



Poly(itaconic acid)-assisted ultrafiltration of heavy metal ions' removal from wastewater

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Abstract

The complexation–ultrafiltration technique has been introduced as a capable system to remove heavy metals ions from wastewater. This method needs a water-soluble polymer; therefore, in this paper we synthesized super water-soluble poly(itaconic acid) (PITA) and employed it in polymer-assisted ultrafiltration process to remove Pb(II) ions from synthetic wastewater solutions. The itaconic acid can be produced from different agricultural products and is a green and eco-friendly material. Factors influencing the removal of the metals ions including poly(itaconic acid) concentration, pH and permeate flux were investigated. The results showed that the maximum percentage of metal ion removal was obtained in the basic pH (pH > 7). The flux test was performed by 200 mg/L of poly(itaconic acid) and after 60 min, the flux of membrane was 33.4 L/m²h. The simultaneously selective removal ability of the poly(itaconic acid) for adsorption of different metal ions (Pb²⁺, Sn²⁺, Cu²⁺, Zn²⁺, and Cd²⁺) was also studied. The trend of rejection was Pb²⁺ > Cu²⁺ > Sn²⁺ > Zn²⁺ > Cd²⁺. The highest rejection of Pb(II) ions was achieved as 86%. Generally, the results of this research demonstrated that poly(itaconic acid) (with two carboxyl groups on its repeating unit) is more effective in removing heavy metals ions from wastewater in comparison with customary polymers.

Keywords Polymer-assisted ultrafiltration · Adsorption · Poly(itaconic acid) · Heavy metal ions removal · Water-soluble polymers

Introduction

Nowadays, due to water scarcity and growing population, the deleterious effect of polluted water by heavy metals on ecology and health makes wastewater recycling as a vital necessity [1]. Meanwhile, the volume of water contaminated with heavy metals is remarkable in the industry. To remove heavy metal ions from water several conventional methods, for instance, electrochemical removal [2], adsorption [3] and ion exchange chemical precipitation [4] have been employed. These methods suffer from high-energy requirements, production of toxic sludge, and instant incomplete removal which are significant shortcomings [5].

A number of wastewaters polluted by heavy metal ions usually have low concentrations of the metal ions but large volume effluents, which often makes the application of traditional separation methods challenging and needs modified materials [6]. Nowadays, polymeric membrane, for example, reverse osmosis (RO), nanofiltration (NF), and ultrafiltration (UF) have been progressively employed for the treatment of industrially produced wastewaters to increase the quality of the effluent [7]. But complexation–ultrafiltration process (CUP) is an efficient technique in wastewater purification which combines the membrane filtration and the selectivity of the chelating agent acting in synergy [8, 9].

The benefits of this technique are the conceptual simplicity, interesting kinetics due to rapid reactions, modularity, low energy consumption, high removal efficiency, high separation selectivity, removal or recovery of metal ions in a homogenous phase even at low concentrations, a large choice of membranes with excellent chemical, various polymers commercially available, and a reversible procedure: possible recycling of the polymers [10, 11].

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