ABSTRACT

The use of low cost and eco-friendly agro waste such as watermelon rind (WR) has been investigated as an ideal alternate adsorbent for the removal of Pb^{2+}, Cd^{2+}, Cu^{2+}, Ni^{2+} and Co^{2+} ions and synthetic dyes such as methylene blue (MB), crystal violet (CV) and rhodamine B (RB) from aqueous solution. Native watermelon rind was pretreated with two different methodologies such as protonation with 0.1M HCl and activation with 1:1 ortho phosphoric acid prior to adsorption studies. Batch mode adsorption studies were carried out for removal of heavy metals and dyes by native, protonated and activated watermelon rind. Batch parameters such as pH, adsorbent dose, contact time, initial adsorbate concentration and temperature were studied. Further effect of salt ionic strength on removal of MB, CV and RB by native, protonated and activated watermelon rind adsorbents was investigated.

The kinetic data obtained for the removal of heavy metals and dyes by native, protonated and activated watermelon rind adsorbents was applied to pseudo first order kinetic, pseudo second order kinetic and intra particle diffusion models. The kinetic data was found to represent well with pseudo second order kinetic model. The equilibrium data obtained were analyzed with two well known isotherms Freundlich and Langmuir isotherm models and in most cases the data tend to fit well with Langmuir isotherm model. The thermodynamic parameters including the change in free energy ($\Delta G^\circ$), enthalpy ($\Delta H^\circ$) and entropy ($\Delta S^\circ$) were derived to describe the thermodynamic behavior of adsorption of metal ions and dyes onto WR, PWR and AWR. Further FTIR analysis was carried out for metal and dye loaded different watermelon rind samples and found that hydroxyl and carboxyl groups are predominant contributors in uptake of cations from aqueous solution.

The effect of presence of co-cations on removal of single metal ion was investigated and found that Pb^{2+} ions have highest preferential uptake and least was Co^{2+} ions. Elemental analysis was carried out in order to confirm the adsorption of metal ions onto watermelon rind.
Based on the batch adsorption results, fixed bed column studies were performed for removal of Pb$^{2+}$ and MB ions from aqueous solution. Column parameters such as effect of flow rate, bed height and initial adsorbate concentration were studied. It was found that breakthrough time and saturation decreases with increase in flow rate and initial adsorbate concentration and decreases with decrease in bed height. The breakthrough curves obtained at different conditions were modeled with various mathematical such as Adams-Bohart, Thomas and Yoon-Nelson models and Thomas and Yoon-Nelson models can be employed to predict the breakthrough curves. These results summarize that watermelon rind a non hazardous agro waste is capable of removing heavy metals and synthetic dyes from aqueous solution.