

Mineral recycling turns industrial

Secondary raw materials left from industrial processes could come into their own in the next five or ten years, aided by market changes and better recycling technology. This is a major step towards a zero-waste economy, suggests **Mike O'Driscoll**

The recycling of industrial minerals in Europe is about to take a quantum leap in the next five to ten years, boosted by the European Commission and other pan-European initiatives, rising primary raw material costs, and the evolution of processing technology.

This trend has sparked increasing interest among certain mineral processors to invest in and develop production lines dedicated to recycling industrial wastes containing industrial minerals, or secondary raw materials (SRM). This sector is expected to grow significantly over the next ten years.

Leading SRM for industrial mineral markets include spent refractory bricks, steel slag, aluminium salt slag, fly ash, glass, silica fume, construction products and wastewater. However, there are many other SRMs under evaluation for recycling. While recycling has been researched and established for some years for some SRMs – particularly glass, fly ash and slag – it has been initiated for others, such as refractory bricks and aluminium-salt slag, but has then been held back by technical and economic factors until recently. However, the level and sophistication recycling these materials is seeing a distinct upswing and these sectors are set to expand.

Spent refractories

Recycling of spent refractories is being pursued with particular vigour, with refractory majors such as Austria-based RHI declaring raw-material substitution and recycling as an integral part of its Strategy 2020 growth plan.

Meanwhile, refractory-recycling processors are upgrading and expanding their facilities. German firm Horn & Co Group, for example, employs an automated sorting system supplied by laser-based sensor system specialist Secopta that is based on laser-induced breakdown spectroscopy. New specialist plants are opening, such as LKAB Minerals' Moerdijk refractory recycling facility in the Netherlands, which opened in May 2015 after seven months under construction.

Pulverised fly ash generated from coal-fired power stations and municipal incinerators has seen much use in cement, concrete and filler applications over the years. However, certain companies have recently been developing its use in other markets. EKO Export in Poland imports and processes fly ash from Russia,

Kazakhstan and Ukraine for casting, ceramics and plastics (distributed by Mine Feuerfest); and LWP Technologies in Australia uses fly ash in the manufacturing of ceramic proppants for shale-gas hydraulic fracturing.

In China, rising demand for alumina has seen fly ash evaluated and used as an alternative source to bauxite. In October 2014, China's first commercial plant for alumina extraction from fly ash using the limestone-sintering method was brought online in Ordos, Inner Mongolia, by the Inner Mongolia Mengxi High-Tech Group with a capacity of 200,000 tonne per annum.

Recycling drivers: EC and other initiatives

There are many relevant organisations and initiatives, but leading examples include the European Commission's Raw Materials Initiative, launched in 2008. It moots resource efficiency and the supply of "secondary raw materials" through recycling as one of its three pillars.

Allied to this are EC projects such as Moving Towards a Circular Economy, with an

"ambitious circular economy strategy" due in late 2015. In April 2015 the EC published its interim *Circular Economy Strategy Roadmap*.

There is also the EC's Resource-Efficient Europe, described as a "flagship initiative" of the Europe 2020 strategy.

But the key EC project appears to be Horizon 2020. This mammoth undertaking has been described as the biggest EU research and innovation programme ever, with nearly €80bn of funding available over 2014 to 2020. Seen as a means to boost economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the members of the European Parliament.

IMA-Europe, the influential umbrella association for Europe's industrial minerals industry, has also played its part by launching the *Imagine the Future with Industrial Minerals 2050 Roadmap* in September 2014.

IMA-Europe estimates that up to 60% of all minerals currently consumed in Europe are recycled along with the glass, paper, plastics, or concrete in which they are used.

The roadmap envisages a zero-waste

Extract and reuse Secondary raw material examples for industrial mineral markets

Secondary raw material*	Mineral/material recovered	Market
Aluminium salt slag	Alumina	Cement; ceramics; geopolymers; metallurgy; mineral wool; refractories
Batteries	Graphite; lithium; manganese dioxide	Batteries; ceramics; chemicals; glass; refractories
Fly ash	Aluminosilicate	Ceramics; coatings; construction; foundry; plastics; proppants (oil & gas drilling)
Glass	Rare earths; silica glass; plastics; sealants	Abrasives; chemicals; coatings; concrete
Gypsum wallboard	Gypsum	Wallboard
Refractories	Alumina; andalusite; bauxite; chromite; dolomite; mag-carbon; graphite; magnesia; silicon carbide; zirconia	Ceramics; metallurgy; refractories
Steel slag	Alumina; calcia; magnesia; silica	Abrasives; aggregate; cement; concrete; fertiliser; filtration; metallurgy
Waste water	Phosphorus	Fertiliser
WEEE**	Antimony trioxide; bromine FR; fluorspar; graphite; rare earths	Batteries; ceramics; chemicals; flame retardants

