

Kinetics and equilibrium studies for removal of silver from aqueous solutions by hybrid hydrogels

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Introduction

Silver (Ag^+) is a precious metal that has been widely employed in almost industrial activities for many years due to its excellent properties, for instance, malleability, ductility, electrical and thermal conductivity, corrosion and oxidation resistance, antimicrobial and luster. Therefore, all these industrial activities have been given the Ag^+ pollution in wastewaters, leading to possible exposure to aquatic organisms¹. Nowadays, many methods are being used to removal Ag^+ from water such as ion exchange, precipitation, solid phase extraction, etc. However, these methods is expensive and not effective in the case of low metal ion concentration. So the removal or recovery of Ag^+ ions using low-cost and high-capacity hydrogels based on natural polymers has great scientific attention.

In this paper, we report the preparation of a hybrid hydrogel by graft copolymerization of one vinyl monomer along the chains of carboxymethyl cellulose (CMC) and carboxymethyl chitosan (CMCts) by γ irradiation. These polymers are extracted from agriculture wastes and seafood products so they are cheap and less toxic. The chosen vinyl monomer is sodium styrene sulfonate (SSS). The main advantages of SSS as compared to other monomers exhibits high removal efficiency for treatment of metal ions from water and are low toxicity.

Batch technique was used in order to determine the equilibrium. After defining optimum reaction conditions (pH, temperature, contact time), experimental results were applied to Langmuir, Freundlich isotherms. First- and second-order reaction kinetics parameters were calculated for determination of adsorption mechanisms. It is thought that results of this study can be useful for treatment processes of sectors containing heavy metal in their wastewaters.

Experimental

CMC/CMCts/SSS hybrid hydrogels were prepared using 60-kGy- γ -radiation at atmosphere condition as described in previous study². Batch adsorption experiments were performed in a wide variety of conditions including different pH, temperature and weight of hydrogels. Effects of each factor were determined keeping other variables constant. All tests were carried out at least three times and average was used in the analysis.

In the kinetic experiments, 0.200 g of hybrid hydrogel was soaked into 40 mL of Ag^+ of various concentrations (50-1000 ppb) in polypropylene tube. Samples were taken at different time intervals (0–48 hr.) and remaining metal concentrations were analyzed by ICP-MS. The structure, thermal stability, and morphology of hybrid hydrogel were characterized by Fourier transform infrared (FTIR) and EDS spectra, thermogravimetric analysis, and scanning electron microscopy.

Results and Discussion

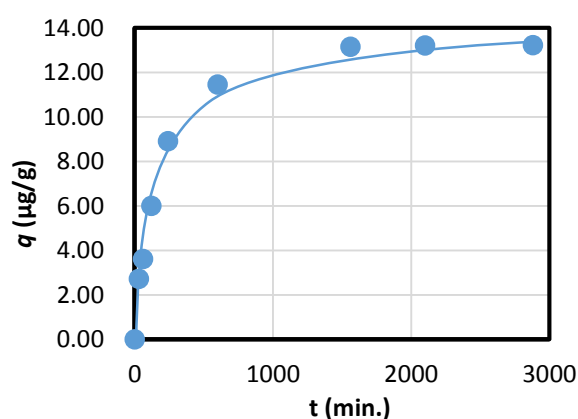


Fig. 1. Effect of soaking time on the adsorption of Ag^+ onto hybrid hydrogel (Initial Ag^+ concentration 100ppb, pH 5, 25°C)

Fig. 1 shows the dependence of Ag^+ adsorption in pH 5 with soaking time. The kinetics of Ag^+ removal of hybrid gels indicated rapid binding of metal ions to the adsorbents during 10 hrs., followed by a slow increase until equilibrium state was reached after 26 hrs. and unchanged in equilibrium time up to 48 hrs. The initial rapid phase may be due to the increased number of vacant sites available at the initial stage.

Other results will be presented at the meeting.

Acknowledgment

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References

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