Finding new ways to recycle

As demand for industrial minerals grows, delegates from around the globe met in Germany to discuss ways to extract more high-quality recyclable materials from the sector's waste. ***Mike O'Driscoll*** looks at some of the projects

Imformed, or Industrial Mineral Forums & Research, was established in 2015 to provide professional networking opportunities and market-research expertise for the global industrial minerals sector. Its annual mineral recycling forum took place earlier this year in Cologne, Germany.

Before the main event, delegates went on a one-day tour of recycling group Horn & Co's nearby facilities at Weitefeld, Hunsborn and Siegen, to see first hand how steel and refractory waste is sorted, both by hand and laser-based sensor system, crushed, sized and packaged ready for customer delivery.

Circularity and sustainability

The event opened with a keynote speech on the role of industrial minerals in the circular economy. Roger Doome, secretary general of the Industrial Minerals Association Europe, said the circularity of the industrial-minerals sector was driven by resource optimisation, functional recycling and the recovery of secondary raw materials. However, "industrial mineral recycling and re-use alone will not be sufficient to meet the demand for raw materials", he warned. "Circularity without sustainability is stillborn."

Doome went on to detail industrial minerals' use in certain sectors with a view to future recycling, such as in renewable energy, mobile phones and transport. He also highlighted the EU Raw Materials Initiative and the 2018 measures for "an ambitious EU circular economy package".

Waste valorisation examples included waste slurry from limestone processing (calcite, wollastonite, dolomite and silicates) used as filter sand, and kaolin waste used to make lightweight materials for construction. According to Doome, the industrial minerals sector estimates up to 50% of all the minerals consumed in Europe are currently recycled along with the steel, glass, paper, plastic and concrete they are used in. "Industrial minerals consumption would increase by 50% in the absence of functional recycling. Recycling should be sustainable," he said.

Steel-waste recycling

Jitka Halamová, a process engineer at steelmaker ArcelorMittal Ostrava in the Czech Republic, spoke about the efficient use of steel-waste resources using methodology and technological innovation. She explained how the company, part of one of the world's largest steel and mining groups, has been aimed to increase recycling of waste material since 2012 to cut operational costs.

A project implemented in 2016 is still increasing waste recovery, with some 40% of waste now being used. The key benefits are costs savings as a result of reducing the use of raw materials and avoiding landfilling. One example is in steel-ladle slag recycling: in the past, only iron was removed and the remainder sent to landfill. Today, after screening a small fraction, most is used in the plant, replacing previously required dolomite and limestone inputs.

Delegates also heard about a new recycling project, which had started in April, involving thermal treatment of steelworks' dust and waste chlorides for use in steel and cement applications. Gerhard Auer, research and development manager at Ferro Duo, described the German company's development of a "ready-for-implementation process" for the economic processing of chloride-containing by-products, such as bypass dust from cement production, and heavy-metal-comprising by-products, particularly dusts from blast furnace or steel production comprising zinc and lead by joint thermal treatment.

The project will run for two and half years with funding from the German economic ministry. The key objectives will be a basic feasibility assessment for different combinations of materials, evaluating the process parameters, integration into steel or cement processes, and setting up a demonstration unit.

> **"Industrial minerals consumption would increase by 50% in the absence of functional recycling. Recycling should be sustainable"**
>
> **Roger Doome, secretary general, Industrial Minerals Association Europe**

Refractory recycling

Mario López, a recycling specialist from RHI Magnesita, talked about South American refractory recycling rates. He described building a refractory-recycling business through the use of so-called plan-do-check-action (PDCA) and standardise-do-check-act (SDCA) methodologies.

The results, he said, "spoke for themselves", with vastly increased recycling volumes and 2017 targets either hit or exceeded. The 2018 action plan includes projects on developing supply and production chains for mag-carbon recycling in Brazil and mag-spinel recycling in Argentina.

In Brazil, total spent refractories are estimated at 50,000 tonnes per annum. In 2016, Magnesita recycled just 15,500 tonnes. Since the beginning of the project in 2016, some 50,000 tonnes of spent magnesium oxide refractories have been recycled, equivalent to 98,000 tonnes of magnesite ore and 3,500 litres of fuel.

