

The Potential use of Tobacco Waste for the Passive Treatment of Acid Mine Drainage

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Abstract

Tobacco waste (dust and stem) was successfully used as a metal cation adsorbent, pH modifier and carbon/energy source for sulfate reducing bacteria during acid mine drainage (AMD) biotreatment. Firstly, the compositional analysis for both tobacco waste and the AMD were conducted. Batch adsorption and bioremediation tests were then run using the synthetic and gold mining tailing dump-based AMD wastewater. The industrial AMD assayed in (Fe^{2+} -420.23), (Ni^{2+} - 20.32), (Cu^{2+} -38.21), (Zn^{2+} -5.73) and (SO_4^{2-} -3318.23) all in mg/L. Adsorption tests lasted 15 hours, while bioremediation incubation periods were 50 days. For the bioremediation, sulfate reducing bacteria were inoculated into the AMD effluent after growing for some time in a nutrient enriched growth media. Different adsorbent loadings of 20-, 40-, 80- and 160 g/L were tested for adsorption and while 80 g/L was chosen for bioremediation trials. Tobacco waste performance as metal cation adsorbent, AMD pH modifier and energy source for SRBs was monitored by recording metals removal efficiencies, sulfate reduction, pH trends and dissolved COD in the AMD effluent during the trials. Metal removals during adsorption were found to be at maximum of 38-, 41-, 31- and 43% for iron, nickel, copper and zinc respectively. These results were for 80 g/L adsorbent (tobacco waste) loadings. At different loadings, the overall metal removals were lowest for the lowest adsorbent loading of 20 g/L and highest for the highest loading of 160 g/L. The increase in metal removals as adsorbent loading increase were significant between 20 g/L and 80 g/L, and increasing the adsorbent loading further to 160 g/L did not introduce a proportional increase in metal removals, hence no further increases in adsorbent loading were investigated. The Langmuir adsorption isotherm best fitted the iron data while the Sips adsorption isotherm described well the adsorption of nickel, copper and zinc onto tobacco waste. Introducing SRBs in the bioremediation scheme increased the metals removal as well as the sulfate reduction into sulfides and sulfur. The pH of the AMD also increased and a few carbonates and hydroxides also precipitated out. Maximum metal removals in SRB mediated remediation were 95-, 97-, 70- and 93% for iron, nickel, copper and zinc respectively. Copper demonstrated the highest recalcitrance

to both adsorption and bioremediation. Sulfate removal reached 63% in synthetic AMD while it was slightly higher at 67% in industrial AMD. The final AMD pH after the SRB mediated bioremediation went up by 2.05 units starting from a value of 2.7 (industrial) and 3 (synthetic). The metals and sulfate concentration remaining in AMD during AMD treatment can be modelled using the exponential decay function. Overall, the tobacco waste proved to have a high potential both as adsorbent and as carbon source for sulfate reducing bacteria that facilitate AMD biological treatment.

Keywords: *acid mine drainage (AMD); adsorption; bioremediation; sulfate reducing bacteria (SRB); tobacco waste*