Selective recovery of levulinic acid from mixed acid solutions

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1. Introduction – Today, several industries are under an increasing pressure to produce sustainable materials using green and efficienct synthesis methods. The main purpose of the effort is to develop more eco-friendly and low-cost manufacture techniques, chemical transformations, procedures and processes in industry. Nowadays, among the commodity chemicals, levulinic acid (LA) is presented as one of the most significant ones due to its availability to be utilized during the production of novel green biofuels [1]. For this purpose, high-purity LA is required. It can be obtained from lignocellulosic materials with the use of chemical and biological methods. However, it exists in a media containing more than one type of carboxylic acids (acetic acid (AA) and/or formic acid (FA)) and some other by-products. This results in a growing need for the selective obtainment of LA from aqueous based mixed acid solutions containing by-products and also unreacted substrates. Without any doubt, selective recovery of LA from the chemicals having similar structures, carboxylic acids, is the most challenging part of the process. Several separation methods have been evaluated for the aim and among them; reactive extraction is shown as the most appropriate to reach the high-purity and low-cost LA [2,3]. The present study is on the selective reactive extraction of levulinic acid from mixed-acid solutions having acetic acid and formic acid.

2. Experimental – Initial concentrations of each acid were kept constant as 0.25 M. Experiments were carried out using two-acid and three-acid aqueous solutions. Trioctylamine was chosen as the extraction agent (0.1-0.5 M) while intermediate-molecular weight alcohols were used as the organic phase diluents. Effects of several parameters such as extractant concentration, aqueous phase pH (1-7) and organic phase diluent type were investigated.

3. Results and Discussion - The results showed that all parameters studied had significant influences on the selective recovery. The difference in the pK_a value of the acids helped the process. Among the parameters, pH was observed to be the most critical one while obtaining a selective extraction. In the literature, separation factor, which is the ratio between the distribution coefficients of the solute, was shown as the helpful tool. Separation factor values about 8-10 was obtained in this study. However at these conditions, the purity of the acid portion extracted into the organic phase was lower than the acceptable levels. Therefore, percent of the acid extracted to the organic phase was considered to investigate the separation process. The results demonstrated that concentration of the extractant positively affected the extraction efficiency. However, the influence was not the same for the purity. To solve the problem, initial pH was increased. This helped to obtain a selective reactive extraction. More than 90% LA was selectively recovered using a multi stage extraction unit from a three-acid solution containing AA and FA besides the target product.

4. Conclusions – The results showed that reactive extraction method can be successfully used to obtain high-purity LA from aqueous mixed solutions.

5. References

[1] J. J. Bozell et al., *Resour. Conserv. Recy.*, **28**(3-4), (2000) p. 227
[2] A. S. Kertesz and C. J. King, *Biotechnol. Bioeng.*, **28**(2), (1986) p. 269
[3] M. E. Marti and T. Gurkan, *Sep. Purif. Technol.*, **156**(2), (2015) p. 148