World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:01, 2018

Recycling Waste Product for Metal Removal from Water

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Abstract : The research was performed to assess the potential of nickel smelter slag, an industrial waste, as an adsorbent in the removal of metals from aqueous solution. An investigation was carried out for Arsenic (As), Copper (Cu), lead (Pb) and Cadmium (Cd) adsorption from aqueous solution. Smelter slag was obtain from Ni ore at the Vale Inco Ni smelter in Sudbury, Ontario, Canada. The batch experimental studies were conducted to evaluate the removal efficiencies of smelter slag. The slag was characterized by surface analytical techniques. The slag contained different iron oxides and iron silicate bearing compounds. In this study, the effect of pH, contact time, particle size, competition by other ions, slag dose and distribution coefficient were evaluated to measure the optimum adsorption conditions of the slag as an adsorbent for As, Cu, Pb and Cd. The results showed 95-99% removal of As, Cu, Pb, and almost 50-60% removal of Cd, while batch experimental studies were conducted at 5-10 mg/L of initial concentration of metals, 10 g/L of slag doses, 10 hours of contact time and 170 rpm of shaking speed and 25oC condition. The maximum removal of Arsenic (As), Copper (Cu), lead (Pb) was achieved at pH 5 while the maximum removal of Cd was found after pH 7. The column experiment was also conducted to evaluate adsorption depth and service time for metal removal. This study also determined adsorption capacity, adsorption rate and mass transfer rate. The maximum adsorption capacity was found to be 3.84 mg/g for As, 4 mg/g for Pb, and 3.86 mg/g for Cu. The adsorption capacity of nickel slag for the four test metals were in decreasing order of Pb > Cu > As > Cd. Modelling of experimental data with Visual MINTEQ revealed that saturation indices of < 0 were recorded in all cases suggesting that the metals at this pH were under- saturated and thus in their aqueous forms. This confirms the absence of precipitation in the removal of these metals at the pHs. The experimental results also showed that Fe and Ni leaching from the slag during the adsorption process was found to be very minimal, ranging from 0.01 to 0.022 mg/L indicating the potential adsorbent in the treatment industry. The study also revealed that waste product (Ni smelter slag) can be used about five times more before disposal in a landfill or as a stabilization material. It also highlighted the recycled slags as a potential reactive adsorbent in the field of remediation engineering. It also explored the benefits of using renewable waste products for the water treatment industry.

Keywords : adsorption, industrial waste, recycling, slag, treatment
Conference Title : ICWMEE 2018 : International Conference on Waste Management and Environmental Engineering
Conference Location : Sydney, Australia
Conference Dates : January 29-30, 2018