ADSORPTION AND REMOVAL OF CU (II) IONS ONTO A STARCH FILM SORBENT FROM AQUEOUS MEDIUM

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Abstract

The biosorption capacity of sorbent starch-based films prepared by solution casting method from aqueous solution was investigated. Batches studies are carried out and the key processing parameters (sorbent quantity, contact time, metal ion concentration, temperature and acidity of the adsorbate solution.) were studied. The adsorption condition of Cu(II) metal ions onto starch biodegradable film have been studied, FTIR spectra, UV adsorption and PH measurements before and after adsorption demonstrated that the hydroxyl, carboxyl, and carbonyl groups are responsible for the biosorption process, the adsorbed amounts of copper was 79,8,% of the total concentration of the metal ions. The best adsorption capacities were 5,44mg/g at optimum conditions. All the above results demonstrated that starch based films are generally regarded as safe and environmentally acceptable, and this bisorbents films can be used as a possible alternative low-cost adsorbent for the removal of heavy metals from aqueous solution.

Keywords: starch biodegradable films, metal adsorption, heavy metals.

1. INTRODUCTION

The wide spread of Pollution and contamination that are caused due to the continual usage of Heavy metals in industrial applications become serious problem that threaten the mankind health in addition to the different damages concerning all the living species and the ecological systems. We can entirely say that the next set of activities such as the industrialization of chemical products, paint pigments, metallurgy and nuclear industry (Quintelas et al., 2009) are the main causative for the prevalence of heavy metals in wastewater in special and in the whole environment in general. Heavy metals are not biodegradable and they can lead to the emergence of a numerous diseases and systems disorders (Inglezakis et al ., 2003) whenever they stack in the mankind organisms. For preserving the whole environment and the human health we have to work on removing the heavy metals from the different water resources and especially the waste water.

This thesis aims at investigating the adsorption capability and possibility of using starch- based biodegradable films for the removal of cooper Cu (II) from aqueous solution. The effects of PH, contact time, adsorbent dosage, initial metal concentration and temperature on the removal of Cu (II) were

studied using kinetic and isothermal tests. Starch-based film characteristics were determined

2. Materials And Methods

2.1. *Materials*:

All the chemicals used in the biosorption were of analytical grade. The stock solution of Cu (II) was prepared from standard stock salts of cooper (II) sulphate ($CuSO_4$.$5H_2O$) (Merck, Germany).Corn starch was supplied in powder form by Sigma-Aldrich.

2.2. Metal solutions:

The stock solution of Cu (II) was prepared from ($CuSO_4$.$5H_2O$) to prepare appropriate concentration of Cu (II) ions. Ultra pure water was used in all dilution

2.3. Biosorbent preparation:

Corn starch is first mixed with glycerol in distilled water, after total dispersion, the suspension were heated on hot plate while stirring constantly until it gelatinized, finally the mixture (starch gel) was cast onto a glass Petri dishes. After drying at room temperature (25°C) for several days, the films were kept in desiccators.

2.4Adsorption studies:

Batch operation was employed for biosorption. For each experiment, 20 ml of metal solution of desired concentration was added to a known quantity of the biosorbent films. The initial pH of metal solution was adjusted. The mixture was shaken in a temperature controlled flask shaker .When adsorption procedure completed in such time, the mixture was then filtered and the filtrate was analyzed for final pH and final Cu (II) concentration, the equilibrium concentrations were analyzed for residual metal ion concentration by using an atomic absorption spectrometer

3. Results and discussions:

3.1. Effect of sorbent amount on metal adsorption:

The effects of adsorbent dosage of starch films on the removal of Cu (II) ions are presented in Fig 1. The quantity of the starch based films was varied, ranging from 10 to 1000 mg for the 20 ml of 100 mg/L solution. The PH

solution was controlled at 5.0 by adding dilute HCl or NaOH solutions. The reaction temperature was maintained constant at 30 C°. Afterwards, the solutions were filtered for analysis. It is apparent that the adsorption (%) of Cu (II) increased on starch based films kept increasing with an increase in the adsorbent dosage. When the amount of sorbent 20 mg of starch based film, the adsorption was ≥ 20%; with 50 mg of sorbent, ≥60% of the Cu ions was adsorbed, but the adsorption density decreased. This may be attributed to the number of available adsorption sites increased by increasing adsorbent dosage .The decrease in adsorption density with increasing adsorbent dosage is mainly due to unsaturated adsorption sites through the adsorption reaction (Kadirveeli and Namasivayam, 2003) (Sureshand Babu, 2009).Another reason may be owing to the particle interaction, such as aggregation , caused high adsorbent concentration. Such aggregation would lead to a decrease in the total surface area of the adsorbent (Ramesh et al., 2007).

