Reactive Extraction: An Intensifying Approach for the Recovery of Carboxylic Acids

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Now, It is essential to replace the petroleum based feed-stocks by renewable resources for the sustainable development of industrial sectors. Fermentation technology is an attractive alternative to produce organic acids from renewable sources. In order to make the fermentation route economically viable, it is necessary to develop novel fermentation processes that use highly efficient separation techniques. Among various available alternatives for recovery of carboxylic acids from fermentation broth, reactive extraction with a chemical reaction phenomenon is a promising technique. Reactive extraction can effectively be utilized as a process intensification method to obtain significant improvements in yields and selectivity of desired products in multi-reactions.

My PhD work deals with experimental and theoretical studies on the recovery of carboxylic acids such as mono-carboxylic acids (formic-, acetic-, propionic-, and butyric acid), glycolic acid and pyridine carboxylic acids (nicotinic-, isonicotinic- and picolinic acid) from its dilute aqueous solutions typically encountered in fermentation processes. Both organo-phosphorus and aliphatic-amine based compounds have been investigated as potential reactive extractants. Among the diluents, hexane, cyclohexane, decane, dodecane, MIBK, toluene, benzene, dichloromethane, etc., are studied with or without modifiers such as 1-octanol, 1-decanol and oleyl alcohol.

My presentation encompasses three phases: (i) Reactive extraction of carboxylic acids from its dilute aqueous solutions typically encountered in fermentation processes, waste stream and bio-oil, (ii) Modeling and simulation of metallocene catalyzed polyolefins (iii) Ionic liquids (green solvents) applications in extraction of bio and organic products. In the first phase (75% of presentation), the discussion will be focused on acid/extractant/diluent system including biocompatible extraction system, possible equilibrium mechanism of reactive extraction and kinetics of the reaction between extractant and acid. Response surface methodology and differential evolution approaches are also employed to obtain the optimum process variables and maximize the recovery of glycolic acid from fermentation broth. The linear solvation energy relation (LSER) based on the solvatochromic parameters of diluents are proposed and used to quantify the effect of diluent on the values of extraction efficiency, K_D. In the second phase of my presentation, a comprehensive model development and simulation to determine the kinetic parameters of polymerization process of olefins as well as the effect of various polymerization parameters on the properties of polyethylene and polypropylene, is presented. Since Ionic liquids offer great opportunities to be used in Green processes, the work carried out in the extraction of bio- and organic compounds using Ionic liquids is presented in last phase.