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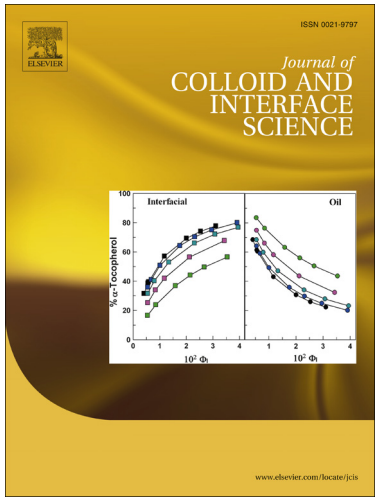

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Kinetic study of brilliant green adsorption from aqueous solution onto white rice husk ash

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Abstract

The present research was focused on the study of adsorption kinetics of brilliant green (BG) onto white rice husk ash from aqueous solutions. The research was performed in the temperature interval 290–320 K in 10 degree steps and in the concentration range of 3–100 mg L^{-1}. Batch studies were conducted in order to determine the optimal adsorbent dose, and the time required to reach the adsorption equilibrium at each temperature. The effect of the initial concentration of brilliant green was studied (pH not adjusted), as well as the effect of temperature. The maximum adsorption capacity of the WRHA for BG at 320 K was determined to be 85.56 mg g^{-1}. The adsorption kinetic data were analyzed employing several kinetic models: pseudo-first-order equation, pseudo-second-order equation, Elovich equation, Banghman's equation, Diffusion-chemisorption model, and Boyd kinetic expression. It was established that the adsorption process obeyed the pseudo-second-order kinetic model best. Based on the rate constants obtained by this kinetic model using Arrhenius and Eyring equations, the activation parameters were determined, namely the activation energy (50.04 kJ mol^{-1}), the change of entropy (– 318.31 J mol^{-1} K^{-1}), enthalpy (– 47.50 kJ mol^{-1}) and Gibbs free energy (range 44.81 to 54.36 kJ mol^{-1}) for the formation of activated complex from the reagents.

Keywords: Brilliant green; Dye removal; White rice husk ash; Batch study; Adsorption kinetics.

1. Introduction

The coloring of wastewater from the production of dyes and pigment, as well as from industries that use these colorants, such as leather, textile, fiber, carpet, paper, printing, automotive, plastic, ceramic, glass, food coloring, cosmetics, pharmaceutical and other industries, has always been a major problem. The coloration is a visible problem, which indicates that the water is unfit for drinking, domestic usage and irrigation, but more importantly, it hides in itself possible carcinogenicity, reproductive toxicity, neurotoxicity and chronic toxicity, and can cause irritation of skin and eyes. As to brilliant green dye (BG) it is described as an irritant, causing skin and eye burns, nausea, vomiting, diarrhea, and abdominal pain, and it is classified as very toxic: probable lethal dose is 50–500 mg/kg in humans [1]. On one hand the reasons mentioned above have served as a ground for a stricter legislation in recent years and on the other – for the increasing research efforts in finding more efficient and cost-effective methods for the removal of dyes from effluent, in particular the adsorption method. Concerning the adsorption method, studies were mainly aimed at