Magnetic Biochar by One-Step Impregnation Pyrolysis of Peganum harmala L. for Removal of Rhodamine B

Abstract

A new magnetic P. harmala biochar/Mn-ZnFe2O4 material was prepared by the one-step pyrolysis approach and characterized by FT-IR, SEM, XRD, and BET techniques. The efficacy of removing rhodamine B (RhB) via adsorption and catalytic degradation was examined. Adsorption removal attained 82% of 10 mg·L-1 RhB at pH 4.0, 90 min of agitation, and 3.2 g·L-1 of adsorbent. The adsorption kinetics indicated a diffusion-limited mechanism and matched the second-order model. The equilibrium data are better suited by the Langmuir isotherm, and the maximum monolayer adsorption capacity ($q$max) was 34.5 mg·g-1. The D-R and Tempkin isotherms both showed an endothermic chemical adsorption process and negligible lateral repulsive forces, respectively. The catalytic removal by Fenton-like degradation was 40 and 99%, respectively, for the biochar/H2O2 and biochar/Mn-ZnFe2O4/H2O2. The prospective use of P. harmala biochar/Mn-ZnFe2O4 as an alternative material for RhB decontamination of water was validated by the successful removal of RhB from industrial wastewater of greater than 77% by adsorption and of 95% by the catalytic degradation.