Optimization, equilibrium, kinetic modeling, and thermodynamic studies of biosorption of aniline blue by the dead biomass of Aspergillus fumigatus

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ABSTRACT

The effect of biosorbent concentration, initial pH, temperature, agitation rate, adsorption time, and initial dye concentration was studied for the biosorption of aniline blue dye using dead fungal biomass of Aspergillus fumigatus. The maximum biosorption of aniline blue was observed at the sorbent concentration of 1 g/L, initial pH 10, temperature 30˚C, agitation rate 160 rpm, and initial dye concentration of 50 mg/L. The experimental data were analyzed using Freundlich, Temkin, and Scatchard equilibrium isotherm models out of which the Freundlich isotherm ($R^2 = 0.98$) was found to best fit the experimental data. Thermodynamic parameters such as enthalpy change ($-3.08$ kJ/mol) and entropy change ($8.32$ J/mol K) were also calculated. The biosorption kinetics of Aniline blue was found to obey pseudo-second-order kinetic model ($R^2 = 0.967$). The results showed that biosorption was favorable and spontaneous, thus, indicating the positive affinity of the dye towards the adsorbent. The characteristics of the fungal biosorbent were studied using Fourier transform-infrared spectroscopy (FTIR) and scanning electron microscopic (SEM).

Keywords: Aniline blue; Aspergillus fumigatus; Thermodynamic analysis; Biosorption isotherm; Kinetic model

1. Introduction

Pollution control is one of the prime concerns of today's society. Untreated or partially treated waste-water and industrial effluents discharged into the natural ecosystems pose a serious problem. Synthetic dyes are extensively used in many industries, such as textile, leather tanning, paper production, food technology, and hair coloring [1]. Wastewater discharged from these industries is usually polluted by dyes that react with metal ions present in the wastewater to form toxic substances which damage the esthetic quality of water bodies, reduce light penetration, and photosynthesis. Some of the dyes are carcinogenic, allergenic, and mutagenic causing many waterborne diseases that are threatening to both the mankind and other living beings. Dyes are biologically nondegradable and are, therefore, difficult to decolorize once released into the aquatic environment [2,3]. Chemical methods, such as coagulation, flocculation, electro-floatation; conventional oxidation methods