Short communication

Removal of metal ions using dead-end filtration

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Abstract

Experimental results on a study on removal of metal ions using lecithin-enhanced dead-end filtration with 0.1 micron nylon membrane has been reported in this paper. The effects of metal-ion concentration on the pH, conductivity and zeta potential of lecithin dispersions were determined. The zeta potential of lecithin was determined to be -79 mV whilst the critical micelle concentration was 9 g·ℓ$^{-1}$. Significantly, the study showed that lecithin has the ability to adsorb metal ions. This study gives an alternate technology for metal ion removal from aqueous solutions.

Keywords: dead-end filtration, nylon, lecithin, metal ions

Introduction

The negative effects of heavy metals on the biota and environment have necessitated the need to look for suitable technologies for their removal from industrial effluent before discharging them into the water-bodies, soils and aquifers. The industries that discharge effluents with heavy metals include mining, battery, metal-finishing, semi-conductor manufacturing and mineral processing.

Quite a number of studies have been carried out on metal-ion removal in aqueous solutions and reported in the literature (Ahmadi et al., 1994; Broom et al., 1994; Huang and Batchelor, 1994; Juang and Shiau, 2000; Scamehorn et al., 1989; Wakeman and Kotzian 2000).

Surfactants due to their high selectivity properties have been used in enhancing membrane filtration for the removal of metal ions in aqueous solutions. Natural surfactants are preferred to synthetic surfactants because the synthetic surfactants have the disadvantage of introducing secondary pollutants into the filtrate. In addition, the natural surfactants are non-toxic, biodegradable and abundant.

Lecithin, a natural surfactant, which was used in this study to enhance the dead-end filtration, is primarily made from plant seed, although it can be produced from a variety of animal or vegetable sources. It is a complex mixture of phosphatides or phospholipids and is amphoteric. Commercial lecithins have been widely used in the medical, cosmetic and food industry. Lecithin is naturally occurring, cheap, non-toxic, biodegradable and forms large size micelles (Attwood and Florence, 1983)

In the present study the removal of Pb ion, mixtures of Pb and Cu, and mixtures of Pb, Cu and Cd ions using lecithin-enhanced dead-end filtration with 0.1 μm nylon membranes was investigated.

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Experimental procedures and materials

Feed characteristics

Surface tension

Surface tension measurements were carried out to determine the CMC of the lecithin dispersions with and without metal ions. A digital platinum ring tensiometer (White Electrical Instrument Co. Ltd.) was used for the surface tension measurements. The effects of Pb, mixtures of Pb and Cu, and mixtures of Pb, Cu and Cd ions on surface tension of lecithin dispersions were measured.

Metal ions

A Varian SpectrAA atomic absorption spectrophotometer (AAS) was used to determine the concentration of the metal ions present in both the feed dispersions and filtrates.

Zeta potential and particle size

The magnitude of the zeta potential gives an indication of the stability of the colloidal system. A Malvern ZetaSizer was used for the zeta potential measurements. For each sample, three readings were taken and averaged to obtain the value of the zeta potential of the sample. The Malvern Mastersizer was used to determine the particle size of the feed dispersions.

pH

A pH meter (WPA, UK) was used for pH measurements for all the feed dispersions and filtrate.

Conductivity

A conductivity meter (Philips digital, UK) was used to determine the conductivity of all the different feed dispersions and filtrate.

Experimental set-up

The experimental set-up for the dead-end filtration is shown in Fig. 1. It consists of a compressor, pressure gauge, filtration kit with a nylon membrane having a pore size of 0.1 μm and a measuring cylinder. Compressed air at a pressure of 2.068x10^5 N·m^{-2} (30 psi), measured using a pressure gauge, acted as the driving