Removal of Basic Yellow Dye from Aqueous Solution by Sorption on Green Alga Caulerpa scalpelliformis

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Removal of basic yellow dye from aqueous solution by sorption on green alga *Caulerpa scalpelliformis*

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Abstract

Dynamic batch experiments were carried out for the biosorption of basic yellow dye on to the green macroalgae *Caulerpa scalpelliformis*. The factors affecting the sorption process such as the initial concentration of the dye and pH of the solution, the adsorbent dosage and the time of contact were studied. The sorption kinetics followed pseudo-second order kinetic model. The *Caulerpa* species exhibited a maximum uptake of 27 mg of dye per gram of seaweed. The Boyd's plot confirmed the external mass transfer as the rate-limiting step. The average effective diffusion coefficient was found to be 2.47×10^{-4} cm^2/s. Sorption equilibrium studies demonstrated that the biosorption followed Freundlich isotherm model, which implies a heterogeneous sorption phenomenon. Various thermodynamic parameters such as enthalpy of sorption ΔH°, free energy change ΔG° and entropy ΔS° were estimated. The negative value of ΔH° and negative values of ΔG° show the sorption process is exothermic and spontaneous. The negative value of entropy ΔS° shows the decreased randomness at the solid–liquid interface during the sorption of dyes onto green seaweed.

Keywords: Basic yellow dye; Biosorption; Diffusion coefficient; Equilibrium isotherm; Green seaweed; Macroalgae

1. Introduction

Pollution control is one of the prime concerns of society today. Untreated or partially treated wastewaters and industrial effluents into natural ecosystems pose a serious problem to the environment. Among the industrial wastewaters, the removal of color from dye bearing effluents is one of the major problems due to the difficulty in treating such wastewaters by conventional treatment methods. This is because synthetic dyes have a complex aromatic molecular structure, which makes them more stable and difficult to biodegrade [1]. Although number of processes like flocculation, chemical coagulation, precipitation, ozonation and adsorption has been employed for the treatment of dye bearing wastewaters, they possess inherent limitations such as high cost, formation of hazardous by-products and intensive energy requirements [2]. Biological processes such as bioaccumulation and biodegradation have been proposed as having potential application in removal of dyes from dye bearing wastewater [3,4].

Biosorption passive uptake of pollutants from aqueous solutions by the use of non-growing or non-living microbial mass, thus allowing the recovery or environmentally acceptable disposal of the pollutants, could also be considered [5–8]. The main attractions of biosorption are high selectivity and efficiency, cost effectiveness and good removal performance. Raw materials, which are either abundant or wastes from other industrial operations, can be used as biosorbents, presenting performances often comparable with those of ion exchange resins. The use of dead cells in biosorption is most advantageous for wastewater treatment in that, the dead organisms are not affected by toxic wastes, do not require a continuous supply of nutrients and can be regenerated and reused for many cycles. Dead cells may be stored or used for extended periods at room temperature without putrefaction. Biological materials such as chitin, chitosan, peat, yeasts, fungi or bacterial biomass are used as chelating and complexing sorbents in order to concentrate and remove dyes from solutions [9–14]. However, these low cost adsorbents have generally low adsorption capacities, leading to utilization of large amounts of adsorbents.

Algae have been found to be potential, suitable biosorbent because of their fast and easy growth and their wide availability. The special surface properties of algae, bacteria and fungi

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