

ABSTRACT

Adsorption is a process by which an adsorbent can attract a component to its surface in aqueous solution and form an attachment via physical or chemical bond, thus removing the component from the liquid phase. Adsorption process is an excellent choice because it does not require any additional pretreatment steps before its application. The advantages of adsorption over other treatment methods are: high efficiency, minimization of chemical or biological sludge, no additional nutrient requirement, and regeneration of the adsorbent. Adsorption by activated carbon has been found to be an effective and widely employed means of water and wastewater treatment. The main focus of this study is to prepare and characterize activated carbon from elephant dung (EDAC), an animal waste, and to utilize it as an effective low cost adsorbent for the removal of acid [Acid Blue 92(AB92) and Acid yellow 17 (AY17)], basic [Rhodamine B (RhB), Crystal Violet (CV) and Malachite Green (MG)] and reactive [Reactive Orange 16 (RO16) and Reactive Yellow 15 (RY15)] dyes from aqueous solution.

The adsorbent (EDAC) was characterized by spectral, elemental analysis and physico chemical methods. The presence of functional groups was analyzed by Fourier Transform Infra red Spectroscopy (FTIR). The surface morphology was examined by Scanning Electron Microscope (SEM). The amorphous nature of the adsorbent was confirmed by X-Ray Diffraction method (XRD). The thermal stability of EDAC was tested by Thermo

Gravimetric Analysis (TGA). Estimation of Carbon, Hydrogen, Nitrogen and Sulphur was done by Elemental analysis. The surface area of EDAC was determined by Braunneur–Emmet–Teller (BET) surface area analyzer. The acidic (carboxylic, phenolic and lactonic) and basic groups covering the surface of EDAC were determined by Boehm titration method. The other physico-chemical parameters were characterized by standard procedures.

The adsorption performance of EDAC was studied by conducting batch adsorption experiments. The operation parameters investigated include initial dye concentration and contact time, pH of the solution, adsorbent dosage and temperature. Three different kinetic models such as Pseudo first order, Pseudo second order and Elovich model were employed to analyze the kinetics of adsorption. The results indicated that the kinetics followed Pseudo second order model. Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm models were adopted to describe the existence of adsorbate between the liquid and solid phase. The adsorption of all dyes was best described by Langmuir isotherm. The effect of pH on the removal of all dyes was studied over a pH range of 2-11. Highly acidic solution pH favored the removal of acid and reactive dyes whereas neutral and alkaline medium favored the removal of basic dyes, except RhB which showed maximum removal at pH 3. The mechanistic aspects of adsorption and possibility of recovery of adsorbent were investigated by conducting desorption studies. Acid and reactive dyes were desorbed by alkaline medium indicating the physisorption mechanism. Basic dyes were desorbed by organic medium indicating chemisorption mechanism.

Mass transfer studies were examined by carrying out intraparticle diffusion and film diffusion models to elucidate the mechanism of adsorption. The results suggested that the adsorption process was controlled by both particle diffusion and film diffusion. The magnitude of activation energy (E_a) was evaluated for confirming the nature of adsorption. The thermodynamic parameters such as Gibb's free energy of adsorption (ΔG), enthalpy of adsorption (ΔH) and entropy of adsorption (ΔS) were determined by conducting a series of experiments at different temperatures (301, 308, 318, 328 and 338 K). The results indicated that the adsorption was endothermic and spontaneous.

The amounts of EDAC required for the 90% removal of volume of 20 L of AB92, AY17, RhB, CV, MG, RO16 and RY15 solution of concentration of 60 mg/L were calculated based on the Langmuir isotherm equation. The applicability of EDAC was tested by treating with an effluent collected from a dyeing unit. Competitive adsorption of dyes was investigated at the same time by taking AB92, RhB, CV, MG and RY15 mixture. From the results it was found that more than 90% of acid and basic dyes were removed whereas reactive dye was not removed considerably. The adsorption performance of EDAC for the removal of RY15 was compared with Commercial Activated Carbon (CAC) by carrying out kinetics and isothermal studies. The results revealed that EDAC could be employed as an alternative to commercial adsorbents in wastewater treatment for the removal of dyes.