SEPARATION EFFICIENCY IN A SIEVE PLATES EXTRACTOR

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Abstract –This work analyzes the separation efficiency data involving mass transfer between two immiscible liquid phases in a bench lab extractor without mechanical agitation. The experimental apparatus consisted in a cylindrical glass column containing perforated plates, operating in countercurrent mode. The experimental runs were developed by using butane-acetic acid-water system, following a factorial experimental design involving the variables: dispersed phase velocity, the continuous phase velocity and the number of stages (two and four plates). The collected acid acetic raffinate and extract was analysed by titration with sodium hydroxide. Separation efficiencies were estimated through Murphree (1925) and Kawase (1990) models. The results showed that the higher was the dispersed flow, higher was the separation efficiency. An opposite behavior was observed for the continuous phase flow effect. In relation to the number of plates, higher efficiencies were achieved for 4 plates arrangement. The results provided empirical equations to predict the extraction efficiency, which exhibited good correlation with experimental data.

***Keywords*— Liquid-liquid extraction; efficiency; mass transfer.**

I. INTRODUCTION

In recent years the knowledge about separation efficiency in liquid-liquid extraction columns has notably increased, once it is directly connected to mass transfer between the liquid phases present in the mixture. According to Tudose and Apreotesei (2001) and Lisa *et al.* (2003), the solute transfer between two immiscible liquids is still a complex phenomenological process. However, its applications, mainly in purification processes, are of great relevance to chemical industries and various types of solvent extraction contactors, including spray and packed columns, have been used for a range of applications in the hydrometallurgical, pharmaceutical and petrochemical industries form many years.

According to Stella *et al.* (2008) the optimal design of a solvent extraction column involves maximizing the performance by increasing the interfacial area for mass transfer, mass transfer coefficient and concentration driving force. As the interfacial area is dependent on the dispersed phase droplet size and holdup in the column, it is important to accurately predict and optimize the hydrodynamic characteristics.

The performance of an extraction unit operated continuously is also dependent on the amount of solvent present in extractor. If the solvent quantities are high compared to the feed, the solute concentration gradients are favorable to mass transfer (Zuniga *et al.*, 2006).

Jahya *et al.* (2005), Treyball (1980), Stella *et al.* (2006) among others evaluated the performance of extraction columns based on data from axial dispersion, holdup, NUT, NETS, etc. However there are few studies in the literature in which the performance of the producers is measured through data separation efficiency

Góis *et al.* (1999), for example, reported that mass transfer between liquids phases in an extraction column depends, among other factors, on the interfacial contact area between continuous and dispersed phases, and its extension can be evaluated through the separation efficiency measurement.

About efficiency in extraction columns, the literature shows that efficiencies can be evaluated by Murphree's efficiency, where actual exit concentrations are compared with thermodynamic equilibrium conditions. Murphree's efficiency is expressed by

$$\lambda = \frac{x_f - x_r}{x_f - x_r^*} . \quad (1)$$

Another model, also very used to calculate the separation efficiency in extraction columns, was proposed by Kawase (1990). This model considers the efficiency as a solute recuperation ratio in the extract current, as described by

$$\lambda = \frac{x_f - x_r}{x_f} . \quad (2)$$

The exact meaning of the variables in equations (1) and (2) is described in the nomenclature. They represent the concentrations of solute at the top of the column feed (x_f), the concentration of the raffinate output (x_r) from the base and the equilibrium concentration equivalent for the raffinate (x_r^*)

Therefore, the main objective of the present work was to study the influence of operational and geometrical parameters on the performance of a perforated plate column, using separation efficiency parameters calculated by Murphree (1925) and Kawase (1990) models. The factors whose effects were evaluated were continuous and dispersed phases flows and the number of stages, associated to the column height. Empirical correlations to predict the extraction efficiency based on the models discussed above were also proposed.

II. EXPERIMENTAL APPARATUS

The extraction column used in the present work consisted of a glass tube with 0,0923 m of internal diameter and heights ranging from 0,70 to 0,90 m, corresponding to 2 or 4 stages. The stages were divided by aluminum