Removal of Metal Ions from Aqueous Solutions using Carboxymethyl Cellulose /Sodium Styrene Sulfonate Hydrogels prepared by Radiation Grafting

Kyushu Univ.: Tran Thu Hong, Hirotaka Okabe, Yoshiki Hidaka, Kazuhiro Hara

E-mail: hong@athena.ap.kyushu-u.ac.jp

Introduction

Water sources like lakes, sea, groundwater, etc. are becoming polluted by different kinds of contaminants, including toxic heavy metals (e.g., Cr, Pb, Cu, Ni, Cd, Fe, etc.) accidentally discharged from industrial and domestic sources. Decontamination methods includes but is not limited to use of chemical precipitation, reverse osmosis, membrane filtration and electro-chemical treatment technologies [1]. But in the continued search for more efficient, cheaper and alternative adsorbents, this study proposes the use of CarboxyMethyl Cellulose / Sodium Styrene Sulfonate (CMC/SSS) hydrogels synthesized using gamma radiation, for heavy metal ions adsorption from aqueous solution. The parameters influencing the adsorption capacity of grafted gels such as SSS content, contact time and initial concentration were investigated.

Experimental

A series of hydrogels were prepared by the following procedure. An aqueous solution of 20wt% CMC/SSS in paste-like state with w/w ratios of CMC/SSS 1:0, 1:1, 2:1 and 1:2 were into PE tubes, that were irradiated in 20-100 kGy. The irradiated gels were extracted, washed with distilled water to remove un-reacted ingredients. The particles size fraction $5mm^3$(~ 0.200 g) were chosen for all experiments. The obtained hydrogels were characterized by gel fraction, swelling ratio and IR spectroscopy and applied against the multi-element ion solution (Fluka, Sigma-Aldrich) diluted 100 times.

Results and Discussion

CMC/SSS hydrogels were successfully prepared using gamma irradiation. The gel fraction (%) versus dose of hydrogels produced from different ratios of CMC and SSS is presented in Fig 1. The ratio of 1:0 gave the highest gel fraction, compared with other ratios. FT/IR spectra of grafted gels have characteristic bands at 1042 and 1015 cm^{-1} (-SO_3Na group) while the bands detected at 1216 and 1160 cm^{-1} were due to S=O stretching vibration to confirm the presence of function groups responsible for the adsorption of metal ions.

The nature of the adsorption depends on several factors: the adsorbents, initial feed concentration of metal ions or contact time, etc. Fig. 2 shows the various metal ion removal of grafted CMC/SSS

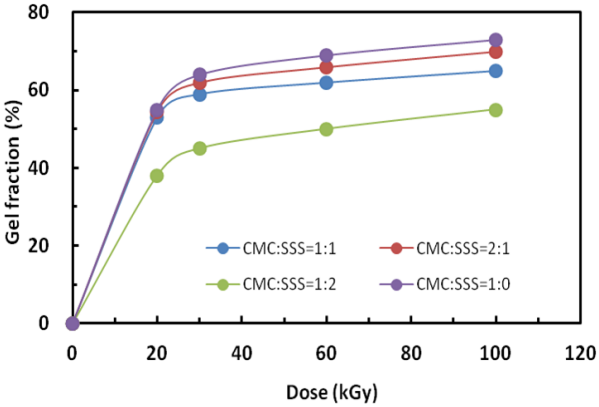

Fig.1 Effect of dose on gel fraction of CMC/SSS hydrogels prepared by gamma irradiation.

adsorbents. As can be seen, the CMC/SSS gels showed high metal removal capacities at equilibrium for Cr (76.3%), Pb (64.5%), Mn (54.4%) and Fe (48.5%) but very low for Se (5%). The CMC/SSS adsorbents did not present selectivity behavior for any specific metal ion, which means that the percentage removal does not depend on the metal ion's size even though the metal ions have different ionic radii, Pb(II) 133 pm and Mn(II) 81 pm. Metal ion removal can be produced by electrostatic interaction between the sulfonic group and the metal ions.

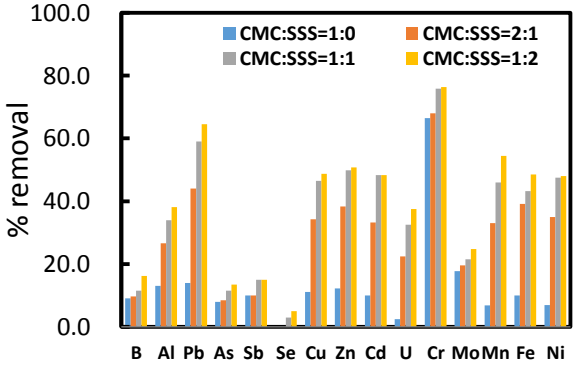

Fig. 2 Percentage removal of various metals.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number 21656239, 24360398.

Reference

1. Barakat MA., *Arab J Chem*. **4**, 361 (2011). doi:10.1016/j.arabjc.2010.07.019.