Liquid-Liquid Extraction

Overview

Liquid-liquid extraction (LLE) is an important unit operation that allows one to separate liquids using differences in solubility of a solute liquid in different solvents. In this experiment, methyl ethyl ketone (MEK) is the solute which is extracted from Isopar M (a low-volatility organic solvent) into deionized (DI) water. The experiments are performed with continuous water phase and dispersed organic phase. The LLE system contains three columns with random packing:

1. Two columns of different cross-section packed with Rasching rings.
2. One column with Pall rings.

Figure 1. Schematic of the LLE system (1st floor and outside). Red and blue lines represent piping for the organic and aqueous phases, respectively. For simplicity, only one column is shown.
Most of the LLE system is located on the 1st floor of the Unit Ops Lab. The feed tanks for the organic phase are located on the 3rd floor and the waste drums for the extract (water + solute) are located outside. The solvent (DI water) is supplied by the DI water system of the CHE building.

The schematic of the 1st floor and outside components of the LLE system is shown in Fig. 1 (for simplicity, only one column is shown). An overview of the system on the 1st floor is shown in Figure 2.

![Figure 2. Overview of the LLE system (1st floor).](image)

The schematic of the feed tanks on the 3rd floor is shown in Figure 3. At the end of each lab session, the raffinate (organic phase product of the LLE) should be pumped from the raffinate tank on the 1st floor back to the feed tank on the 3rd floor. If necessary, the solute concentration in the feed tank can be increased by pumping some of the pure MEK from the solute tank to the feed tank.

![Figure 3. Schematic of the LLE feed tanks on the 3rd floor](image)
Objectives

The main purpose of this lab is to investigate dependence of the mass transfer coefficients on the following parameters:

1. Flow rates of water and organic streams;
2. Packing type;
3. Column size.

For each of the columns, you should

1. Determine the mass transfer coefficient experimentally for a range of flow rates. For this, you will use the experimentally measured flow rates and compositions of the streams and compute the mass transfer coefficient using the number of transfer unit (NTU) method.
2. Develop an empirical relationship between the flow rates and the mass transfer coefficient using the experimental data.
3. Verify the empirical relationship by predicting the MEK composition in outlet streams at a new set of operating conditions and comparing the prediction with experimental measurements performed at these conditions.

In addition, for the columns with Rasching rings, you should scale up the results obtained for the smaller column to predict the performance of the larger column and verify the predictions experimentally.