CHAPTER 1

INTRODUCTION

Liquid-liquid extraction has become an important separation tool in modern process technology. An overall review of countercurrent liquid-liquid extraction columns indicate a classification into 2 types [1,2]:

1. No energy input, such as the spray column, the packed column, and the sieve-tray column.

2. With mechanical energy input, such as agitation (rotating-disk contactors) and pulsation (packed, sieve-tray, and Karr-type).

Liquid-liquid extraction columns are often operated with two liquid phases flowing in opposite directions. The heavy phase is supplied at the top and flows down-ward, while the lighter phase is supplied at the bottom and flows upward. Various processes are used to first contact both phases intimatelly and then separate the phases from one another. The pair of liquid phases must have a sufficient difference in density in order that the droplet phase may rise (or fall) through the continuous phase. For example iodine-water/carbon tetrachloride, separations of these sort are essentially physical in character, and the various components are unchanged chemically. Nevertheless, the chemical nature of the liquids strongly influences the extent of separation, since the distribution of a solute depends on the extent of non-ideality of the solutions involved[3].

Most of the difficulties in scaling up extractors are caused by non-ideality of internal flow within the contactor[4], rather than by the complexity of the mass transfer phenomena itself. It is assumed that if the internal flows is properly expressed, the description of the mass transfer rates may be simplified.

In the ideal case the mass transfer coefficients would be calculated or measured in small-scale laboratory equipment. The behavior of the actual extractor could then be predicted, using the measured values in a suitable model.

Of these, one relates to differentially continuous columns in which longitudinal diffusion is superimposed upon piston flow of the phases. This leads to a fourth-order differential equation which can be solved analytically for the case of a linear equilibrium relationship to give the concentration profile in the form of a sum of exponentials. This solution, together with the boundary conditions which determine the constants, was first obtained by Sleicher[5], who gave the results of computer calculations in terms of an "extraction efficiency". The results were expressed by an empirical relation, and analytical solutions were also given for less complex cases (see also Pratt[6]).

Hartland and Mecklenburgh[7] have also given the full analytical solutions to the stagewise case, presenting these side by side with those for the differential case. Such a solution has now been obtained, and the derivation is given, starting from a more convenient form of the general solution similar to that given by Miyauchi [8,9] for the case of differential equations. (see also Smoot [10]).

The two-dimensional diffusion model which is described in dimensionless form by the differential equation has been found by many investigators to describe and correlate within engineering accuracy the longitudinal mixing in a wide variety of fluid systems. Solutions of boundary conditions corresponding to the physical configurations encountered in many flow-systems have been described, and methods have been given for deriving numerical estimates of the Peclet number and Number of true over-all transfer units from dynamic response curves obtained by excitation of the procees dynamic with an injection of tracer material [11].

It is believed that the Forward Mixing phenomena influences efficiencies of liquid-liquid extraction columns. A Mathematical Model to explain this phenomena need to be studied. The Forward Mixing of the dispersed phase droplets can be described by factors such as varying velocities, distribution of drop sizes etc...

1.1 The objectives of this work

1. To study the influence of Forward Mixing on the liquid-liquid extraction column.

2. To study what Mathematical Model can be used with the droplet flow.

1.2 The scope of this work

1. Develop computer programs
2. Run computer simulations

From the concentration profiles obtained the following studies were made

1. A study of the interrelationship between Number of true over-all transfer units in the dispersed phase with Peclet numbers and jump ratios.
2. A study of HETP in extraction columns of different heights
3. A study of concentration profile solutions.