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Review

Removal of bromophenol blue dye from industrial waste water by synthesizing polymer-clay composite

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ABSTRACT

A composite material was prepared by incorporating the clay (Kaolinite (Kao)) into a poly(acrylamide co-acrylic acid) (P(AAm-AA)) through the in situ polymerization method with cross-linker. The prepared composite adsorbent was firstly characterized by FTIR, SEM, XRD and Thermal analysis. After characterization, the composite adsorbent P(AAm-AA)/Kao was potentially studied for sorption of bromophenol blue (BPB) dye. Different factors that could affect the dye adsorption behavior were studied as time of contact, dye concentration and temperature. The kinetic studies revealed that the adsorption results fitted well with Lagergren (pseudo first order reaction rate). The isotherm studies also display that the adsorption data fit with Freundlisch more than Langmuir isotherm model. Based on the effect of temperature the thermodynamic parameters were calculated and the free energy change (ΔG^o) value of −110.323 kJ/mol was obtained, referring to the feasibility and spontaneous nature of the sorption reaction. Also the relatively high negative value of entropy change $\Delta S^o = -509.4$ J mol^{-1} K^{-1}, suggests the chemical nature of the sorption reaction.

Contents

1. Introduction

Organic dyes represent effective chemical hazard encountered in our environment as organic pollutants. These organic pollutants have undesirable effects either on the environment or on human being, so the dye effluent is one of the most serious water pollution source representing

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problems in various industries such as textile, paper, plastic, leather, food, cosmetic, etc. [1,2]. Due to the growing use of dyes, the resulted dye wastewater is becoming a major environmental threat, and the removal of these pollutants from wastewater represents a challenge. Dyes, as many as organic compounds are regularly stable and withstand to go degrade with time, sunlight, biological and chemical treatments. Even small amounts of dyes, when present in wastewater, it can highly affect the aquatic life due to their toxicity and prevention of light penetration [3–5]. The removal of dyes from textile industry wastewater is a major importance, as the presence of dyes in wastewater inhibits the treatment of such water by conventional methods. Although different methods have been developed, the economical issue and effectiveness of the removal method of dyes represent challenge to researchers and technologists. Different methods have been studied for removal of dyes from wastewater, including physical, chemical, and biological methods [1,2,6–8]. Adsorption is one of the most effective methods used for dye removal. Different kinds of adsorbent materials have been reported for dye removal such as activated carbon [9–12], zeolite [9,13,14], fly ash [15,16], chitin and chitosan [17–19].

Polymeric adsorbent materials play an important role in the treatment of wastewater. Polymeric hydrogel materials have attracted more scientific interest due to their many uses and applications in many fields, such as molecular filters, super absorbents, and contact lenses [20–24]. In recent years, the modification of sorption properties of the polymeric adsorbents was potentially studied. Important modification is the incorporation of nano-or micro-particles of inorganic materials, such as montmorillonite, kaolinite, mica, bentonite and sercite into the polymer networks [25–29]. The polymeric composites have found different technological and industrial applications in many fields as; food and pharmaceutical industries, agriculture and related fields (in the controlled release of moisture, fertilizers, pesticides, etc.), electronic instruments (as a protector against corrosion and short circuits, etc.) and biomedicine (as artificial organs, etc.). Chitosan intercalated montmorillonite (Chi-MMT) was prepared and used for adsorption of different dyes [30]. A nanocomposite (NC) material based on nanoclay (Laponite (Lap) XLS) was prepared by incorporating the clay into poly(acrylamide) (PAAm) polymer. The produced composite was used for adsorption of crystal violet dye [31]. In the present study polymer clay composite was prepared by incorporating the kaolinite clay into poly(acrylamide co-acrylic acid) in presence of crosslinker using chemical polymerization method. The prepared composite (P(AAm-AA)-Kao) was characterized by FTIR, XRD, SEM and thermal analysis and applied for removal of bromophenol blue (BPB) dye from aqueous solutions.

