World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:14, No:07, 2020

Adsorptive Removal of Methylene Blue Dye from Aqueous Solutions by Leaf and Stem Biochar Derived from Lantana camara: Adsorption Kinetics, Equilibrium, Thermodynamics and Possible Mechanism

Authors : Deepa Kundu, Prabhakar Sharma, Sayan Bhattacharya, Jianying Shang

Abstract : The discharge of dye-containing effluents in the water bodies has raised concern due to the potential hazards related to their toxicity in the environment. There are various treatment technologies available for the removal of dyes from wastewaters. The use of biosorbent to remove dyes from wastewater is one of the effective and inexpensive techniques. In the study, the adsorption of phenothiazine dye methylene blue onto biosorbent prepared from Lantana camara L. has been studied in aqueous solutions. The batch adsorption experiments were conducted and the effects of various parameters such as pH (3-12), contact time, adsorbent dose (100-400 mg/L), initial dye concentration (5-20 mg/L), and temperature (303, 313 and 323 K) were investigated. The prepared leaf (BCL600) and shoot (BCS600) biochar of Lantana were characterized using FTIR, SEM, elemental analysis, and zeta potential (pH~7). A comparison between the adsorption potential of both the biosorbent was also evaluated. The results indicated that the amount of methylene blue dye (mg/g) adsorbed onto the surface of biochar was highly dependent on the pH of the dye solutions as it increased with an increase in pH from 3 to 12. It was observed that the dye treated with BCS600 and BCL600 attained an equilibrium within 60 and 100 minutes, respectively. The rate of the adsorption process was determined by performing the Lagergren pseudo-first-order and pseudo-second-order kinetics. It was found that dye treated with both BCS600 and BCL600 followed pseudo-second-order kinetics implying the multi-step nature of the adsorption process involving external adsorption and diffusion of dye molecules into the interior of the adsorbents. The data obtained from batch experiments were fitted well with Langmuir and Freundlich isotherms ($R^2 > 0.98$) to indicate the multilayer adsorption of dye over the biochar surfaces. The thermodynamic studies revealed that the adsorption process is favourable, spontaneous, and endothermic in nature. Based on the results, the inexpensive and easily available Lantana camara biomass can be used to remove methylene blue dye from wastewater. It can also help in managing the growth of the notorious weed in the environment.

Keywords : adsorption kinetics, biochar, Lantana camara, methylene blue dye, possible mechanism, thermodynamics
Conference Title : ICEPR 2020 : International Conference on Environmental Pollution and Remediation
Conference Location : Berlin, Germany
Conference Dates : July 23-24, 2020