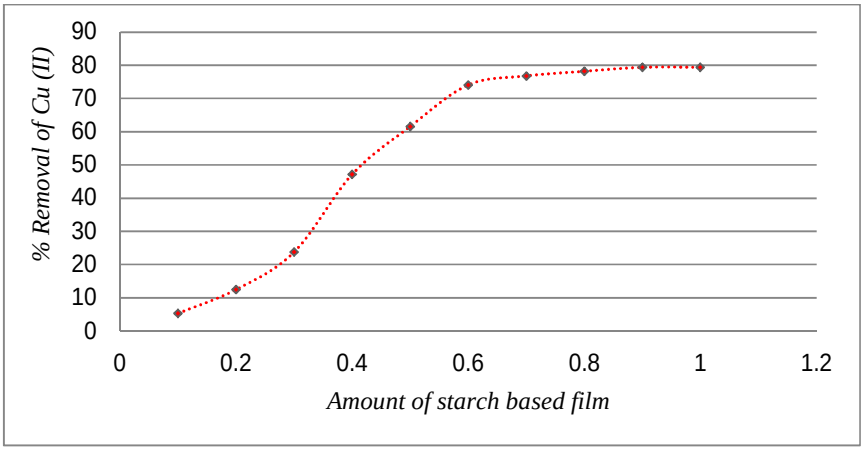

Fig.1. Effect of sorbent amount on Cu (II) ions adsorption on starch based films (30C°, PH5, Solution volume 20mL, C= 100 mg/L)

3.2. Effect of the initial PH on the metal adsorption capacity

The solution PH has a great influence on the adsorption process, which can determine the surface charge of the adsorbent.(Shengtoa Xing et al.,2010),. It affects not only the surface charge of the adsorbent, but also the ionization degree of the adsorbate. (E.S.Abdel-Halim, Salem S. Al-Deyab),.The effect of PH on the adsorption of Cu(II) ions by starch based films is showed in Fig.4.The effect of PH on adsorption capacities of Cu(II) ions were examined by varying the initial PHs of the solution., at lower PH the adsorbent have no affinity to Cu(II) ions so that very little Cu(II) ions are adsorbed, this can be

attributed to the fact that at lower PH (PH≤2), the carboxyl groups do not ionize and the ion exchange sites on the surface of the starch based films are still protonated. Thus the electrostatic repulsion between the negatively charged Cu (II) species and negatively charged starch based films was increased. Under such conditions the metal ions do not exchange and remain in the solution, but the removal efficiencies increased remarkably with the rise in the initial PH.

This can be explained with competitive adsorption of HO_{3+} ions and metal ions for the same active adsorption sites. With the increase in PH, the adsorption surface become less positive and there for electrostatic attraction between starch based films surface and Cu (II) ions.

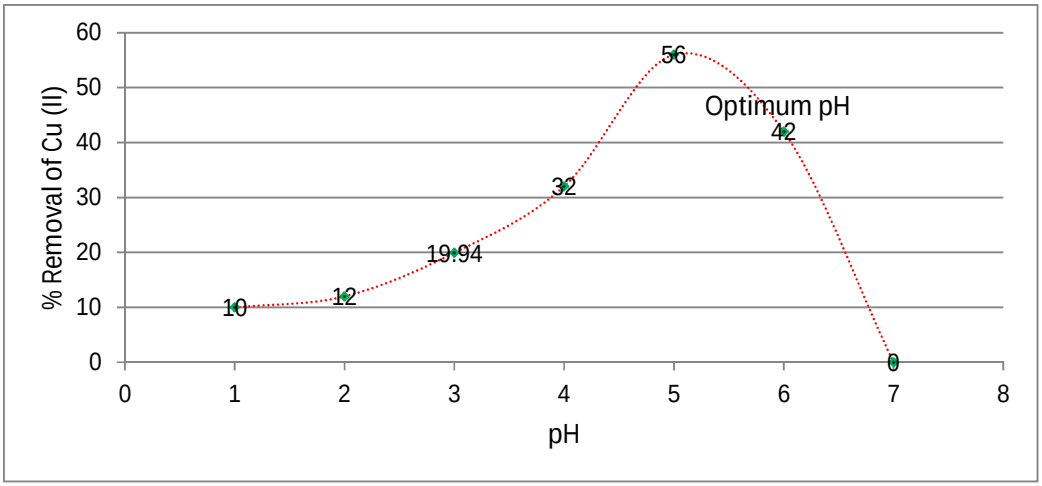

Fig.2. Effect of initial PH on Cu (II) ions adsorption using starch-based films (30C°, amount of biosorbent = 20 mg, Solution volume 20mL, C= 100 mg/L)

Conclusion

The present study is focused on the adsorption of cooper (II) ions onto starch based-films from aqueous solution; it addressed the important parameters of Cu (II) removal from sulfate media with the aim of identifying optimum adsorption conditions. The extent of biosorption dependent on process parameters such as PH and biosorbent dosage. The best efficiency sorption was record by Copper (II) ions was estimated as 87, 7%, the maximum sorption capacities were 7, 43 mg/g for Cu (II) were obtained at optimum PH 5.0. Results obtained from the present results concludes and revealed that, starch-based films was an effective biosorbent can be used as a low-cost adsorbent for removing Cu(Il) ions from aqueous solution.