BIOLOGICAL SOURCE TREATMENT FOR THE TREATMENT AND PREVENTION OF ACID MINE DRAINAGE[1]

Jeffrey M. Morris[2] and Song Jin[2]

Abstract. A biological source treatment (BST) technique has been developed to address acid mine drainage (AMD) at its source. The BST technique utilizes down-hole injections of microbial inoculum and substrate amendments to establish a hydrophobic biofilm on the surface of metal sulfide, which raises groundwater pH to circum-neutral levels and prevents further oxidation of AMD source material. Microcosm studies in the laboratory demonstrated that the BST technique can effectively raise the pH of pyrite-containing AMD water to circum-neutral levels under aerobic conditions in as little as 7 d, and the pH remains at these levels for > 19 months. Microbial analysis identified >70 species forming a complex biofilm-like structure over the pyrite. The biofilm dominantly consisted of facultative anaerobes, which potentially interact with obligate anaerobes, such as sulfate-reducing bacteria, to maintain an oxygen-free micro-environment surrounding the pyrite, even though the outer water stays aerobic. The biofilm became established in water samples with an initial pH as low as 2, and subsequently caused the water pH to increase to circum-neutral levels. Concurrently, concentrations of aluminum, arsenic, copper, iron, lead, nickel, and zinc all decreased substantially compared to baseline concentrations in sterile microcosms. A field study of the BST technique was conducted at a reclaimed coal mine in central Tennessee (USA) and results indicated a modest increase in pH in the treated area (an average of 0.7 pH units and as much as 1.5 units). Dissolved (0.45 µm-filtered) iron concentrations decreased on average by 4 mg/L and as much as 84% (from 93 to 15 mg/L), conductivity decreased on average by 75 µS/cm, and sulfate decreased on average by 79 mg/L in monitoring wells down-gradient from BST injection sites. Electromagnetic surveys were conducted to identify AMD source material and monitor BST performance by measuring changes in groundwater resistivity throughout the site. These surveys revealed a treatment zone created between injection wells where the resistance of contaminated groundwater from up-gradient AMD sources increased as it flowed past injection wells, thus, suggesting this technique could be used to treat AMD sources directly or intercept and neutralize sub-surface AMD.

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[2]Dr. Jeffrey M. Morris is a Lead Scientist and Dr. Song Jin is a Principal Scientist at Western Research Institute, Laramie, WY 82072.