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Optimization of Multistage Extractor for the Butanol Separation from Aqueous Solution Using Ionic Liquids

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Abstract : n-Butanol can be regarded as a potential biofuel. Being resistive to corrosion and having high calorific value, butanol is a very attractive energy source as opposed to ethanol. By fermentation process called ABE (acetone, butanol, ethanol), bio-butanol can be produced. ABE carried out mostly by bacteria Clostridium acetobutylicum. The major drawback of the process is the butanol concentration higher than 10 g/L, delays the growth of microbes resulting in a low yield. It indicates the simultaneous separation of butanol from the fermentation broth. Two hydrophobic Ionic Liquids (ILs) 1-butyl-1-methylpiperidinium bis (trifluoromethylsulfonyl)imide [bmPIP][Tf_2N] and 1-hexyl-3-methylimidazolium bis (trifluoromethylsulfonyl)imide [hmim][Tf_2N] were chosen. The binary interaction parameters for both ternary systems i.e. [bmPIP][Tf_2N] + water + n-butanol and [hmim][Tf_2N] + water +n-butanol were taken from the literature that was generated by NRTL model. Particle swarm optimization (PSO) with the isothermal sum rate (ISR) method was used to optimize the cost of liquid-liquid extractor. For [hmim][Tf_2N] + water +n-butanol system, PSO shows 84% success rate with the number of stages equal to eight and solvent flow rate equal to 461 kmol/hr. The number of stages was three with 269.95 kmol/hr solvent flow rate for [bmPIP][Tf_2N] + water + n-butanol system. Moreover, both ILs were very efficient as the loss of ILs in raffinate phase was negligible.

Keywords : particle swarm optimization, isothermal sum rate method, success rate, extraction
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