Demonstration of High Temperature Heap Bioleaching of Chalcopyrite Copper Ore

It is a worldwide phenomenon that, as copper mines are getting deeper, more sulfidic ore is encountered. Furthermore, the average grade of reserves and unexploited deposits is dropping. Acid heap leaching has been widely used to extract copper from oxide ores, and heap bioleaching (with forced air injection) is used for the treatment of low-grade secondary sulfide copper ores. The deeper primary hypogene copper ores account for the larger proportion of known resources that remain in the ground, but these are of relatively low copper grade. In addition, chalcopyrite is well known to be refractory to leaching, and a lot of research effort has therefore been spent on tailoring the heap leaching process to treating chalcopyrite ore.

Mintek has made significant progress in this regard and the completion of a demonstration campaign on a number of ore heaps of about 20,000 tonnes each has been an important milestone. The process relies partly on published principles of heat retention in the heaps by balancing the irrigation and aeration flows, in order to raise the in-heap temperatures sufficiently to achieve economic chalcopyrite leaching kinetics. But in addition to heat retention, a practical operation also requires control of the ionic strength of the leach solution to sustain bacterial activity, the management of solution flows (switching between raffinate and intermediate leach solution [ILS] for irrigation, and routing drainages to either pregnant or ILS pond), and correct start-up of the heap to initiate bacterial action and heat generation. To assist operators in keeping track of the frequent interventions required particularly on a plant with multiple ore cells each at a different stage of operation, the HeapStar® heap leach administrative and guidance system was developed as part of the project. This system takes inputs of actions and results from all active heaps, produces reports of sampling and adjustments required, and facilitates convenient calculation of the spacing of drainage pipes, dripper lines and drippers during heap construction. It therefore offers various functions that can support the operation of any heap leach operation, not only high-temperature heap bioleaching.
Another by-product of the demonstration project was the SmartColumn™ concept for simulating the environment at the centre of a heap. It facilitates direct experimental observation of the development of the temperature profile starting from ambient to the maximum that will be achieved during the operation of a heap under a selected set of operating parameters.

The demonstration project continued over a period that included two winter seasons, where minimum temperatures below -10 °C were frequently experienced, while maintaining elevated temperatures in the heaps.

The accompanying photographs provide an impression of the operation in both summer and winter.