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A study of zinc borne waste water treatment with dispersion supported liquid membrane

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ABSTRACT

This paper based on a theoretical study of the supported liquid membrane separation technology, explores the appropriate liquid membrane separation system, makes a study on the Pb (II) transmission behavior in the PC-88A-kerosene-HCl dispersion supported liquid membrane system and reviews influence of the feed liquid pH value, volume ratio between the membrane liquid and analytic agent, HCI concentration during analytic phase and initial Pb (II) transmission concentration. The results show that the migration of Pb (II) is well completed for 190 min with the migration rate being up to 95% on the premise that the feed liquid pH is equal to 6.0, Pb (II) initial concentration of 3.0×10^{-3} mol/L, HCl concentration during the stripped and dispersed phase is 4.0 mol/L, volume ratio between the stripped liquid and organic phase is 40:160 and that of the conventional supported liquid membrane is only 72.4%. The dispersion supported liquid membrane is characterized by higher transmission efficiency, stable membrane system and long membrane service life. The procedure has provided accurate results with zinc borne waste water treatment.

Introduction

Waste water in industry, daily life waste water and various waste waters in mining contain numerous heavy metals which should lead to food chain biological enrichment and cause serious threats to creatures and human health [1–3]. A heavy metal is a trace element which is indispensable to the human body health with its high content should bring serious consequences and the lead contamination is primarily due to waste water and garbage from mining, smelting, rubber production, dyestuff, printing, ceramics, lead glass, soldering, cables and lead pipes [4–6]. Lead shall be released to environment in production and operation process, and enter into the human body in a direct or indirect way, thus resulting in serious health problems such as stomachache, headache, tremor and neuro-dysphoria [7]. Given a low concentration, the chronic lead poisoning shall primarily affect the brain and nervous system. The lead borne waste water treatment method includes methods such as chemical precipitation, ion exchange, liquid-membrane, biological adsorption, electrolytic and so forth.

In order to minimize the heavy metals' serious influence on the ecological system, people have been in pursuit of new technology for the treatment of waste water contaminated by such metals. Pei and Yao [8] analyzes the zinc ion

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transmission model in the PC-88A-kerosene supported liquid membrane system. Given different experimental conditions, more experiments have been carried out to predict the zinc transmission extent in a supported liquid membrane system. Bhattacharyya and Mohapatra [9] reports the trivalent chrome transmission in the liquid membrane system taking the di-phosphoric acid (2-ethyl hexyl) as carrier. Zhao and Shen [10] analyzes the bivalent and trivalent metal ion transmission behavior in the optional migration carried out in a supported liquid membrane, thereby taking a new type of organic phosphoric acid as carrier; the analysis results show that various adopted extraction agents will properly separate the mixed ions Cu (I), Co (II), Ni (II), Pb (II), Fe (III) and Cd (II). Pei and Yao [11] analyzes the silver and mercury transmission and separation in a generally improved and supported liquid membrane system with two-membrane and three-chamber system established to achieve a rapid silver and mercury ions separation. Artur and Marcelo [12] analyzes the cobalt ion solvent extraction adopting Cyanex272 as extraction agent and its migration by the supported liquid membrane focusing on discussion about the transmission flux in the liquid and the equilibrium constant in solvent extraction to obtain optimum experimental condition based on the liquid phase pH, carrier Cyanex272 concentration, Co (II) concentration in liquid phase and the stripping agent acidity influence analysis. Hamed and Amirmostafa [13] analyzes zinc ion transmission model in the P C-88A-kerosene supported liquid membrane system with more experiments made to predict the zinc transmission extent in the supported liquid membrane system given experimental conditions together with the stirring rate, carrier concentration and temperature influence on the surveyed metal ion transmission.

The Supported Liquid Membrane (SLM) separation technology requires much attention due to its advantages comprising less energy consumption, low cost, favorable selectivity and banned secondary pollution. However, SLM separation technology has not been applied to industrialization, the reason for which is that transmission process shall make membrane phase diminish to nothing and bring about a declined separation performance and a reduced service life. The dispersion supported liquid membrane technology avoids the membrane phase disadvantage, thereby being liable to diminish to nothing in the supported liquid membrane. It is especially applicable to metal ion's low concentration enrichment and separation. The 2-ethylhexyl phosphoric acid – mono-2-ethylhexyl (P_{507}) is the metal ion extraction agent which is characterized by an excellent extraction property, small water solubility and has no poison.

The dispersion Supported Liquid Membrane (DSLM) technology presented in this paper is new and is developed based on SLM [14,15]. with the liquid membrane added to the analytical phase to constitute a dispersion system which is effectively capable of solving the membrane phase's petering out problem in SLM.I It is especially applicable to the low concentration metal ion enrichment and separation A study on the Pb (II) liquid membrane separation has been conducted, but there is still a lack of Pb (II) transmission DSLM technology report. The 2-ethylhexyl phosphoric acid – mono-2-ethylhexyl ester (PC-88A) is a metal ion extraction agent which is characterized by an excellent extraction property, small water solubility and has no poison. This paper takes P_{507} as a flow carrier for the liquid membrane and selects PVDF as a support, kerosene as a membrane solvent to analyze the Pb (II) transmission process in the dispersion supported liquid membrane system composed of organic phosphoric acid-kerosene-HCl to discuss various factors and mechanisms which influence on its transmission so as to provide a theoretic foundation for effective Pb (II) borne waste water control.

Experimental part

Instruments and reagents

UV-1200 type spectrophotometer (Shanghai Huipuda Instrument Plant);
JJ-1 type precision and timing motor stirrer (Danyangmen Quartz Glass Plant in Jintan);
P_{507}:product name PC-88A, from Oba Chemical Industry Company in Japan;
$PbSO_4$, $NH_3.H_2O$, NH_4Cl, HAc and NaAc are analytically pure; water for experiment is deionized.

The self-made dispersion supported liquid membrane migration pool comprises liquid, analytical pools and a support. The liquid and analytical pools are 200 mL in volume respectively, equipped with adjustable speed motor stirrer; the support is PVDF, and with 18 cm^2 effective area.

Experimental method

The experiment process is performed as follows:

- PVDF is immersed in the membrane solution for a given time for adsorption;
- Take it out to volatilize the membrane solvent;
- Fix it to the migration pool;
- Add the prepared sample feed liquid and the membrane solution to feed liquid and analytical pools respectively;
- Start the stirrers in the fed liquid and analytical pools;
- Add appropriate HCl to the analytical pool and start timing to sample for analysis at different appropriate intervals.

Pb (II) concentration shall be determined by the spectrophotometric method.

Experiment principle

The metal ion reaction and migration processes in dispersion supported liquid membrane system are approximately composed of the following steps:

(1) Metal ion in feed liquid phase must pass through water dispersion layer between the feed liquid and membrane phases.
(2) The (Pb^{2+}) metal ion and carrier (HR), at interface between water-membrane phases, must have the following coordination reactions: