Investigation of Performance of Imidazolium Ionic Liquid in the Extraction and Separation of Rare Earth Elements from Aqueous Solution

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Abstract

In this study, ionic liquids for extraction and separation of rare earth elements such as cerium, samarium, gadolinium and dysprosium have been studied and tested. The results showed that pure ionic fluids $[C_6MIM]PF_6$ and $[C_6MIM]NTf_2$, as the solvent, could extract rare earth metals without an extractant. But, the extraction efficiency was low (19.54% for cerium extraction with $[C_6MIM]PF_6$, and 11.11% with $[C_6MIM]PF_6$). The use of TOPO extractant in these ionic liquids led to the higher extraction efficiency (higher than 80% for extraction of ions with a mixture of TOPO and $[C_6MIM]PF_6$. Since ionic liquids are high viscosity solvents, their application in liquid-liquid extraction columns will be complicated, so the combination of ionic liquids with TOPO and TBP solvent was studied. The experimental results showed that the mixture of three compounds TOPO, TBP, and $[C_6MIM]NTf_2$ was better than the mixture with $[C_6MIM]PF_6$. But, in the mixture of two components, TOPO and $[C_6MIM]PF_6$ was more appropriate for ion extraction. The result showed in continuous applications with high volume, the mixture of these three substances can lead to the extraction of rare earth metals with a high extraction efficiency.

Keywords: **Rare Earth Elements, Ionic Liquids, Extractant, Solvent, Imidazolium.**

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Modeling and Simulation of Copper Biosorption Process in a Fixed Bed Column

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Abstract

In this research, the biosorption process of copper metal from industrial wastewater by Rhizopus Arrhizus has been modeled in a fixed bed column. The performances of the three isotherms of Langmuir, Freundlich, and BET were compared to calculate the adsorption rate. Based on the modeling results, the Freundlich model with a correlation coefficient of 0.974 showed better agreement with the experimental results than the other models. The highest agreement of Freundlich model with experimental data was obtained at k=0.991 and n= 0.8551. Then, the effect of the selected model parameters on the adsorption rate was investigated, and it was found that at a constant Freundlich coefficient, an increase in the power of the model enhances the available adsorption capacity for low solute concentrations. The effects of operating conditions in the column include volume flow, column diameter, column length, initial concentration, and adsorbent density on the adsorption rate were also investigated. In general, it can be stated that the modeling of biological processes for metal removal is one of the important tools in understanding the behavior of these processes with the least cost, and also the performance of the process can be evaluated at different operating conditions.

Keywords: **Biosorption, Copper Metal, Rhizopus Arrhizus, Isotherm model, Fixed bed Column.**

Measurement and Calculation of Methane Solubility in Water and Diethylene Glycol Solution

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Abstract

In this study, the solubility of methane in pure diethylene glycol, pure water and in the aqueous solution of diethylene glycol has been investigated. The effects of pressure, temperature and mixture concentration on the solubility of methane in the aqueous phase were studied. Design Expert software has been used to reduce and optimize the number of experiments and investigate the effect of different parameters on the solubility data. Kricheveky's model was used to predict the Henry's constant of pure water and DEG. The model parameters have been extracted at different temperatures and pressures. In order to estimate the solubility of methane in the mixture from the pure data, O'Connell's model has been applied. The model parameter has been evaluated using Margules equation. Results showed that the proposed model has good capability to predict the solubility in the mixture.

Keywords: Solubility, Diethylene Glycol, Methane, Henry's Law, Water.

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Optimization of Compact Heat Exchanger for Minimization of Entropy Generation Using Differential Evolution Algorithm

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Abstract

Considering the importance of heat exchangers in operational units, in this research, the differential evolution (DE) algorithm was used to optimize compact heat exchanger aim to minimize the number of entropy generation units. The number of total entropy generation units of heat and pressure in the compact heat exchanger as an objective function and six decision variables including heat exchanger length, fin frequency, fin length, number of layers of flow on both sides of the offset strip fin, fin height, and fin thickness with a series of restrictions were Investigated. The results obtained from DE optimization were compared and validated by genetic algorithm (GA) and particle swarm optimization (PSO). The level of this algorithm in minimizing entropy generation (by 1.5 and 17.6% compared to the PSO method and GA) revealed high ability of the DE method in optimizing compact heat exchangers. Moreover, the effect of changes in control parameters in the DE algorithm on convergence and the degree of optimization of the objective function was studied.

Keywords: Optimization, Differential Evolution Algorithm, Compact Exchanger, Entropy Generation.

Treatment of Quaternary Solution of Water/Ethanol/Acetaldehyde/Acetic Acid by Activated Carbon Bed

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Abstract

Adsorption technology due to inexpensiveness, simplicity of operation, universal nature and effectiveness has been considered as one of the promising method of separation processes. Thereby in this study an adsorption process was applied by using activated carbon as adsorbent for separation of three pollutants of ethanol, acetaldehyde and acetic acid from aqueous solution. The solution contained 5 wt.% ethanol, 1.5 wt.% acetic acid and 0.2 wt.% acetaldehyde and in this work the effect of three parameters including retention time, solution temperature and adsorbent dosage were investigated. Moreover, the experiments were designed and optimized by RSM method and the results revealed that the optimal retention time, solution temperature and adsorbent dosage are 4 hr, 30°C and 2.8 g adsorbate/cc solution, respectively. The maximum amount of adsorption for ethanol, acetic acid and acetaldehyde was determined to be 65, 85 and 85%, respectively and their adsorption capacity was calculated to be 144.4, 64.2 and 7.6 mg adsorbate/ gr adsorbent.

Keywords: Adsorption, Quaternary Solution, Activated Carbon, Experimental Design.

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Methods for Viscosity Reduction of Heavy Crude Oil with Focus on Nano Catalysts: A Review Study

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Abstract

Investigations on a variety of methods for reducing the viscosity of heavy crude oil show that conventional methods due to their high temperature and pressure are expensive, unsafe, costly maintenance with huge utility and low efficiency. Thermal cracking was the first method of reducing viscosity, which presence of catalysts could improve some of its problems such as instability and extremely high temperatures. But temperature was still high and due to these basic problems, efforts are continuing to achieve better result and more efficiency. Usage of dispersed nanocatalysts greatly increased the efficiency of these reactions so that at presence of hydrogen and nano dispersed catalyst viscosity reduced up to 99%. Many nanocatalysts have been studied so far, for example, nano zeolite, carbon, iron, and nickel which have yielded good results, but these methods also have some special problems such as synthesis of nanocatalysts with appropriate surface and bed and collecting them after reaction. Processes with modern technology such as irradiation, cavitation and electromagnetic waves at a laboratory scale have been able to produce good results at very low temperatures and low pressures. In one of these experiments, the microwave could reduce 99.7% viscosity of heavy oil at the presence of nanoparticles of carbon nanotubes. Of course, these methods have not been commercialized yet because of complicated conditions and special equipment so this way is very good for continuing research on them.

Keywords: Viscosity Reduction, Heavy Crude Oil, Nanocatalyst, Cracking.