HEAP LEACH

Following the Flow

Heap leaching has always offered a low-cost extractive solution with minimal environmental impact. Building on its inherent flexibility to accommodate new challenges, techniques and technologies, it shows no signs of lagging interest from producers or suppliers.

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Since its commercial introduction to the mining industry in the late 1960s, heap leaching of low-grade ores to recover valuable commodities-mostly gold and copper, but also nickel, uranium and to a lesser extent, vanadium and other metals - has grown steadily and proven to be a flexible and less-capital-intensive approach that appeals to both ends of the industry's corporate spectrum, from new or smaller companies looking for a way to get a property into production as quickly and cheaply as possible, to established producers that want to monetize marginal mineralization.

It's a steadily evolving technology that has been able to accommodate mineralogical changes in the mining landscape, and it has been user-friendly in terms of adopting new forms of technology that offer the prospect of lower pad construction and closing costs, more efficient fluids application and collection, and ultimately, higher recovery rates.

Many of the long-term trends and changes in heap-leach operations are highlighted in a recent paper presented at the 2016 Society for Mining, Metallurgy and Exploration (SME) Annual Meeting* that updated a survey of copper leach producers conducted in 1998. The authors sent questionnaires to 40 copper-leach operators, including properties that were contacted in the original survey and are still in operation; 28 operations responded.

Among the broad trends identified by the survey results is a geographical shift in overall capacity of copper SX-EW plants Latin America gained 12%, moving from 46% to 58% at the expense of the south western U.S., which dropped from 42% to 38%; and Africa, which didn't register on the recent survey after holding a 9% share in 1988. Australia gained one point, growing from 3% to 4%.

The results also showed a swing in primary copper mineralogy to mixed leach-ore types: in 1988, oxide ore accounted for 29% and sulphide 14%, with oxide/sulphide mixed ores representing 57%. In the updated survey, oxides dropped to 20%, sulphides to 12%, and mixed ores grew to 68%. Other notable results from the survey are shown in the accompanying figure on the next page.

To identify ways in which industry suppliers are responding to the heap-leach sector's changing conditions and requirements, E&MJ conducted an informal survey of its own; we took a look at recent product announcements, spoke with supplier representatives, and put together a brief sampling of the newest technologies available to the industry. Among those, we found an increasing emphasis on automation and better control systems for material handling equipment - not a surprising result, as leach pad footprint size and height continue to grow while the industry attempts to pare construction and labor costs as it searches for solutions to optimize metal recovery and its return on heap leach project investment.

** Washnock, R. , Zarate, G. and Scheffel, R., Copper Leaching: 2014-2015 Global Operating Data, Preprint 16-041, SME Annual Meeting, Feb. 21-24, 2106, Phoenix, Arizona.*

Maintaining the Flow

As the industry shifts from truck-dump pad loading to conveyor-based stacker/spreader systems, the focus changes from what is almost a batch-loading process to one that is more or less continuous. Careful planning is necessary-involving a wide range of disciplines-to extract the best performance from these highly engineered materials handling systems. We spoke with Matthew Hanson, business development manager at Superior Industries, a Minnesota-based supplier of conveyor systems and components, about how the company goes about laying the basic groundwork for recommending a leach-pad loading system package to its customers.

E&MJ: **What are the basic set of project-specific factors that Superior's engineers take into account when specifying an equipment package for a given heap-leach operation?**

Hanson: The first area we look at is material characteristics-the type of material, its PCF, size and tons per hour requirement. With this information we can then size the belt width of the conveyor system. The next step would be to look at the pad layout and the stacking plan in order to properly size length and number of grasshopper conveyors required. As soon as we have determined the grasshopper length, we will then size our HIC (Horizontal Index Conveyor) based off of this. The last step would be to determine the cell width and pile height to correctly size the stacker.

E&MJ: **What are some of the individual site characteristics you encounter that require additional engineering or customization?**

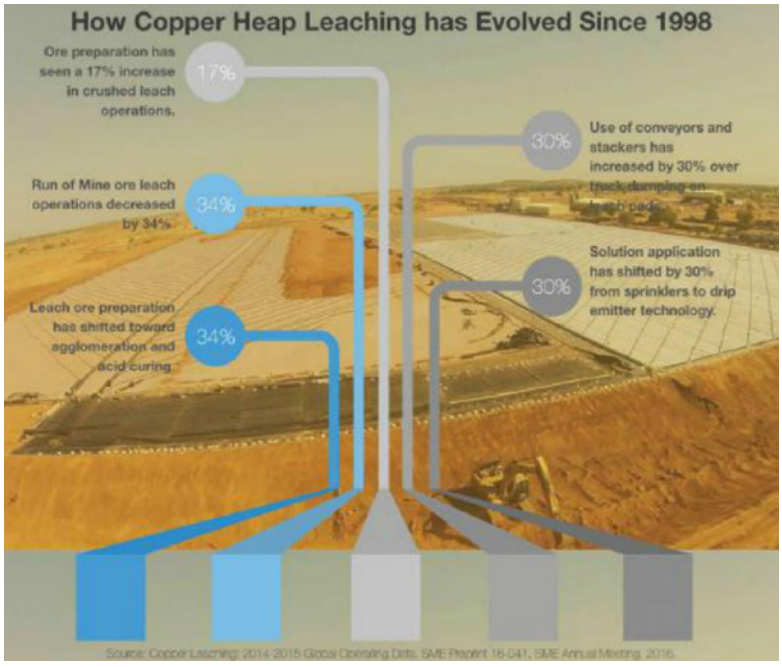
Hanson: Weather conditions in any given area will always need to be looked at. Rain, snow and wind cannot be over looked. The valley fill sites are always more complex than a standard site. One aspect that needs to be looked at thoroughly is the power travel for all the conveyors-the HIC will need to be sized to tow the stacker and itself up the worst incline. The radial travel of the stacker also must be taken into account.

