Metal Recovery from an Open Pit Mine

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A remediation process has been proposed by the Clarkson University Remediation Engineers (CURE) that will treat waters accumulating in an abandoned sulfide mine located in New Mexico. Currently, water in an open pit and shaft is contaminated with high levels of metal ions and other pollutants. This highly acidic water, otherwise known as acid mine drainage, poses serious environmental risks to a nearby creek and aquifer. The proposed remediation process treats this water to a level suitable for creek discharge, as compliant with the state and federal regulations. In doing so, the purity of the local creek and aquifer will be ensured for the life of the operation. Copper and zinc metals in the water will be recovered in a saleable form as copper sulfide and zinc sulfide. The revenue from these metals will help offset the capital and operating costs of the plant, thereby minimizing economic impact. The amount of waste produced is minimal, and all waste will be disposed of in a manner compliant with Resource Conservation Recovery Act (RCRA) regulations.

CURE investigated a number of remediation process possibilities. The process that incorporated maximum revenue from saleable products, created minimal waste sludge, and produced effluent water suitable for creek discharge was determined to be the BioCURE process [1]. This process utilizes a biological phase and a chemical phase, which can be optimized independently to treat contaminated water resulting from the conditions in the mine and open pit. This process is particularly useful in treating waters that have considerable concentrations of sulfate and metal ions. The ultimate products of the process are the formation of insoluble metal sulfides and an effluent suitable for discharge. Selective recovery of metals is made possible in the chemical stage by varying the pH of the solution, regulating sulfide dosage, and altering the residence time in the clarifiers. The biological phase utilizes sulfate-reducing bacteria that produce sulfide ions and carbonate compounds. The sulfide is then used to precipitate the desired metals to produce a high metal concentration sludge that can be sold to smelters, thus offsetting operational costs. The carbonate compounds are used to raise the pH of the solution in specific stages of the chemical phase.

Bench-scale testing of the BioCURE process verified the feasibility of metals removal via sulfide precipitation. A sample of the acid mine drainage in question was prepared and allowed to settle for a time equal to the detention time of the initial clarifier. The supernatant was tested for metals precipitation using aqueous sodium sulfide, which was determined to be an appropriate substitute for gaseous hydrogen sulfide. Results showed that metal removals were adequate for creek discharge. Sulfate concentrations were also determined, illustrating that there was sufficient sulfate within the supernatant to allow for the biological production of sulfide levels adequate for metals precipitation. A bioreactor, which houses the

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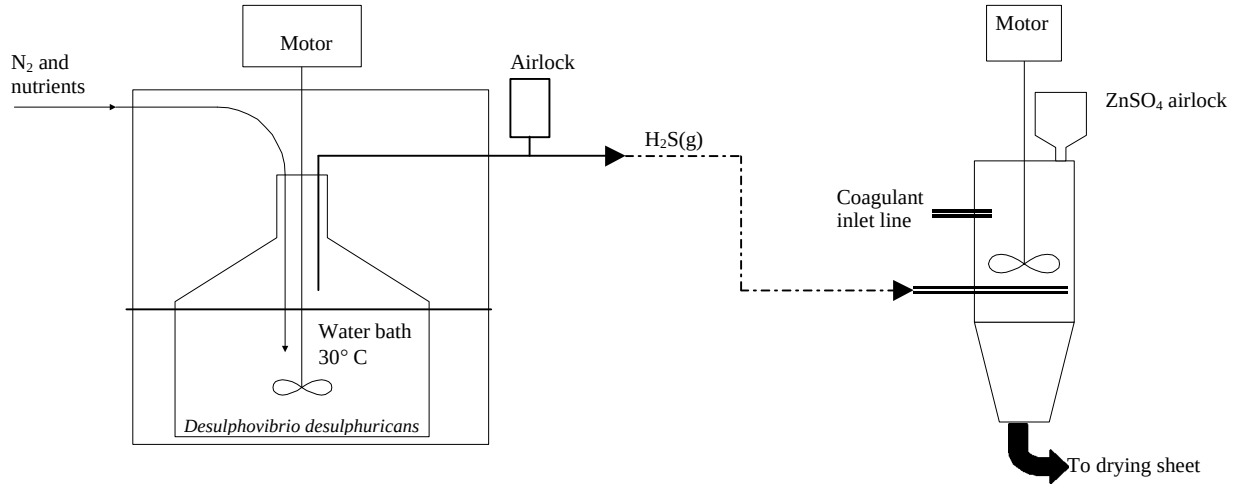
sulfate reducing organisms, was constructed and refined in order to achieve maximum growth rates. This anaerobic reactor was monitored for the production of sulfide in the form of hydrogen sulfide gas when provided a substrate rich in sulfate. A schematic of the bench-scale design bioreactor and clarifier/mixer is shown in Figure 1.

Figure 1



To verify accuracy of the bench-scale process, computer modeling calculations were performed using MINEQL+ [2]. This is a program used by environmental engineers to predict interactions of free ions in solution. The simulated results showed very similar concentration levels as to what was observed in the laboratory.

Bench-scale design, full-scale design, health and safety, and public involvement are among the issues covered extensively in the design process. These will ensure worker safety and minimize any negative impact to the surrounding community and environment. CURE is confident that the BioCURE process is a successful, long-term solution to the New Mexico site.

Reference:

[1] United States Patent & Trademark Office. Patent No. 5,587,079. "Process for Treating Solutions Containing Sulfate and Metal Ions". December 24, 1996.

[2] Schecher, William, and McAvoy, Drew. MINEQL+ A Chemical Equilibrium Modeling System, Version 4.0. Environmental Research Software. Hollowell, ME (1998).