CHAPTER 1

INTRODUCTION

Liquid - liquid extraction processes are being increasingly used to great advantages in the separation of liquid mixtures or recovery of valuable components from reaction products.[1] The important applications of liquid - liquid extraction may be classified into 2 types:

1. The Organic Chemical Industry, such as the petroleum industry, the coal tar industry, the oils and fats, and phamaceutical industry.

2. The Inorganic Chemical Industry, such as the metallurgical industry for example

Liquid - liquid extraction columns are often used and operated with two liquid phases flowing countercurrent to each other. The heavy phase is introduced at the top and flows downward, while the lighter phase is introduced at the bottom and flow upward. Various methods are used to bring the two phases into contact with each other and then separate them.[2] These non-mechanically agitated extraction columns may be divided into the following common types.

1. Plate columns
2. Spray columns
3. Packed columns

Packed columns have found a wide application in industrial practice for continuous countercurrent liquid-

liquid extraction. Packings such as Raschig rings, Lessing rings, Intalox and Berl saddles are commonly used. The pair of liquid phases must have a sufficient difference in density to induce and maintain traffic of the phases in the interstices of the packings. The continuous phase fills the interstitial voids in the packed section and travels through the column along the tortuous path offered by the packings. The dispersed phase in the form of droplets is allowed to pass through the continuous phase. The pieces of packing in the column helps to increase the local velocity of the continuous phase and restricts recirculation and mixing in the phase. At the same time, they improve the distribution and hold-up of the dispersed phase by distorting and breaking the bigger drops and hindering their free movement, thus yielding more surface area for mass transfer.

The wettability of the packing surface decides the pattern of the flow of the dispersed phase.(3) If the dispersed phase preferentially wets the packings, the flow pattern of this phase in the column will be in the form of extended films over the surface of the packings, whereas if the continuous phase preferentially wets the packing surface, dispersed phase will flow in the form of discrete droplets, the packing acting as baffles and dispersers for the droplets.

The movement of the dispersed phase droplets swarm is controlled by factors such as the distribution of drop sizes, hindered settling and drop interactions caused by the crowding of the droplets, local velocity of the fluid, and eddy motions in the continuous phase. The surface tension and other interfacial properties of the solvents have been found to control the droplet characteristics such as drop break up, coalescence and redistribution of drop sizes.

Normal packed liquid - liquid extraction columns suffer from the disadvantage that the only energy available for dispersing the two phases is that derived from gravity acting on the density difference between the two liquids.(4) Unfortunately this is rarely sufficient to obtain the most effective interface contact and mass transfer. An additional energy input can be obtained by pulsing the liquids up and down inside the column. The packings are thus made to act rather like a stirrer causing additional turbulence within the column but with the advantage that the energy of pulsation is transmitted uniformly throughout the column.

Numerous investigators have studied the enhancement in the rate of mass transfer obtained with pulsation and an increase in the efficiency of over three times that of an ordinary packed column has been reported. The pulsation, however, also increases the axial dispersion in the column by adding a forced backmixing effect in the void spaces of the packing. The increase in mass transfer rate must outweigh the extra mixing produced if pulsation of the column is to be useful. Taylor and Leonard[5] have studied the increase in dispersion obtained with pulsation for single phase flow of liquids through open circular tubes but, so far, the only major investigation of axial dispersion in pulsed packed columns is that of Vermeulen et al.[6]

In this work a pulsed packed liquid-liquid extraction column is used to investigate the influence of the wetting characteristics on efficiencies.

1.1 The scope of this work

1. To study the influence of wetting characteristics on flooding capacities.

2. To study the influence of wetting characteristics on column efficiencies.

1.2 The objectives of this work

Factors governing the mass transfer rate and the efficiency such as types of packings, size of packings, column diameter, drop size, characteristic velocity of the droplets, interfacial area of contact and longitudinal mixing are widely discussed except the factor of surface properties of the packings. The lack of surface property effect data makes design work imperfect. It is, therefore, very interesting to investigate how this effect influences the efficiency of pulsed packed liquid-liquid extraction columns and how the results may be generalized for other columns.

The objectives of this work are summarized as follows:

1. To study the influence of random packing on flooding capacities.

2. To make a comparative study of the influence of wetting characteristics on flooding capacities using stainless steel and unknown teflon-like plastic packings.

3. To make a comparative study of the influence of wetting characteristics on column efficiencies using the same packings.

4. To make a comparative study on the column efficiencies between pulsed perforated-plate columns and pulsed packed columns.

5. To conclude on the optimum conditions obtained on the equipment and systems used.