COST-EFFECTIVE TREATMENT OF HIGH-RISK MINE IMPACTED WATER USING CRAB-SHELL AMENDMENTS TO SPENT MUSHROOM COMPOST: COLUMN STUDIES[1]

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Abstract: Anaerobic passive treatment systems remediating high-strength mine impacted water (MIW) have not displayed consistent success. A promising new substrate, crab-shell chitin, has been shown to effectively treat acidic MIW. Previous data indicates that crab-shell chitin provides improved remediation of AMD over the traditional spent mushroom compost (SMC) and limestone mixture used in vertical flow wetlands. However, previous research was conducted using low-strength MIW. This study utilizes high-strength MIW from an abandoned mine site in Cambria County, PA (Klondike site) to determine the effectiveness of treatment with crab-shell chitin. The treatment system at the Klondike site currently consists of a failed vertical flow wetland which utilizes the traditional substrates of SMC and limestone. Typical levels of total iron and hot acidity at the Klondike site are approximately 140 mg/L and 380 mg/L as $CaCO_3$, respectively. This study will determine the fractional amendment of crab-shell chitin required to remediate the failed vertical flow wetland currently in place. Initial batch tests on water from the Klondike site were used to derive the most promising fractional amendment ratios to be studied in this column test.

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Methods/Materials/Experimental Design

Column studies were used to quantify acidity reduction rates, metal removal capacities, and confirm suitable retention times when crab-shell chitin and/or SMC are used as substrates for the treatment of high-strength MIW from the Klondike site. Eight, 1-foot long, clear PVC columns with 3.5-cm inner diameters and lateral sampling ports were wet-packed with the following components (where the % listed are by mass): 1) 50% crab-shell chitin + 50% SMC; 2) 60% crab-shell chitin + 40% SMC; 3) 70% crab-shell chitin + 30% SMC; 4) 80% crab-shell chitin + 20% SMC; 5) 90% crab-shell chitin + 10% SMC; 6) 100% crab-shell chitin; 7) 90% SMC + 10% limestone (current standard); or 8) 100% silica sand only (control). A multichannel peristaltic pump was used to deliver water from the abandoned Klondike mine site through the columns at rate necessary to produce a 12-hr hydraulic retention time (HRT) typical of vertical flow wetlands. Aqueous samples were collected from the effluent sampling ports of each column every 1 to 7 days, depending on the observed rate of remediation, and analyzed for pH, ammonia, acidity, alkalinity, DOC, anions, Fe^{2+}, total iron, sulfur, and other dissolved metals. In-line electrodes were used to measure pH and ORP. The effluent from each column was aerated in a collection vessel with a 24-hr HRT typical of aeration ponds, and the concentration of Fe^{2+}, total iron, and other dissolved metals in the aerated effluent measured periodically. The columns are currently in progress and will be run for up to four months, or until the neutralization capacity of the packing material is exhausted.

Results

In addition to treatment data, this presentation will include a cost analysis of the different treatments based on total metals removed and treatment cell volume using AMDTreat software (U.S. Office of Surface Mining). The results will be used to help guide the selection of an appropriate and applicable substrate mixture for the Klondike site.