CHAPTER I
INTRODUCTION

Ion exchange can be defined as a reversible exchange of ions between a solid phase of resin and a solution phase in which there are no changes in the structure of the solid. Most ion exchange materials are synthetic plastics consisting of a hydrocarbon network to which are attached a large number of active groups. The development of the hydrocarbon network is now typically formed by copolymerization of styrene and divinylbenzene monomer. An increase in the amount of the cross-link agent decreases solubility, matrix elasticity, and ion mobility, but increases the mechanical strength of the resin.

Today, ion exchange has a significant role in the field of chemical engineering. It is commonly applied in a large number of chemical processes. For example, water treatment is still the largest single industrial application of ion exchange, and at present there is a large and increasing demand not only for softened water, but also for pure or demineralized water. Large amounts of such high quality water are essential to many highly technological industries such as those producing fabricated metal, paper, electronic components, processed foodstuff, pharmaceuticals, and electrical power.

The ion-exchange system of a strongly acidic cation resin was employed in this study. Dowex50-X8, which represents a commercially manufactured resin, is based on a styrene divinyl benzene copolymer that has been sulfated with sulfuric acid; the X8 denotes 8 % divinyl benzene. The resin can adsorb Ca^{2+} ions from an aqueous solution and release in exchange the same number of H^+ ions. For this experiment, a H^+ ion saturated resin in a completely packed column is used for ion-exchange work. When the solution passes through the column, it becomes more dilute in Ca^{2+} and more concentrated in H^+. The exchange of Ca^{2+} ions is not instantaneous since it takes time for Ca^{2+} ions to diffuse from the bulk solution to the surface of the resin and then to positions inside the resin. The exchange rate becomes slower as the Ca^{2+} ion concentration in the resin approaches saturation. Finally, the resin becomes saturated with Ca^{2+} ions and further exchange ceases. The ion exchange process is reversible so that the resin can be regenerated by allowing it to come in contact with a strong hydrochloric acid solution. The previous exchange rate expressions were more complicated. If they weren't, they can't describe exactly true ion-exchange process. In this perspective, a simple expression for the rate of exchange should be developed and used to evaluate the performance of the ion-exchange column. Moreover, although the single ion adsorption has been fully understood, not much been done for the mixed-ion adsorption. So besides investigating the ion-exchange of a single-ion solution with the resin, Ca^{2+}/H^{+}, the ion-exchange of a mixed-ion solution, $Ca^{2+}/Mg^{2+}/H^{+}$, is also studied in order to understand the competitive adsorption between Ca^{2+} and Mg^{2+} ions. In the case of mixed-ion solution exchange with the resin, the desorption of a particular ion will be studied to find the fraction of ions adsorbed onto the resin. The main objectives of this work are (1) to develop a better expression for describing the exchange rate of ions on exchange resins, (2) to evaluate the performance of the ion-exchange column in downflow with fixed-bed operation and compare the results with theoretical predictions and (3) to examine simultaneous adsorption of mixed-ion systems in order to investigate preferential adsorption.