The Role Of Biological Technologies In The Advancement Of Mineral Processing Technology

There are many definitions for the term biotechnology. Perhaps the clearest and most easily understood is that used by the US government:

> "using living organisms or their products for commercial purposes."

Biotechnology has been practiced by human society since the beginning of recorded history in such activities as baking bread, brewing alcoholic beverages, or breeding food crops or domestic animals. Like many technologies, biological based science took a long time to cross the boundary into the mineral processing industry and did not gain wide acceptance until the later part of the twentieth century. Some may argue that it still does not have wide application.

Brief History

Biological activity related to mineral dissolution has long been known to occur in nature and in fact is primarily responsible for acid mine drainage (AMD). Although the cause of acid mine drainage was a mystery for centuries we now know that certain naturally occurring bacteria help speed up the process. With a knowledge of the cause, a cure can not be far away and in fact acid mine drainage is now well understood and most modern mines take proactive steps to prevent AMD. Knowledge of how the bacteria and the environment react to exposed mineral surfaces has enabled the mining industry to greatly improve the environment. Preventing biological attack is often just as important as encouraging it!

The earliest exploitation of biological systems by the metallurgical industry was in the leaching of uranium in the 1950's. It was not until the late 1980's that bioleaching was exploited for the treatment of refractory gold ores and it has been only recently that commercial processes were developed for the leaching of base metals sulphide such as copper, zinc, nickel, cobalt, etc.. But biotechnology does not end with leaching, biotechnology has also been successfully applied to cyanide destruction and metal removal from waste waters.

Cyanide destruction using bacterial processes was pioneered in Lead, South Dakota at the Homestake Mine. Large rotating biological contactors containing a suitable biomass were used to treat cyanide containing effluents with great success. More recent developments in biotechnology utilize bacteria to produce H_2S which is then used to precipitate metals from mine effluents.

Today there are a wide variety of biotechnologies to choose from which can broadly be broken down as follows:

Whole Ore Leaching Processes:

- Heap leach for refractory gold treatment – Newmont, GeoBiotics
- Heap leach for base metal sulphide recovery – GeoBiotics, BHP, Bactech, Straits Resources, Titan Resources

Concentrate Leaching Processes:

Stirred tank biooxidation for refractory gold treatment – Goldfields, Bactech
Stirred tank biooxidation for base metal sulphide extraction – BHP, Bactech
Heap leach for refractory gold treatment – Geobiotics
Heap leach for base metal sulphide recovery – GeoBiotics

Waste Water Purification Processes:

Cyanide destruction processes – MSE, Whitlock and Associates,
Heavy metal removal – MSE, BioteQ
Nitrate removal – MSE
Hydrocarbon removal – MSE

Why Biotechnology?

Biotechnologies offer many advantages over conventional technologies both for pretreatment, leaching and waste water cleanup. These advantages occur as a result of bacteria systems being adaptable, not highly dependant on the grade of the ore or concentration of the solution and being self-sustaining. The end result is a process that can treat refractory gold ores at a much lower cost, a process that can extract copper from very low grade ores and an effluent treatment system that can operate on very low metal concentrations for extremely low cost and long periods. Bacterial processes tend to be slower than conventional chemically driven reactions but the cost advantage can be tremendous. Additionally, bacterial systems generally operate at ambient pressures and near ambient temperatures, which makes them inherently safer.

Biological systems are natural and have evolved over millions of years to perform a single task effectively, be it chalcopyrite leaching or cyanide destruction, the bacteria are tireless and never complain. We simply have to provide a suitable environment for the growth of these cultures to achieve success. By using bacterial systems we are exploiting naturally occurring systems for our benefit and in doing so we are saving money and leaving behind a cleaner environment. The use of biotechnologies can reduce operating costs thus, lower cut-off grades making low grade deposits economic. Bioremediation can help purify abandoned mine sites reducing the mining legacy and new bio-effluent treatments can ensure that we leave as little impact as possible while still making a profit. In short biotechnologies can bring the mining industry towards sustainable development.

Todd Harvey