CHITIN AS A FRACTIONAL AMENDMENT TO COMPOST TO ENHANCE THE EFFICIENCY OF MIW TREATMENT: LONGEVITY TESTS IN CONTINUOUS FLOW COLUMNS[1]

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Abstract: Previously, our laboratory has shown that crab-shell chitin, a waste product of the shellfish industry, is capable of neutralizing acidity, reducing sulfate, and thoroughly removing aluminum, iron, and manganese from acidic mine impacted waters (MIW). Despite its remarkable effectiveness, the relatively high cost of crab-shell chitin ($1.32/kg or $0.60/lb) compared to the leading substrate, spent mushroom compost ($50/ton), may preclude its use in many systems. To facilitate the development of an effective but cost-efficient approach for MIW bioremediation, crab-shell chitin was used as a fractional amendment to spent mushroom compost substrate (SMS) in this study.

Continuous-flow PVC laboratory columns were used to evaluate different chitin-SMS mixtures for their ability to support MIW treatment. The five substrate conditions evaluated were: no substrate control (column filled with inert sand); 10% limestone + 90% SMS; 5% chitin + 95% SMS; 50% chitin + 50% SMS; and 100% chitin. Before being packed into the columns, these substrates were mixed with sand at a 1:22 ratio by mass (to provide sufficient hydraulic conductivity) and 50 g benthic sediment (as a bacterial inoculum). Natural, acidic MIW containing Al, Fe, Mn, and Zn was then continuously pumped through the columns to achieve hydraulic residence times ranging from 6-24 hours. Aqueous samples were collected regularly from the columns and tested for pH, acidity, alkalinity, volatile fatty acids, total dissolved carbon, ammonium, anions, dissolved metals, and oxidation/reduction potential to assess substrate suitability for a field-scale passive treatment system. The columns were evaluated for a period of 148 days, or an average of 416 pore volumes.

The treatment capacity of each substrate was defined here as the volume of MIW treated to pH>6 and alkalinity >0 mg/L as $CaCO_3$, prior to the breakthrough of metals to influent levels. The treatment capacity (and associated substrate costs) for each substrate mixture was determined to be: 36.7 L/kg ($1.38/1000 L) for 10% limestone + 90% SMS; 40.1 L/kg ($2.95/1000 L) for 5% chitin + 95% SMS; 162 L/kg ($4.25/1000 L) for 50% chitin + 50% SMS; and 428 L/kg ($3.09/1000 L) for 100% chitin. Based on the calculated treatment capacities as well as effluent water quality data over the lifetime of the columns, it appears that a small fraction of chitin (5%) does not provide a significant benefit over traditional limestone and compost substrates. Larger fractions of chitin (50-100%) are significantly more efficient than traditional limestone substrates, especially for the removal of metals.

Additional Key Words: Acid mine drainage, bioremediation, passive treatment.

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