Development of Passive Treatment Systems for Treating Acid Mine Drainage Seeps at Stockton Mine

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Abstract

Acid mine drainage (AMD) at Stockton Coal Mine emanates from the oxidation of pyrite within carbonaceous mudstones during mining, which subsequently releases acidity resulting in metals leaching from overburden. Water chemistry and flow were monitored at numerous seeps at Stockton. Manchester Seep, which daylights at the toe of an overburden embankment, was chosen to conduct research pertaining to development of passive-treatment systems for neutralizing acidity and sequestering metals in AMD. Median dissolved metal concentrations were 62.9 mg/L Fe, 32.5 mg/L Al, 0.0514 mg/L Cu, 0.175 mg/L Ni, 0.993 mg/L Zn and 0.00109 mg/L Cd.

Sulphate-reducing bioreactors were chosen as the most feasible passive treatment technology for remediation of Manchester Seep AMD. Chemical and geotechnical parameters, including hydraulic conductivity, were determined for mixtures of organic and alkaline waste products suitable for use as bioreactor substrates. Seven mesocosm-scale bioreactors were fed aerated AMD (collected from Manchester Seep) in a laboratory for nearly four months. Bioreactors incorporating mussel shells performed the best and were capable of sequestering >0.80 mol metals/m^3 substrate/day (or neutralising acidity at rates >66 g $CaCO_3/m^2$/day) while removing >98.2% of metals. Tracer studies were later conducted on two bioreactor systems containing the same substrate composition but different reactor shapes. Results will be applied to reactor models to better ascertain the relationship between reactor hydraulics and treatment performance.

Pilot-scale treatment schemes incorporating three treatment stages were recently constructed to treat a portion of Manchester Seep AMD. The first stage consists of a sedimentation basin to remove sediment. The second stage includes three bioreactors in parallel to test treatment effectiveness of different substrate mixtures, depths and hydraulic configurations. Data derived from the lab study were used to optimise these designs. The final treatment stage consists of three different aerobic wetland configurations operated in parallel to compare their effectiveness at providing oxygenation and tertiary treatment of metals (primarily Fe) from bioreactor effluent.

Keywords:

acid mine drainage (AMD), acid rock drainage (ARD), sulphate-reducing bioreactors, Stockton Mine, mine-water treatment, passive treatment systems