Sulfate Removal by Selected Organic Substrates in Continuous Flow-Through Columns[1]

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Abstract: Sulfate-reducing bioreactors are common process units in metals-contaminated mine water passive treatment systems (PTS). Although their effectiveness has been demonstrated for both alkalinity generation and retention of trace metals as sulfides, sulfate removal has been generally inconsequential. Given the recent emphasis on abatement of total dissolved solids (TDS) and specific conductance, and the contribution of sulfate to both parameters, effective sulfate removal has become paramount. In this study[3], a laboratory bench-scale continuous flow-through column study was conducted to evaluate sulfate removal using three different locally available organic substrates (Norman Aged Compost (NAC), Murphy Compost (MC), and Spent Mushroom Compost (SMC)) for use in future PTS designs. These substrates were chosen following the conclusion of a batch study of seven locally available substrates, which identified the chosen materials as having the greatest sulfate removal capability and sulfate reducing bacteria (SRB) populations. In the column study, each organic substrate was tested in triplicate, with each column filled with a 2:1 mix of organic substrate to washed river rock and was inoculated with 50 mL of an active known SRB solution from the batch study. A solution of magnesium sulfate [1000 mg L^{-1} $\pm$ 10%] was passed through the column at a flow rate of 0.5 mL day^{-1} resulting in an estimated detention time of eight days. The effluent of each column was analyzed for total and dissolved sulfate, total sulfide, pH, ORP, and temperature. Sulfate concentrations in all flow through columns initially decreased dramatically to below 200 mg L^{-1} after the initial 10 days but rose to near 500 mg L^{-1} after 50 days in both MC and NAC treatments. The effluent of the SMC columns remained at or below 200 mg L^{-1} for the duration of the study. For all columns, pH remained circumneutral, and ORP was between -140 mV and -375 mV. Mean sulfide concentrations on day 75 of the study were 32.5 mg L^{-1} for NAC, 65.2 mg L^{-1} for MC, and 146.9 mg L^{-1} for SMC. Use of specific organic substrates under controlled conditions may allow sulfate-reducing bioreactors to help address elevated sulfate concentrations.

Additional Key Words: Vertical-flow bioreactor, sulfate reduction, retention time.

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3. The study was conducted in Norman, OK at the University of Oklahoma and organic substrates were collected near N 35.2226° N, W 97.4395°.