CHAPTER I

INTRODUCTION

Ion exchange, which is a specific type of adsorption, can be defined as a reversible exchange of ions between a solid phase of adsorbent and a solution phase in which there are no changes in the structure of the solid. It is commonly applied in a large number of chemical processes such as water softening and demineralization to produce pure water, catalysis and ion separation.

The ion exchange materials can be divided into two main groups. The first is synthetic plastics consisting of a hydrocarbon network to which a large number of active groups are attached. The development of the hydrocarbon network is now typically formed by copolymerization of styrene and divinylbenzene monomer. Furthermore, adding the amount of the cross-link agent can also be done in order to decrease the solubility of resin etc. The second is natural materials such as clay minerals, zeolite, chitin and chitosan. The latter consists of biopolymers and is mostly found in shells of crustaceans such as shrimp, crabs, and squids. For ion exchange resins, they can be classified into four main groups: strongly acid cation resin, strongly basic anion resin, weakly cation resin, and weakly basic anion resin, all of that depend on the functional groups of the resins.

The ion-exchange process of a strongly acid cation resin (Dowex50-x8) was used in this study. Dowex50-x8, a commercially manufactured resin, is a styrene divinyl benzene copolymer that has been sulfated with sulfuric acid. The 50 represents size-mesh of resin in the range of 50-100 mesh, and x8 represents percent crosslinking or percent of divinyl benzene. The resin can adsorb the metal ions (e.g., $Ca^{2+}$and Mg^{2+}) from an aqueous solution and release the same number of H^+ ions in exchange. In this work, a H^+ ion saturated resin in a completely packed column is used for ion-exchange study. When the metal solution (e.g., Ca^{2+}) 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 active sites inside the resin. The exchange rate becomes slower as the Ca^{2+} ion concentration in the resin approaches equilibrium. Finally, the ion exchange process is ended when the resin becomes saturated with Ca^{2+} ions. This process is reversible so that the resin can be regenerated by a strong hydrochloric acid solution.

The kinetics of ion exchange processes have been extensively studied in the past years. Although the knowledge of single ion adsorption has been fully understood, understanding of adsorption in mixed-ion systems, which occurs in the most of the aqueous streams, has not been fully developed. In addition, there is still a need to develop a simple model to describe mixed-ion adsorption kinetics. Therefore, in the present work we focused our research on the study of the adsorption of metal ions on Dowex50-x8 from single-ion and mixed-ion solutions of $Ca^{2+}/Mg^{2+}/H^{+}$ in both batch and fixed bed operations in order to examine the adsorption kinetics and preferential adsorption in mixed-ion systems. Furthermore, a previously developed mathematical model was modified to better describe the rate of adsorption in the mixed-ion (multicomponent) system.