ENGINEERING EXCHANGE by Peter Diekmeyer

The return of roasting?

Difficult gold ores are enticing operators to take another look at this technology


Bernd Reeb

Hindustan Zinc Ltd.'s 170,000 TPA zinc roaster in Chanderiya, India

Miners who need to process refractory ores should be giving roasting a second chance, according to some at the forefront of the technology. During the last few decades, North American mining companies have shied away from the process, which involves heating refractory ores to release the valuables inside. Roasting lost much of its lustre following implementation of tougher emissions standards, but with new technology available to curtail environmental problems and the move towards increasingly low-grade refractory ores, a resurgence is now possible.

"The new ore bodies that companies are looking to bring on stream in coming years will require considerably more effort to make them profitable," explains Arthur Barnes, principal extractive metallurgy consultant at Xstrata Process Support (XPS). The main contributors to refractoriness are sulphides and carbons, and with increasing need to remove these from the ores, Barnes believes that in many cases, roasting can be cheaper and easier to implement than alternative techniques.

Myths and realities

The concept of roasting is relatively simple. At high temperatures, gases react with the ore and carry away unwanted elements, leaving a more refined material behind for further processing. At the turn of the 20th century, the heating process was conducted out in the open, which, as one might imagine, led to substantial emissions. Additionally, concerns about unstable arsenic-containing effluent generated by roasting at the Giant Mine in Yellowknife, which started operations in 1948, contributed to an abandonment of the process in North America. The problems were very real: at the beginning of the 1950s, emissions of arsenic trioxide dust at the Giant Mine were as high as 7,400 kilograms per day.

But today's roasters are not much like their old, badly polluting predecessors. Fluidized bed technology, which has been evolving for decades, uses high-temperature gas jets to heat ground ore. Under the right conditions, the ore begins to act as a liquid, making the process more efficient than when simply heating one layer. The classical fluidized bed technology is called "bubbling," since the top of the ore layer can be seen to bubble like it is boiling inside the reactor. Newer, circulating fluidized bed roasters, on the other hand, have gas entering the reactor at such a velocity that particles are picked up and brought to the top of the reactor. Then, the particles are separated with a cyclone and returned to the mix, creating a very controllable, homogenous temperature.

But even though fluidized bed technology has continually improved, the demand for it has dropped off. "During the 1950s and 1960s, Outotec installed about five metallurgical fluidized bed roasting plants each year," says Marcus Runkel, a senior process engineer at the company. "This doubled to ten per year during the 1970s and 1980s before falling off to about two per year in the 1990s, and then to just one plant a year now." Runkel feels that demand for fluidized bed roasting installations could be poised for a comeback in North America. While the number of plants being built has decreased, plant sizes and throughput have increased. "The average plant capacity from the early years increased by a factor of about 15 to plant sizes today," he says.

According to Barnes, "newer technologies, such as second-stage after-burners and oxidizers, are available to address environmental concerns." He says that "as a result, much of the current reluctance to use roasting in North America is probably due to institutional inertia."

Runkel agrees. "Environmental standards around the world have been increasing," he says. "It is almost mandatory to always use the best technology that is available. Heat recovery and gas cleaning are integral parts of a roasting plant. Heat recovery, specifically, gives roasting an advantage over the hydrometallurgical processes," he explains. "Technical solutions for roasting are available to meet all environmental regulations."

Old habits die hard

Right now, most North American mine operators rely on pressure oxidation processes to treat ores that contain pyrite, arsenopyrite and carbonaceous material for domestic operations. However, pressure oxidation, which requires autoclaves, necessitates major capital investments in equipment and operating costs to get running, as well as lengthy permitting processes. "There is no easy way to treat these complex or low-grade ores," says Runkel, so many operators are considering alternative procedures like fluidized bed roasting, which, while also expensive and time-consuming, have the potential to be very efficient.

XPS operates three fluid-bed reactors that it uses to test whether roasting can be used to treat highly refractory ore samples. While their facilities are near Sudbury, their clients are primarily companies that want to conduct preliminary mineralogical modelling outside of North America. XPS looks at both the physical and chemical aspects of the roasting process from samples drawn from ore bodies in places where roasting is more widespread, says Barnes. The facility operates under conditions of strict confidentiality, so Barnes cannot disclose specifics, other than to say that a large variety of samples have been tested and that the process has been "encouraging."

The flexible range of reactor units at XPS, which can operate in a variety of modes (such as "bubbling bed," circulating bed, two-stage, sub-stoichiometric and combinations of these) gives XPS the ability to accommodate a variety of sample sizes ranging from a few kilograms to a few tonnes. "The facilities are busy," Barnes says.

Running small-scale roasting tests can be challenging. Assembling the 10 kilograms of concentrate to use as test material is difficult because the samples available from mine sites prior to commercial drilling are generally just drill cores. To process 10 kilograms of concentrate for testing purposes could require close to a tonne of core material, says Barnes. Once the testing is completed, he generally recommends that the mine developer start talking with a commercial roasting facility developer.

Research can help overcome hurdles

Barnes admits that there are considerable challenges in getting roasting technology accepted again. For example, feeds are far finer these days than they were decades ago, as mineral processing operations seek to maximize gold recovery from supply batches. When processing finer feeds, operators need to take more care to limit the maximum velocity of the fluidizing gases. For example, if the velocity is too high, it is difficult to maintain a stable bed, with a distinct "fluid" boundary, and the bed becomes much more diffuse.

Ensuring correct operating conditions is particularly important when processing highly refractory gold ores, and especially ones containing arsenic. As a result, Barnes notes that "all roasting predictions and calculations need to be confirmed or modified by carefully controlled and monitored testing" at facilities such as XPS's and Outotec's. CIM

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