2. Experimental

2.1. Materials

Acrylic acid (AA) and acrylamide (AM), were obtained as chemically pure reagents from Shanghai Wulian Chemical Factory, Shanghai, China and were used as received. Potassium persulfate (PPS) as analytical grade was obtained from Xi_an Chemical Reagent Factory, Xi_an, China. N,N-methylenebisacrylamide (MBA) is a chemically pure obtained from Shanghai Chemical Reagent Factory, Shanghai, China, and was used as received. Kaolinite micro-powder was obtained from Xuyi Colloidal Co., Ltd, Jiangsu, China and was used as received. All solutions were prepared with double distilled water.

2.2. Preparation of composite adsorbent

Polymer clay composite adsorbent was prepared following a reported procedure [31]. In this procedure, appropriate amount of kaolinite (Fig. 1), crosslinker and initiator was added to acrylic acid with certain degree of neutralization. The produced composite was washed several times with distilled water, dried at 70 °C to constant weight, then milled and screened. All samples were sized to appropriate mesh size.

2.3. Characterization

The IR spectrum of the composite adsorbent was recorded on FTIR (KBr method with a NICOLET 6700 FTIR thermo scientific.) using KBr pellets. Thermal stability studies of dry composite and the content of polymer in the composite was determined by thermogravimetric analysis (Shimadzu DTA-50 thermal analyzer), in which the sample was heated from 50 to 900 °C at a heating rate of 10 °C/min. The prepared

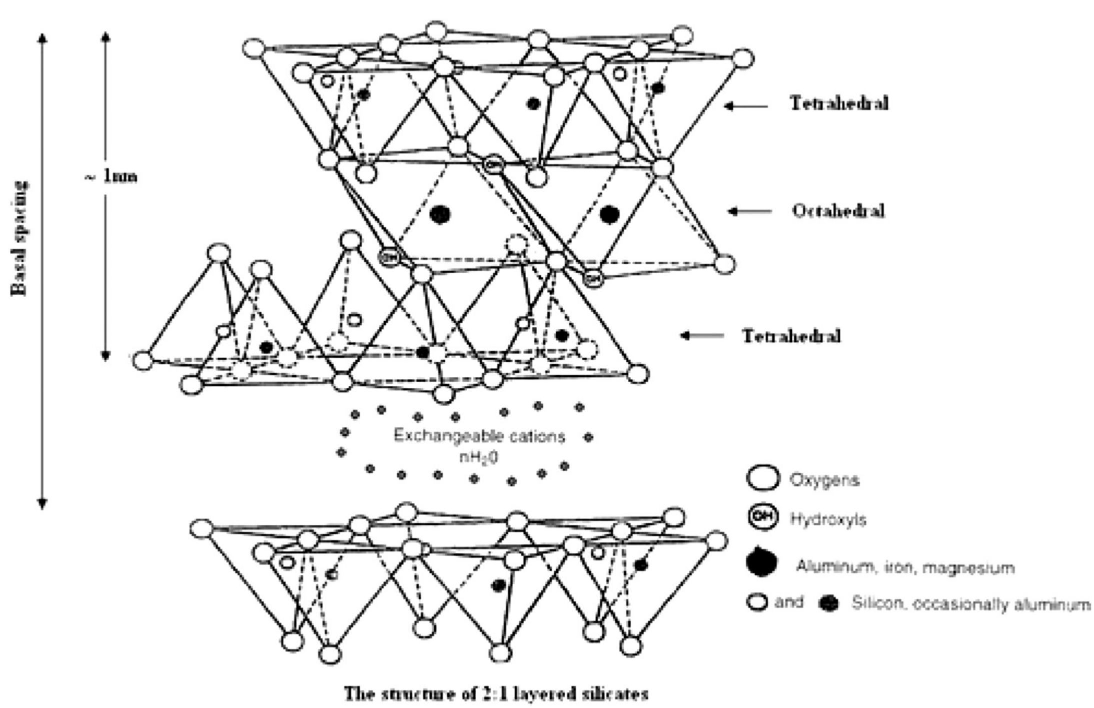

Fig. 1. Schematic structure of kaolinite.

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