Abstract

This study reports on converting waste into an activated carbon material for the efficient removal of diazinon pesticide (DP). The asphalt waste obtained from the streets was converted into an activated carbon and was experimentally examined in a batch system. The prepared carbon adsorbents were characterized by energy-dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and Brunauer–Emmett–Teller (BET) analysis. The results revealed that the activated carbon (AC) had an amorphous structure, high porosity, and a relatively high surface area of 788.33 $m^2 g^{-1}$. Additionally, functional groups such as $–CH_2–$ and SO were detected for the prepared adsorbent. The impact of DP sorption parameters, such as, sorbent dosage, initial concentration, and pH were modelled and optimized using central composite design (CCD) *via* response surface methodology (RSM). The optimal conditions obtained from the CCD were found to be 5.6, 30 mg, and 200 mg L^{-1} for pH, sorbent dosage, and initial pesticide concentration, respectively, with adsorption capacity of 234.25 mg g^{-1}. The experimental data was fitted to the linear form of pseudo first (PFO) and second order (PSO) kinetic models and the data was well described by PSO kinetic models. Based on the thermodynamic parameters, the negative values of Gibbs free energy underscore the spontaneity of the adsorption process. Enthalpy change of 1.9037 kJ mol^{-1} indicated the endothermic nature, while entropy change of 0.01751 kJ $mol^{-1} K^{-1}$ indicated increased disorderliness at the adsorbent–solution interface. The study contributes to sustainable, economical solutions for pesticide contamination, emphasizing the potential of ACs derived from abundant waste materials.