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Adsorption studies of Cu (II), Pb (II) and Cr (VI) by chitosan/unitiol composite

Abstract: Chitosan-unithiol composite for the first time was synthesized by simple and short period procedure. The sorption process was carried out under static conditions at temperature 298 K and at pH=4.5. The concentration of ions of toxic metals before and after sorption was determined by the atomic absorption method. The removal characteristics such as the removal degree and equilibrium time of Cu^{2+}, Pb^{2+} and Cr^{6+} were illustrated. The adsorption equilibrium for Cu^{2+} ions was best described by Langmuir model and for Pb^{2+} and Cr^{6+} ions by Freundlich model. It was found that adsorption of Cu^{2+} and Cr^{6+} by chitosan-unithiol followed first-order kinetics. Adsorption of Pb^{2+} was followed second-order kinetics. The sorption process was also investigated under co-presence of heavy metal ions. The obtained results indicate that the synthesized chitosan-unithiol composite is the effective sorbent for removing toxic metal ions.
Key words: sorption, composite, chitosan, unithiol, degree of removal.

Introduction

One is the main purpose of the adsorption of heavy metals is to find an effective modification method of material. The synthesized material has to be approach to several requirements such as low toxicity, high biocompatibility, adsorption capacity, selective sorption and the absence of side effects during the sorption [1]. In recent years the application of biomaterials such as algae, bacteria, fungi, high plants, and products derived from these organisms have represented big interest [2].

Chitosan is a natural polysaccharide widely used in fundamental studies as well as practical applications, including in treatment of wastewater, heterogeneous catalysts, delivery vaccines materials, agricultural stimulators, antibacterial agent and medical entersorbents [3], [4]. It consists of β-(1→4)-linked D-glucosamine and *N*-acetyl-D-glucosamine units. Chitosan is a well-known adsorbent for toxic and heavy metal ions. Due to the lone pair of electrons on nitrogen in acetoamido group and hydroxyl group can posse high chelating ability. Furthermore, the ability of chitosan depending on the acidity of the medium to form flaky precipitation can be used in sorption. For instant, in the recent years biosorbents based on chitosan has been synthesized and their sorption characteristics were studied for use in separation of heavy metal ions. Intoxication by heavy metal ions can lead to serious diseases of organism. These metal ions non-degradable and are persistent in the medium. Therefore chitosan has been applied in the synthesis various functional composites, by using clays, inorganic substances, natural and synthetic polymers [5].

In this way, a system which consists of chitosan and polyvinyl alcohol was studied. It was found that the adsorption efficiency of this sorbent has the maximum recovery of cadmium ions at pH = 6 and t = 40 C [6].

Also, in the work [7] the adsorption of composite material composed from chitosan and polyvinyl chloride was demonstrated. One of the advantages of this polymer is physical and chemical stability in organic solutions as well as in concentrated acidic and alkaline media. The study showed that the adsorption capacity of the chitosan and polyvinyl chloride system were 90% for Cu (II) and Ni (II) [7]. In the study [8] effect of modification by different compounds were illustrated. For instant, sorption activities of chitosan compounds were increased according to the following sequence: chitosan-cotton [9], [10], chitosan-magnetite [11], chitosan-cellulose [12], chitosan-perlite [13], chitosan-alginate [14], [15] and chitosan- clinoptilolite [16].

It is known that unithiol (2,3-Dimercapto-1-propanesulfonic acid) is widely used in medicine as an

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