E&MJ: **Can prospective heap-leach customers take advantage of any recent advances in materials, control systems, energy-saving technology or other aspects of conveyor equipment design to improve the efficiency of their operation?**

Hanson: Our latest advance is an auto level system on our stacker. This technology allows us to keep the stacker level while moving radially on an uneven terrain. This will be very helpful in regard to belt tracking and with material spillage. Last year, Superior updated its telescoping radial stacker automation program, which didn't affect the physical function of the machine but provided a user-friendly screen design featuring enhanced graphics and onscreen buttons to help operators navigate the software more easily, among a list of other improvements aimed at user convenience.

Controlling the Flow

For larger leach-pad stacking systems, an integrated control system is essential to achieve smooth, uninterrupted material flow at high volume levels. As an example, FLSmidth engineered and delivered a heap-leach stacking system for CNMC Luanshya Copper Mines PLC, located in Luanshya, Zambia, designed to load more than 1,000 t/h of agglomerated copper ore onto the mine's pads.



The order included an overland (OL) conveyor, a mobile overland tripper (MOT), 20 grasshopper conveyors, a mobile transfer and bridge conveyor, and an automated radial stacking conveyor. One FLSmidth team designed and detailed the leach pad stacking conveyors, and another team designed and detailed the OL conveyor and MOT. All conveyor structures were fabricated in South Africa.

The MOT, which straddles the OL conveyor, was equipped with two driving stations so it could be driven to the required stacking location along the OL conveyor. The MOT has intelligent anti-collision instrumentation to assist the operator in keeping it located on the overland centerline while being driven, thus preventing a potential collision that would damage the OL conveyor stringers.

The bridge conveyor was configured with hydraulically driven tracks that could be manually or remotely driven via an operator-controlled radio pendent. The bridge had a separate onboard generator used to power the bridge track drives while towing the radial stacker over long distances. The radial stacker included an elevated operator control cabin featuring an HMI and manual operator controls.

An auto-stacking solution was developed to provide the radial stacker with full operational capabilities in automatic mode. To do this, a mathematical auto-stacking solution was formulated in-house on a conceptual level and refined through numerous design iterations. The final auto-stacking algorithms required specialized programmable logic controller coding and included processes for cone stacking at low tonnages, continuous stacking and manual stacking. Two HMI modules were supplied-one in the field at the head end of the OL conveyor and the other in the operator control room on the radial stacker. FLSmidth provided a wireless network for the transfer of all instrument signals from each mobile conveyor to both HMis, which allows one operator to efficiently pinpoint a technical problem. The wireless network is used for indication only, while all controls were hardwired on each mobile conveyor.

A group-start function can be controlled from the radial stacker's HMI operator interface. Maintenance mode can be selected from dedicated conveyor local control system panels so that each piece of equipment can be started individually. Stockpile height and slew speed are determined by two radar ultrasonic level sensors located on the mobile slinger. The control algorithm of the radial stacker was programmed to suit the design requirements in stockpiling height (trough to peak).

Intelligent pull keys were used on the overland conveyor with feedback to the HMis, where status could be monitored in defined zones. Thermistors were supplied on the 250-kW overland conveyor drive motor to monitor winding temperatures. All of the system's gearboxes are monitored for oil temperature, and fluid couplings were supplied with thermo switches. All process and control instruments were hardwired back to their respective mobile conveyors.

Monitoring the Flow

The use of automation in heap-leach operations extends to leach-solution application practices, as well. Earlier this year, Netafim USA, a manufacturer of dripline products for the mining industry, called attention to its new monitoring and control solution designed to improve operational productivity. Available as a complete package of software, hardware and support equipment, Netafim's system uses proven radio and cell-based technology to provide real-time control and monitoring of the leaching process from a single location. The system provides the capability to remotely monitor solution flow onto the pad, and immediately respond to any problems detected.