RHI Magnesita colleague and recycling manager Michael Postmann gave a talk on the company's past and future refractory recycling, reviewing where the company is now and where it wants to be. At present, RHI Magnesita possesses only limited crushing/drying capacity for recycling material at various sites, and there is no single plant with a sole focus on refractory recycling.

"The use of recycling material is limited due to quality and economics," Postmann said. "At present, RHI Magnesita is using around 100,000 tonnes per year of recycling materials in its own products globally." He added that the company aims to source alternative raw materials and wants to open its product portfolio to use more recycled materials and develop new products for recycled materials.

The final speaker in this section, David Maza, research and development knowledge group leader at Sidenor, reviewed the steel company's strategy in refractory-waste management over the past five years.

He showed how best practices were consolidated in 2014-15, to the Isoval project of 2015-16 covering isostatic refractory valorisation such as nozzles, stoppers, LS tubes, to the pursuit of "excellence" in recycling by 2017.


HORN & CO

A field trip to Horn & Co's recycling facilities in North-Rhine Westphalia and Rhineland-Palatinate

Today, Sidenor is using emergency ladles fully lined with recycled bricks and making higher value added products from recycled isostatic refractories, such as LS tubes.

Foundry sand reclamation

Chris Wilding, sales director for Omega Foundry Machinery, covered another important area of recycling in the metallurgical industry: chromite sand reclamation from foundry waste.

He started with an overview of the chromite sand market. With a view to the enhanced value of recycling foundry sands, he stressed the rather stark outlook of a potential chrome-ore deficit of up to one million tonnes in the short to medium term, driven by burgeoning demand for stainless steel.

Against this background of growing interest in recycling chromite foundry sands, Wilding explained that in order for foundry sands to be recycled, a good separation process is required to give around 98% purity in the final product.

Omega's process uses a combination of medium- and high-intensity drum magnets, plus a density separator. This system achieves up to 99% purity of chromite sand. The sand can be re-used in the foundry from 50% up to 75%, the separated silica sand can also be re-used.

Wilding pointed out that the chromite becomes more magnetic as it is reused, therefore it is eventually removed by the ferrite magnet. And the technology has potential to expand its sources of chromite foundry sand. "We can also start looking at recovering previously dumped chromite/silica sand deposits in landfill sites," Wilding said, revealing that Omega was already involved in conducting such work at a site in Turkey.

Li-ion battery recycling

Hans Eric Melin, managing director of consultancy Creation Inn, looked ahead to the prospect of more electric vehicles (EV) on the roads and what this will mean for future recycling of new-generation batteries and their mineral components.

> "Langveld urged that there was an important legislative role for national and EU nutrient platforms to set realistic contaminant limits, otherwise no phosphate recycling would be possible"

Melin outlined the lithium-ion battery "revolution", covering the wide range of the battery's applications and the main mineral components for potential recycling, as well as the coming wave of recycling required in the future as use continues to grow.

There are three main methods of recycling lithium-ion batteries – mechanical, pyrometallurgical and hydrometallurgical, but the current rate of collecting these batteries for recycling in Europe is poor, despite data indicating many units had reached their end of life, he told delegates.

The upshot is that at present spent batteries are exported to east Asia for recycling, mainly to China, although lithium-ion battery recycling is growing in South Korea. Melin also touched on various "second lives" that can be applied to some batteries, such as in energy storage.

Phosphorus recycling

Kees Langveld, a technical expert at ICL Fertilizers, looked at recycling activity in the fertiliser market. "Phosphorus is an essential element that cannot be replaced. We see a possibility of recycling phosphate. Closing the loop on phosphorus is a real opportunity," said Langveld.

He compared secondary phosphate sources, such as sewage sludge ash, bone meal ash, wood ash and struvite, and highlighted two new technologies for processing such waste: RecoPhos and Tenova-Bateman.

ICL will continue developing new technology to use secondary phosphates. According to Langveld, the company's goal is to replace primary phosphate rock utilisation with secondary phosphates in fertilizer production as soon as possible, with the ambition to replace up to 100% at its Amsterdam plant by 2025.

However, to help facilitate this, Langveld urged that there was an important legislative role for national and EU nutrient platforms to set realistic contaminant limits, otherwise no recycling would be possible. ■

Mike O'Driscoll is director of Imformed