World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:11, No:02, 2017

Performance Study of Neodymium Extraction by Carbon Nanotubes Assisted Emulsion Liquid Membrane Using Response Surface Methodology

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Abstract : The high purity rare earth elements (REEs) have been vastly used in the field of chemical engineering, metallurgy, nuclear energy, optical, magnetic, luminescence and laser materials, superconductors, ceramics, alloys, catalysts, and etc. Neodymium is one of the most abundant rare earths. By development of a neodymium–iron–boron (Nd–Fe–B) permanent magnet, the importance of neodymium has dramatically increased. Solvent extraction processes have many operational limitations such as large inventory of extractants, loss of solvent due to the organic solubility in aqueous solutions, volatilization of diluents, etc. One of the promising methods of liquid membrane processes is emulsion liquid membrane (ELM) which offers an alternative method to the solvent extraction processes. In this work, a study on Nd extraction through multi-walled carbon nanotubes (MWCNTs) assisted ELM using response surface methodology (RSM) has been performed. The ELM composed of diisooctylphosphinic acid (CYANEX 272) as carrier, MWCNTs as nanoparticles, Span-85 (sorbitan triooleate) as surfactant, kerosene as organic diluent and nitric acid as internal phase. The effects of important operating variables namely, surfactant concentration, MWCNTs concentration, and treatment ratio were investigated. Results were optimized using a central composite design (CCD) and a regression model for extraction percentage was developed. The 3D response surfaces of Nd(III) extraction efficiency were achieved and significance of three important variables and their interactions on the Nd extraction efficiency were found out. Results indicated that introducing the MWCNTs to the ELM process led to increasing the Nd extraction due to higher stability of membrane and mass transfer enhancement. MWCNTs concentration of 407 ppm, Span-85 concentration of 2.1 (%v/v) and treatment ratio of 10 were achieved as the optimum conditions. At the optimum condition, the extraction of Nd(III) reached the maximum of 99.03%.

Keywords : emulsion liquid membrane, extraction of neodymium, multi-walled carbon nanotubes, response surface method
Conference Title : ICSPT 2017 : International Conference on Separation and Purification Technology
Conference Location : Barcelona, Spain
Conference Dates : February 26-27, 2017