"Automation and data logging technologies have been incorporated into nearly every facet of modern mining operations, but when it comes to the leaching process ... most mines still employ the very inefficient process of manual monitoring and troubleshooting," said Karen McHale, North American sales and engineering manager for Netafim USA's Mining Division. "We are able to give mines precision control technology that eliminates the need for teams of workers to manually walk miles and miles of leach pads on a daily basis in search of a potential problem."

The automated system incorporates moveable equipment that contain radio or cellular controls, control and air valves, meters, gauges and other components designed to collect and store crucial data that mine operators can use to improve operations and maintenance, as well as to identify problems such as line plugging that can wreak havoc on a leaching system. "Infusing automation into the leaching process means mines can work with smaller teams supported by a real-time assessment of the leaching process without leaving the office. By turning on the leach pad, mines are able to benefit from increased efficiency and reallocate manpower needs to other areas of the mining operation," said McHale.

E&MJ spoke with Mike Stoll, Director of sales and marketing for Netafim USA's Industrial division, about the design intent and specifics of the system.

E&MJ: How has Netafim incorporated automation into the leach process?

Stoll: Netafim is a solutions provider in the mining industry that includes dripline, air vents, flow meters, flushing packages and other valves. From the perspective of how Netafim dripline products are utilized in heap leaching, the process has not historically featured very much automation. That means that there is a large manpower requirement to oversee the day-to-day performance of the pads. The Netafim system minimizes the manpower required and allows the site to direct personnel to a specific and known problem. It does this by providing real-time data to a central location so that any maintenance that needs to be performed is being done because it is required rather than just being done to cover bases. Netafim is taking manual operation out of the equipment in the leach circuit and allowing data to be collected regularly and equipment to be turned on/off from a central location. Personnel do not have to walk the pad to collect data or flush the driplines. It can all be done from a laptop.

E&MJ: What are the primary components of Netafim's automation technology for leach pads?

Stoll: The control and automation system consists of Remote Terminal Units (RTUs), antennas, repeaters, base station and the software (server or cloud-based) to operate it. The equipment that can be controlled consists of valves, flow meters, sensors and other equipment or instrumentation. From the standpoint of cost and support, the ability of the Netafim system to be cloud-based is one of its most attractive features. Imagine a mine operator with two or more sites either in close proximity or even hundreds or thousands of miles apart, and each site needs the level of control the system provides. By using a cloud-based system rather than having individual servers at each site, the company not only saves thousands of dollars in equipment, setup and maintenance, but being cloud based allows the mine to oversee all controlled activities from an individual site as well as from other authorized locations.

E&MJ: How are the primary components of the system deployed?

Stoll: The system provides an open platform that makes it customizable and expandable. It goes from very simple data collection of a flow meter to collecting data and controlling all the equipment installed from a central location. Pad components can be deployed in any variety of ways that include simply physically connecting the components into the piping network or in a way that makes them portable as the pad expands and grows. As with other equipment on a pad, the ability to move components quickly and with a minimum of damage is critical. Netafim works with the individual site on identifying the needed components but each site determines the best way to set the components up.

E&MJ: Is the system easily scalable to allow expansion of capacity?

Stoll: Yes. One of the Netafim system's key attributes is its ability to not only scale upward or downward but also to allow basic monitoring or very advanced monitoring and control of any number of inputs. The value to the mine site is that as or if their needs become more complex, the Netafim system can grow with them without starting anew.

E&MJ: What types of data can be collected?

Stoll: The Remote Terminal Units (RTU's) that are in the field send a radio signal to the base station and then to the software/server for storage. For example, all the data is collected and stored so it can be used for analysis. The most common data collected is flow, temperature and pressure. Limits can be set so alarms can alert personnel if the flow/pressure is too high or too low. The dripline design is configured for certain inlet flows/pressures and if these parameters are above or below those limits solution flow to the pad could be compromised. Monitoring the flow and pressure across the leach pad can alert personnel that plugging may be occurring in the dripline, meaning the lines need to be flushed. The flushing logic can be programmed into the software to flush on a time schedule or when the flow differential exceeds a set point. These data points also show that the equipment is functioning correctly.

E&MJ : How can this data be utilized to improve performance?

Stoll: One of the key maintenance issues with heap leaching is management of the dripline system and keeping the driplines operating at peak performance. The typically unfiltered solution being delivered to the pad can create issues with drip emitters clogging and while the clogging can frequently be remedied, the manpower needed to do that can be expensive. By designing the pads in a way where by the ends of the dripline laterals can be opened so additional flow is pushed through the dripline, the driplines can be "scoured" with the increased flow which creates turbulence in the dripline and dislodges contaminants from the inside walls of the tubing. This is a technique used in many industries including wastewater, flushing water mains, etc.

E&MJ: Can the system be tailored to meet specific operational objectives or reporting requirements?

Stoll: The scalability of the Netafim system is purposely designed to support any level of control from the most basic to very complex.

E&MJ: Does the system require additional training for proper use?

Stoll: Yes. Netafim offers training to the local technical personal on installation, troubleshooting and system operation. Service personnel are available for site visits and the site can call our office for troubleshooting help as well.

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