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ORIGINAL PAPER

Separation of Cd(II) and Ni(II) ions by supported liquid membrane using D2EHPA/M2EHPA as mobile carrier

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The separation of Cd(II) and Ni(II) ions was studied in an aqueous sulphate medium using a supported liquid membrane (SLM). D2EHPA/M2EHPA was used as a mobile carrier, microporous hydrophobic PTFE film was used as a solid support for the liquid membrane, and the strip phase was sulphuric acid. The effects of different parameters such as feed concentration, carrier concentration, feed phase pH, and strip phase pH on the separation factor and flux of Cd(II) and Ni(II) ions were studied. The optimum values obtained to achieve the maximum flux were 5.0 for feed pH, 40 vol. % for D2EHPA/M2EHPA concentration in the membrane phase, 0.5 for strip pH, and 0.012 mass % for feed concentration. Under these optimum conditions, the flux values of Cd(II) and Ni(II) were 15.7×10^{-7} kg m^{-2} s^{-1} and 2.6×10^{-7} kg m^{-2} s^{-1}, respectively. The separation factors of Cd(II) over Ni(II) were studied under different experimental conditions. At a carrier concentration of 10 vol. % and feed concentration of 0.012 mass %, the maximum value of 185.1 was obtained for the separation factor of Cd(II) over Ni(II). After 24 h, the percentages of the extracted Cd(II) and Ni(II) were 83.3 % and 0.45 %, respectively.

Keywords: supported liquid membrane, cadmium, nickel, D2EHPA/M2EHPA

Introduction

Cadmium is a pollutant in the environment and toxic to humans, but has wide applications in different industries such as metallurgy, electroplating, Ni–Cd batteries, and pigments (Jha et al., 2012). The recovery of cadmium from wastes is important because of its extensive consumption, primary sources reduction, environmental concerns and also economic issues. In addition, spent Ni–Cd batteries and the wastes containing cadmium and nickel generated in the battery manufacturing process cause very serious environmental problems (Rathore et al., 2009).

Liquid–liquid extraction, precipitation, adsorption, ion-exchange, etc., are hydrometallurgical separation techniques in general use for the recovery of metals. Among these methods, liquid–liquid extraction has been widely used. This method has some disadvantages such as flooding, a wide range of solvents required, and loading limits (Yang et al., 2003). In addition, different membrane processes such as reverse osmosis, ultrafiltration, and nanofiltration have been employed in the separation of metals. The drawback of these methods is the lack of selectivity (Swain et al., 2006). Liquid membrane transport includes processes incorporating liquid–liquid extraction (LLX) and membrane separation in one operating device. A supported liquid membrane (SLM), in which a thin layer of an organic liquid absorbed into a porous support, is an alternative technique (Marták et al., 2011). Its advantages include ease of operation, low solvent requirement, high selectivity, low energy consumption, zero effluent discharge, and a combination of extraction and stripping in a single stage. However, its major disadvantage is membrane instability. Because of the non-equilibrium mass transfer characteristics in

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