Preparation and Use of Poly (N-Methylhydroxamic Acid) Resin for Separation of Rare Earth Metal Ions*

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Introduction

Yttrium is one of the rare earth elements used in many electronic components [1]. It can be found in xenotime mineral, which is one of the byproducts of tin industry. The mineral also contains other rare earth elements such as cerium, lanthanum, praseodymium, ytterbium, gadolinium and samarium. The conventional method for the separation of these elements is by solvent extraction. However due to environmental problems related to this technique intensive research has been carried out in the use of ion exchange for the separation [2]. Poly(hydroxamic acid) ion exchange resin has been reported to be able to adsorb a few rare earth ions such as Y(III), La(III), Eu(III) and Lu(III) at different pH values [3,4]. The objective of this project is to synthesize poly(N-methyl hydroxamic acid) ion exchange resin from poly(methyl acrylate-divinyl benzene) using one step reaction and use the resin for the separation of yttrium and other rare earth elements.

Materials and Methods

Poly(methyl acrylate-divinyl benzene) was prepared by a polymerization technique using 90.0g methacrylate and 10.0 g divinyl benzene solution. The dry copolymer (4.0 g) was treated with water-ethanol solution containing 2.2 g N-methyl hydroxylamine and 4.0 g NaOH for 24 h at room temperature. Metal ion capacity for the resin was calculated from the amount of the metal ion sorbed by the wet resin which was in equilibrium with 25 cm^3 of its solution (0.005M) at various pH for 16 hr. The presence of hydroxamic acid group was confirmed by the formation of colored complex with vanadium (V), IR spectrum and nitrogent content in the resin. The ability of the resin to separate several mixtures of rare earth ions was determined by column method.

Results and Discussion

The resin obtained in this study was in the form of a macroporous bead. The presence of the hydroxamic acid groups on the resin was confirmed by the formation of a dark purple color complex with vanadium(V) in acidic solution [4]. IR spectrum of the resin exhibited C-N streching bands at 3444 cm^{-1} and 680 cm^{-1}. The nitrogen content of the dry resin was found to be 4.10% which indicated that there was 2.9 mmol/g of the hydroxamic acid. The capacity of the resin for yttrium, cerium, lanthanum, praseodymium, ytterbium, gadolinium and samarium ions was pH dependent which indicated that the resin could be used to separate the metal ions by solutions of suitable concentrations using column method. It was found that the resin was able to separate the mixture of yttrium-samarium, lanthanum-samarium and neodymium-gadolinium –samarium using HCl solution at pH 2 as eluent [5].

Conclusions

Poly(N-methyl hydroxamic acid) ion exchange resin was prepared from poly(methyl acrylate-divinyl benzene) and N-methyl hydroxylamine in basic solution using one step reaction. The resin was found to be suitable for rare earth element separations.

Benefits from the study

The poly(hydroxamic acid) resin can be synthesized more efficiently in one step reaction. The separations of rare earth elements can be carried out with the resin column using a dilute acid solution as eluent. This process is faster and more environmental friendly compared to conventional solvent extraction.

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