

THE USE OF MICROENCAPSULATION TO PREVENT ACID ROCK DRAINAGE¹

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Abstract: Two commercially available microencapsulation products were tested for their ability to coat unoxidized pyrite and prevent its oxidation. EcoBond-ARDTM, a phosphate based compound and KEECO KB-SEATM, a silica based product, were each applied to an unoxidized acid generating waste rock. Three application rates were selected by each company and represented a low, optimum and high application. Laboratory testing has been conducted in humidity cells for 168 weeks. Cells with untreated waste rock (controls) produced drainage below pH 6.0 after 1 week and had an average pH of about 3.3 after 60 weeks. EcoBond-ARDTM delayed the onset of acidification but it was not successful in preventing acid drainage. The pH in all cells treated with EcoBond-ARDTM decreased to below 6 after 12-16 weeks. These cells were terminated after 59 weeks when the pH had decreased to around 3.5, essentially the same as in the controls. Possible explanations for the failure of the EcoBond-ARDTM included insufficient contact time to oxidize the surface of the pyrite or the absence of a durable coating. Additional concerns with the EcoBond-ARDTM were elevated levels of phosphorus and arsenic in the drainage. Initial arsenic concentrations ranged from 400 to 800 ug/L, well above the newly proposed federal drinking water standard of 10 ug/L. Initial phosphate concentrations were 1300 to 3900 mg/L and water of this quality could cause algal blooms in downstream receiving waters. Concentrations did not decrease to below the concern level of 0.03 mg/L until about 30 weeks.

KB-SEATM was successful in preventing acid drainage at all levels of treatment. However, the pH from all cells treated with this product was initially around 12. Although pH has decreased in all cells, the cells treated with 5% had pH values consistently above 9 for about 75 weeks. The rate of sulfide oxidation in these cells was about 10% of the rate measured in the untreated controls and visually there was little sulfide oxidation in the cells treated with the optimum and high application rates (3%, 5%). The pH in the low application rate reactors (1%) has declined slowly and was below 6.5 at 168 weeks. Some oxidation is visible in the reactors and the sulfate release rates had increased slightly.

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The exact mechanism for the success of this product has not yet been determined. Possible explanations include one or more of the following: high pH, due to the presence of lime in the product, cementation of the material, resulting in a macro encapsulation of the rock grains, and microencapsulation of the surfaces with silica.

These cells are being continued to assess the long-term effectiveness of the treatment. The treatment will be considered effective as long as the pH remains above 6.0. Additional work to determine the mechanism should be conducted and cost information needs to be developed.

At least 60% of the calcium associated with the quicklime (CaO) initially applied as a component of the KEECO product remained in the reactor. Some of the lime may have reacted to produce less reactive alkaline compounds, like $\text{Ca}(\text{OH})_2$ and CaCO_3 , and any or all of these compounds could be responsible for maintaining the neutral pH in the reactors. Microscopic evaluation of samples from one of the reactors with optimum treatment (3%) did not clearly identify a mechanism. Silica was generally present along the edge of the pyrite crystals but oxygen penetration into the pyrite had still occurred.