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Treatment of dye wastewater using an ultrasonic aided nanoparticle stacked activated carbon: kinetic and isotherm modelling

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Abstract

The present work explains the biosorption of malachite green dye from aquatic systems by nano zero valent iron stacked activated carbon (NZVI-AC), which was prepared by dual surface modification strategy. NZVI-AC was characterized by using FTIR, SEM-EDX, XRD and TGA. NZVI-AC exhibited efficient performance in dye biosorption properties. Experimental variables such as time, pH, dye concentration, temperature and biosorbent dosage influenced Langmuir adsorption capacity of 187.3 mg/g. The present biosorption system was best described by pseudo-first order kinetics. The dye was completely knocked out of the solution within 60 min at equilibrium. The thermodynamic behaviour of NZVI-AC was exothermic, feasible and spontaneous. Experimental data was engaged to validate new solid-liquid phase equilibrium model, showing the average absolute relative deviation 7.72%. Hence the procedure was non-toxic, potential to retain biosorbent from the solution, applicable for multiple cycles. In context, NZVI-AC can be recommended for the treatment of dyes from industrial effluent.

Key words: Activated carbon; Kinetics; Equilibrium Modelling; Dyes; Ultrasonication

1. Introduction

The discovery of synthetic dyes all over the world now recorded a global annual production of almost 800000 tons of 10000 different synthetic dyes. At the same time, dyeing process discharges 140000 tons of synthetic dyes to the environment, causes negative impacts. Since textile industry generates large volumes of effluents, has received considerable attention in recent years (Aljeboree et al. 2017). Because a small amount of dye solution can even harm aquatic systems. In effect, textile effluents contain a high organic load that must be treated