

BCR evaluates a combined limestone-lime process as encouraging. It sees an advantage in that the bulk of the reactions would be between limestone and various acidic groups. Ferrous iron would be precipitated, but the combined effects of limestone and lime may require only small lime doses. The precipitated ferrous iron would oxidize rapidly, and the resulting acidity would be neutralized by excess limestone already in the system. To complete its study, BCR will do further research on such process factors as mine water composition, its Eh—standard oxidation-reduction potential—and pH, quantity of reagents needed, and agitation and aeration rates.

Potassium permanganate has been evaluated experimentally by Barnes & Tucker Co. for treatment of the more than 14 million gallons per day discharged from one of its mines. The iron content of the water averages 20 parts per minute. The permanganate is being evaluated as a chemical oxidant for ferrous iron.

Sodium hydroxide—and ammonium hydroxide—have been applied to mine drainage in isolated cases but are unlikely to reach wide use. Both react with mine water constituents in basically the same way as hydrated lime but are more expensive—\$60 per ton for sodium hydroxide and \$92 per ton for ammonium hydroxide—and not without problems. Sodium hydroxide is a much stronger base than lime and has the advantage of being fed as a liquid rather than a slurry. It also produces a soft water, compared with lime neutralization, but that is a relative merit depending on the end-use of the treated water. A mid-west coal producer tested sodium hydroxide neutralization to reclaim impounded strip-mine water for use in a coal preparation plant but abandoned it because of a bad side effect on froth formation in flotation equipment. Ammonium hydroxide is a potential hazard to fish. The only full-scale treatment plant using the chemical—as anhydrous ammonia—operates on a closed-loop cycle.

Sodium sulfide as a reagent for treating mine water is being investigated to BCR under a grant from the Appalachian Regional Commission. The reaction is instantaneous and produces an easily filtrable material, iron sulfide. Also, the acid in the mine water is simultaneously neutralized. Further, it may be possible to recover sulfur from the iron sulfide. The recovered sulfur could be used to put the treatment on a reagent-recycling basis. The possibility of making it yield usable byproducts is worth evaluation. In another step to improve the economics of the treatment, BCR is looking into the feasibility of using sulfur-bearing wastes, such as coal mine gob piles, to provide low-cost sodium sulfide.

Ozone, a powerful oxidizing agent, is being tested for mine drainage treatment by a Wilkes College researcher. Like potassium permanganate, ozone's principal function is to oxidize ferrous iron to ferric, so it must be used in conjunction with a suitable agent to neutralize acid. Initial research indicates a high ozone demand, but costs and other data are not yet available.

Bacterial oxidation of iron in mine drainage waters, which has been studied on a small scale by a number of researchers, will get an intensive evaluation in a new project for which Continental Oil Co. and the Federal Water Pollution Control Administration will share costs. Conoco scientists will make laboratory studies of type of iron-oxidizing bacteria that will grow in mine drainage waters and remove iron