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EFFICIENT REMOVAL METHYLENE BLUE DYE AND LEAD ION USING A HYBRID ORGANIC-INORGANIC HYDROGEL

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Abstract: The aim of this work is to study the feasibility of sodium alginate-g-acrylic acid/SiO₂ hydrogel nanocomposite towards its potential application as high performance adsorbent for removal of Methylene Blue (MB) dye and Pb²⁺ from aqueous solution. In this regard, the effects of agitation time, pH, initial dye concentration, adsorbent dose, silicone dioxide concentration, monomer concentration and temperature were optimized with respect to dye and ion adsorption capacity of hydrogel nanocomposites in detail. In general, the results indicated that the synthesized hydrogel nanocomposite with biodegradability and biocompatibility properties can be used in wastewater treatment via dye and heavy metal adsorption.

Keywords: Nanocomposite; Sodium alginate; Silicone dioxide; Acrylic acid, Wastewater treatment.

1. INTRODUCTION

To purify wastewater contaminated by dyes, various techniques including adsorption [1-4], photodegradation [5], chemical oxidation [6], coagulation [7], electrochemical oxidation [8] and microbiological treatment [9] have been employed. Among these techniques, adsorption has been intensively concerned and found to be superior to other techniques due to its simple operation, high efficiency, economy and convenience. Moreover, bioaccumulation of toxic heavy metals in living cells has harmful effects on human beings and animals. Long exposure of Pb²⁺ ion creates various progressive diseases in human bodies even at low concentration, for instance, cardiovascular deficiencies, lungs problem, bone injuries, kidney, liver and central nervous system disorder, hypertension and cancer [10]. So, in the present work, the dye and ion adsorption behaviour of synthesized polymeric hydrogels were studied in detail.

2. EXPERIMENTAL OBSERVATIONS

Batch biosorption experiments were performed with different initial concentrations of MB and Pb²⁺ at pH 3 at 25 °C. Typically, 20 mg of adsorbent was added to 10 mL of dye and ion solution. The equilibrium concentration of dye and ion was determined by a UV/VIS spectrophotometer (Perkin Elmer Lambda 35) from the following equation:

$$Q_e = \frac{(C_0 - C_e) \times V}{m} \quad (1)$$

where Q_e (mg g⁻¹) is the amount of dye adsorbed at equilibrium, C_0 (mg L⁻¹) is the initial dye concentration, C_e (mg L⁻¹) is the concentration of dye at equilibrium, V (L) is the initial volume of the dye solution, and m (g) is the mass of the adsorbent.

Figure 1. Digital images of the produced hydrogel nanocomposite before and after swelling with water.