plants**

The industry participants at the ERECON conference called for the development of new pilot plants for rare earth recovery and recycling in Europe and stressed on the fact that projects should be led by industries.

However, Roderick Eggert, deputy director of CMI, expressed concerns over the possibility funding of new plants should come only from governments, involving more public-private partnerships instead.

Frank Petzoldt, an engineer at the Fraunhofer Institute, said that pilot plants for processing technology are needed in order to develop new processes in rare earth separation, even with the help with the European Commission.

‘Processing is critical in rare earths. In China there is a very strong research group. You can’t ship finite products or ores there. It is too costly. We need more pilot plants in Europe,’ Dudley Kingsnorth, executive director of Industrial Minerals Company of Australia (IMCOA) said.

**Lost skills**

Alain Rollat, technology development manager at Solvay’s rare earths business unit, said that despite an established ability in rare earths separation in Europe, a part of technical expertise has been lost since 1990.

Jim Sims, vice-president corporate communications at US-based rare earth producer Molycorp, told IM that technical skills have been also lost over the years in the US.

One of the reasons the company acquired facilities in China was to enhance Molycorp’s breadth and depth of skills in rare earths processing and separation, particularly in value-added downstream processing.

Sims added that more separations capacity outside China “will be good for all nations, including China” as the diversity of global supply increases and rare earth supply chains are further de-risked.

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**Processing 2014**

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A full assay laboratory metallurgical testing facility and pilot plant on one site allows American Metallurgical Lab to control chain of command from plant through lab to customer. Our technology, expertise and range of services offer a competitive quality and cost advantage to our customers.

American Metallurgical Lab’s assay laboratory has A2LA ISO 17025 accreditation and has the capability to conduct XRF, ICP-OES, pH, turbidity, particle size analysis and heavy mineral analysis. Our metallurgical lab can conduct basic sighter testwork and exploratory analysis including magnetic and gravimetric separation profiles as well as full flowsheet development.

- Wet High Intensity Magnetic Separator (WHIMS)
- High Tension Roll Separator
- Magnetic Separator (RER)
- MLH Induced Roll Lift Magnet
- Pilot Air Classifier
- Roll Crusher
- Jaw Crusher
- Drying Oven And High Capacity Dryer
- Wilfley Shaking Table
- Gravity Spiral Separators
- Cowles Dissolver (Mixer)
- 2-Cell Attrition

The 10 tph pilot plant is operated by personnel with two decades of experience. We work closely with customers to confirm flow sheet design and create products for evaluation.

Full Pilot Plant | Flow Sheet Development & Review
Separation Profiles | Ore Characterization | XRF | ICP-OES
pH | Heavy Mineral Analysis | Turbidity | Particle Size Analysis

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Staffs Powder Processing Ltd addressing growing UK demand for material agglomeration and niche processing

Staffs Powder Processing (SPP) is a family-owned and operated business, based in Stoke-On-Trent, Staffordshire, founded in early 2013 to fill a gap in the UK market.

Owned by two brothers, Matthew and James Evans, who between them have 30 years experience of mineral and chemical processing, the company has heavily invested in new production equipment including crushers, dryers, kilns, agglomeration mixers, and laboratory equipment as it has continued to grow in the UK.

Before the formation of SPP, the Evans brothers worked for the family business which focused on the manufacture and supply of chemicals and minerals to the heavy clay industry.

“We rapidly became the UK’s largest supplier of clays, shales, specialist sands, colours, and additives to the market. Our group of companies employed over 50 staff, with a fully equipped UKAS laboratory, and had a combined turnover of over £10m,” James Evans explained to IM[B].

Need for niche processing

The formation of SPP was a step into the processing side of the industry, with the aim of providing what the company says is much sought after service in pelletising and agglomeration of powdered materials.

According to company director Matthew Evans, there was a need for a company able to offer development and feasibility studies for those wishing to commercialise large scale pellet production plants, which led to the installation of a pilot scale pelletising plant, capable of producing several tonnes of product per day. Following on from this facility, the company has successfully developed and manufactured a wide range of pelletised products for the ceramic, catalyst, mining, agro-chemical, and waste industries.

What SPP says sets it apart from other manufacturers is its flexible approach, knowledge and willingness to adapt plant and machinery, which is the reason the company offers part and complete hire and use of its vast inventory of equipment.

“We see an increasing demand for the pelletisation of dusty or problematic materials, not just because of health and safety issues, but also the need for a free flowing end product,” James Evans said, adding that because of this SPP is continuing to invest in specialist pelletising technology.

In addition to the testing and feasibility studies SPP offers, the company also has the ability and resources to handle many different liquid and powdered chemicals and minerals, and routinely toll processes materials for large multi-national companies. This includes drying, milling, blending, crushing, calcination, and pan granulation though in most cases a combination of processes are used.

The company specialises in two very niche areas in processing, bespoke catalyst formulation and the agglomeration of powders. “We found that there was a distinct lack of UK companies able to design and manufacture transition metal oxide catalysts, and because of this we have developed a unique and cost effective method from formulation through to production” Matthew told IM[B].

“There are only a handful of companies in the UK that can pelletise a product, and of these, very few will process outside work. We like to throw ourselves in the deep end, the result being one week we are granulating a garlic powder and the following week it may well be a fertiliser or waste mine tailings” Matthew added.

SPP are actively seeking long term processing partnerships with minerals and mining companies worldwide

SPP services

**Catalysts:** Transition Metal Oxides Catalysts. Development and sales.

**Drying:** material drying using direct fired rotary dryer, and gas fired tray drying.

**Crushing:** jaw and cone crushing of minerals and chemicals.

**Milling:** using continuous attritor mill. Wet or dry materials. Feed size from 100mm down to 200um. Wet or dry ball milling using ceramic lined ball mills.

**Pelletising:** using various methods including a large Eirich granulator for low cost, high value agglomeration.

**Calcination:** using a large electric mesh belt surface, and also a direct gas fired rotary furnace.

**Blending:** low and high shear blending using stainless steel ribbon blenders, and morton ploughshear mixers.

**Sieving:** sieving of a wide range of products using vibratory deck and circular sieves. Up to 3 tier available.

**Liquid Processing:** using large high shear and saw tooth mixers for dispersion of solids in liquids.

**Jet Milling coming soon!**

Staffs Powder Processing Ltd

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