* ie. waste from processing, or used/discarded mineral-bearing end products to be recycled

** waste electrical and electronic equipment

Source: INFORMED 2015

business model in 2050, with a greater trend towards forming industrial clusters and integration to allow waste from one process to become a valuable raw material for another. This would translate into a 20% improvement in the recycling of industrial minerals.

Consortium projects and research

Another area seeing increased activity involves new consortium-based projects and bodies responsible for researching and developing process flows and technology for specific SRM recycling. The Gypsum to Gypsum (GtoG) project is transforming the European gypsum-demolition-waste market to achieve higher recycling rates of gypsum waste, while P-REX specialises in sustainable sewage-sludge management, fostering phosphorus recycling and energy efficiency.

A thorny issue is that of the regulatory framework in dealing with waste. The EC has acknowledged that “there is often a huge gap between the letter of the law and the regulatory reality when it comes to waste markets”.

This prompted the EC earlier this year to issue a consultation on how waste markets function in the EU, which closed on 4 September 2015. This consultation aimed to obtain a better understanding of the nature and the extent of regulatory failures in causing undue distortions to EU waste markets for recycling and recovery.

What does it mean for the minerals sector?

To start with, raw-material purchasing managers of mineral consumers are going to see SRMs become a more visible and feasible alternative to primary raw materials. It is early days, but eventually, SRMs will be on the same menu as primary mineral sources. SRMs are unlikely to make a significant dent in sales of primary raw materials at present, but their share of the raw-material supply market is likely to increase in the not-too-distant future.

For primary industrial-mineral suppliers, it is certainly a sector to watch, as they may see increasing substitution of their products by SRMs. There may be opportunities here to offer packages of blended SRMs and primary minerals for certain market applications.

New growth market

The mineral logistics sector – with its traders,



Gypsum can be recycled from demolition waste

distributors, handling and storage companies – should view this sector as a new growth market, with rising demand for transporting SRMs from source to processor to consumer. Certain freight companies are already having to adapt systems to accommodate industrial-waste transport. This demand is only going to get bigger.

One persistent factor affecting the development of SRMs has been the stigma attached to recycled end products sourced from “waste”, which conjures up images of material containing dreaded impurities emitting a toxic glow.

The antidote to this over the years has come from advances in processing technology and quality-control systems – from a technical and economic standpoint – which has enabled Horn & Co and other processors to demonstrate to customers that their products are clean. And, above all, they meet specification.

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In particular, the advent of laser-induced breakdown spectroscopy in sensor-sorting systems has attracted interest in the recycling of refractories.

Assuming desired raw material specifications are met, it promises a great green future for the end users, the consumers of SRMs. It will reduce high levels of reliance on scarce, threatened, or inconsistently available and priced primary raw material sources. It will give the buyer a range of competitively priced options and provide that neat green tick to the company’s environmental strategy of helping sustainable development of the world’s natural resources.

The real challenge of the SRM supply chain

But here is a cautionary note: as with all supplies of raw materials to industrial-mineral markets, whether primary or SRM, the fundamental requirement is that the material must maintain high consistency in the required quality and volume availability.

A silica-sand mine supplying a glass plant needs to maintain its quality and supply of silica-sand by evaluating and proving its reserves and resource and, perhaps, mining selectively. A refractory recycling or aluminium-slag recycling processor, in turn, will also have to ensure security of its resource.

Obviously, this resource is not a mineral deposit, but the supply or recovery of a particular industrial waste, the SRM or spent refractories and discarded slag.

Therefore the real challenge for this evolving mineral-recycling sector will be in maintaining and securing its supply of SRM so it can guarantee consistent recycled products to its customers.

We are likely to see more alliances or strategic partnerships (and more competition for them) spring up between SRM providers such as steel, non-ferrous metal and cement plants in the case of recycled refractories and the recycling processors.

So hold on to your seats – and your SRMs it’s going to be an exciting ride over the second half of the decade. ■

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