Mineral recycling

SRCR 2014: Waste streams could offer secondary mineral resources

- Industry urged to reflect sustainability in design
- Urban mines offer ways to retain mineral gain
- Potential to recover rare earths from mine waste

Kaolin mines like these in St Austell, UK, could also provide a secondary source of rare earth minerals.

Laura Syrett

Finland-based engineering group Outotec Oyj has called on the mineral processing industry to recognise its sustainability obligations and invest in ways of recovering minerals efficiently from all available resources, including 'urban mines'.

Speaking at the Sustainability through Resource Conservation and Recycling (SRCR) 2014 conference in Falmouth, UK, in June, Markus Reuter, director of technology management for Outotec, explained how stockpiles of end-of-life consumer products, including batteries, LCD television screens and LED lamps, are a rich source of valuable minerals.

"These urban mines are secondary resources that can be accessed through designed mineralogy recycling (…) Minerals represent gain, but this gain is thrown away when products are not recycled," he said.

Reuter explained how the United Nations Environment Programme (UNEP) Report on Metal Recycling, launched last year in Berlin, Germany, aims to outline the opportunities, limits and available infrastructure for recovering minerals from sources like urban mines.

"The term urban mines is often misused," Reuter told **IM**. "Mining implies finding new sources of value. But the important thing is sustainability – closing the loop," he added.

A three-year research programme (2013-2016) accompanying the report also aims to set up a technology and innovation community within the European Union, designed to help "spread the word" about the possibilities for resource efficiency through recycling and establish best practice guidelines for the future design of mineral processing technology.

"There is no need to waste taxpayers' money by reinventing the wheel," Reuter said. "With the digitalisation of existing technology and systems, we can work to optimise what we already have and improve it," he added.

Antoinette van Schaik, owner of Netherlands-based consultancy MARAS, which designs product-centric approaches to mineral recycling, cautioned against adopting generalised system designs for recovering materials from urban mines.

Van Schaik explained that because of the complexity of many modern consumer products such as mobile phones, which use several minerals and metals including rare earths and tantalum, waste streams from these products would also be complicated and systems for recycling them have to be carefully designed.

"Recycling is product specific," she said. "The key is to take product-centric, thought based approaches that do not oversimplify the flow models."

Recovering rare earths from mine waste

The drive to improve resource efficiency is particularly strong in relation to a number of minerals regarded as "critical" raw materials by many industrial economies, including rare earths.

As a result, a growing number of research institutions and universities are throwing their weight behind the drive to find alternative sources of rare earths to Chinese mines, with a number of studies looking into the possibility of recovering the elements from waste streams of other minerals.

Chenna Rao Borra, a research scientist at the University of Leuven, Belgium, delivered a paper at SRCR outlining the potential to exploit red mud waste from bauxite mining as a secondary source of rare earths.

Red mud is bauxite residue generated as a by-product from the Bayer Process, which is used to refine bauxite to produce alumina. The mud itself is highly toxic, as it contains traces of heavy metals and minerals that can contaminate soil and water.

Storage and neutralisation of this residue therefore represents a significant cost for alumina producers, as well as environmental risks.

Borra and his team are looking at ways of using citric and acetic acids to leach some of these minerals and metals out of a mud sample from Aluminium of Greece Co. to generate a secondary value stream and leave a less harmful residue for disposal.

The work has similar aims to the project being undertaken by Japan's Nippon Light Metal Co., which in February 2013 set up a pilot facility in Kingston, Jamaica, to investigate the possibility of removing rare earths from red mud.

"[Nippon] are possibly working on the same process as us," Borra told **IM**. "But they haven't published anything, so it's difficult to know."

One of the challenges with the acid leaching approach is that leaching rates vary between the individual rare earths because of differences in their ionic associations with host minerals, Borra explained, while leaching chemicals also represent further costs and disposal issues.

In a separate paper delivered at SRCR, Quentin Dehaine, a PhD student at the University of Lorraine, France, outlined research into rare earths recovery from wastes generated by kaolin plants.

Dehaine's work focuses specifically on samples from kaolin production at Imerys-run pits in Cornwall, UK, but he told **IM** that "there is huge potential for recycling rare earths from kaolin all over the world".

Waste derived from the Cornish mines contains a high proportion of the rare earth bearing mineral monazite, Dehaine explained, adding that his findings had shown the potential to recover the light rare earths cerium, lanthanum and neodymium from kaolin tailings.

According to Dehaine's findings, the micaceous residues of kaolin plants represent the most valuable waste streams for rare earths because the minerals have been pre-concentrated in this waste flow as a result of the kaolin plant's in-built sorting methods.

However, the low grade and varying size distribution of rare earth bearing material in this stream will still require adapted recovery techniques, he explained, meaning that further processing design work is needed.