Extended Abstract

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Removal of Transition Metals from Dilute Aqueous Solution by Carboxylic Acid Group containing Absorbent Polymers

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Abstract

A carboxylic acid group containing resin with cation exchange capacity, 12.67 meq/g, has been used to remove Cu2+, Co2+ and Ni2+ ions from dilute aqueous solution. The resin had Cu2+, Co2+ and Ni2+ removal capacity, 216 mg/g, 154 mg/g and 180 mg/g, respectively. The selectivity of the resin for Cu2+ over Co2+ and Ni2+ was investigated in the presence of 1.0 M or 0.5 M sodium chloride. The resin was found to offer high capacity and selectivity for Cu2+. The sorbed metal ions (Cu2+, Co2+ and Ni2+) were easily stripped with dilute HCl. The sorbed Co2+ and Ni2+ could also be stripped with 1.0M NaCl.

Keywords

Ion-exchange; Selectivity; Sodium chloride; Carboxylic acid group-containing absorbents

INTRODUCTION

Heavy metals, in anionic or cationic forms, and some semi-metalloid ions (e.g., arsenic and boron) are the dominant contaminants in water recycle resulting from manufacturing and mining. They represent a serious water pollution problem, threatening the environment and human health [Batley and Florence, 1976; Dabrowski et al., 2004]. Some soluble heavy metals (e.g., cobalt, chromium, copper, mercury, manganese, nickel, and lead) can cause serious damage to the central nervous system (lead, mercury), kidneys (copper, lead, mercury), skin, teeth (nickel, chromium), liver or lungs (nickel, mercury, lead, copper) [Fu and Wang, 2011; Monier and Abdel-Latif, 2013]. Too much intake of some of the metals at high levels may even result in death. Unlike organic contaminants, heavy metal ions cannot be bio-degraded in nature, which makes the remediation a technical challenge [Ozay et al., 2009; Bessboussea et al., 2012]. The current environmental regulations on heavy metals are increasingly stringent, whereas the global need for most heavy metals continues to increase as a result of the rapid development of modern industry. Thus there is an urgent need to develop efficient and effective techniques for processing wastewater containing soluble heavy metals. Membrane separation processes such as reverse osmosis (RO), electro dialysis (ED), and Nano filtration (NF) have been used in removing heavy metal ions from aqueous solutions [Ba et al., 2009; Urgun-Demirtas et al., 2012]. They have already grown from a simple laboratory tool to a mature industrial process. However, these processes are capital- and/or energyintensive because of the high operating pressures or high power consumptions needed [De and Mondal, 2013].

RESULTS AND DISCUSSION

There is a molecular weight distribution in polymers. They are comprised of molecules with a range of molecular weights. Typically, the number average (Mn), weight average (Mw) or the z-average (Mz) of molecular weight can be used to characterize the average molecular weight of a polymer. The polyvinyl amine used in this study is a linear polymer. Though the average molecular weight of the PVAm is much larger than the molecular weight cut-off of the ultra filtration membrane, it was decided to pre-filtrate the low molecular weight fractions of PVAm and any other small molecules (e.g., residual initiators or catalysts left over in PVAm) that could not be completely retained by the membrane during subsequent PEUF processes. This would prevent secondary contamination to the permeate water due to possible passage of these small molecules during the PEUF.

Conclusions

The removal of heavy metals from water with PEUF was investigated using PVAm as a chelating agent. At a PVAm dosage of 0.1wt%, the metal rejections for Pb(II), Cu(II), and Fe(III) reached 99%, 97% and 99%, respectively. Although an increase in the PVAm dosage would increase the metal rejections, the permeation flux would be compromised. The pressure and temperature had little effect on metal rejection in the operating ranges tested, whereas the permeation flux was significantly affected. The PVAm-metal interactions in aqueous solutions were studied using UV-vis spectrometry and conduct metric titration, and it was shown that the metal rejection in PEUF was highly correlated to the coordination properties between the polymer and the metals.

References

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