A sustainable and eco-friendly technique for dye adsorption from aqueous media using waste from Jatropha curcas (isotherm and kinetic model)

ABSTRACT

The 21st century has witnessed a tremendous increase in textile wastewater effluent and consequently the pollution of water bodies that affects aquatic flora and fauna. This necessitates for a sustainable clean-up material to remove this contaminant. To realize this purpose, investigation of batch adsorption was conducted using Congo red (CR) as the adsorbate and Jatropha curcas seed (chaff) as the adsorbent material. Adsorption kinetics and isotherms analysis were conducted and results obtained confirmed the adsorption process as highly dependent on effects such as contact time, adsorbent dosage, initial dye concentration and the particle sizes of the adsorbate. The sorption equilibrium for CR dye unto Jatropha curcas seed (chaff) was achieved within 180 min and the adsorption efficiency was recorded at 82.05%. Furthermore, the result shows that the amount of CR adsorbed per unit mass of adsorbent increases from 11.47 to 82.05 mg/L as the initial concentration increase from 20–100 mg/L. Thus, the driving force for the CR adsorption gradient was due to the high adsorption capacity of Jatropha curcas. The process of the experimental sorption kinetics followed a pseudo-second-order kinetic model while the Freundlich and Langmuir isotherm model was both applicable for obtaining the equilibrium behavior of the adsorption. The chaff from Jatropha curcas seed possess carbonyl, acid amino and phenolic hydroxyl functional groups that act as chemical bonding agents for chemisorptions process at the surfaces of the adsorbent. This confirms the performance of Jatropha curcas (chaff) as an environmentally friendly and low-cost agromaterial for dye removal in aqueous solutions.

Keyword: Adsorption kinetics; Isotherm models; Jatropha curcas; Congo red