Passive Treatment of Sulfate from Mine-Influenced Water[1]

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Abstract: A passive treatment system pilot study was set-up at a confidential mine site in the south Midwestern United States. The mine site has a mine-influenced water seep interception system at the base of reclaimed mine waste rock dumps. The main contaminant of concern is sulfate with concentrations ranging from 1,000 to 2,000 mg/L. A field-based pilot study was conducted at the site to test the efficacy of using a biochemical reactor (BCR)-based system coupled to a novel sulfide precipitation cell (SPC) to reduce sulfate to sulfide and then remove the sulfide through the precipitation of iron sulfides. The pilot consisted of six arrays with each array containing a single BCR unit hydraulically connected to a SPC unit. The substrate recipe for the BCRs was varied slightly between units and two units were actively fed a liquid organic carbon supplement. Substrates tested in the SPC units for sulfide removal included various types of magnetite waste rock and ore, siderite, and zero-valent iron (ZVI).

Seepage water flow rate was set to test the hydraulic residence time (HRT) in the BCR unit. Flow rates varied to test a 3-day, 6-day, 9-day, and 12-day HRT. The combined BCR and SPC treatment system removed up to 50% of the influent sulfate relative to the effluent without any supplemental carbon. Greater percent removal was achieved with slower flow rates (i.e., longer residence in the substrate), though based on the moles of sulfate removed per day per volume of substrate, an 8-9 day residence time was optimal for this system. Variations in the BCR substrate recipe did not have a big impact on performance. By adding supplemental carbon, sulfate removal rates approached 100%. The SPC substrate recipe impacted removal performance; ZVI performed best. However, the ZVI substrate resulted in significant cementation which could diminish permeability over time.

Additional Key Words: sulfide precipitation cell (SPC), zero-valent iron (ZVI), biochemical reactor (BCR).

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