CHAPTER I
INTRODUCTION

Natural gas is one of the most important energy sources for electricity generation because of its cleanliness, high heating value and inexpensive cost. Furthermore, natural gas is also used as a raw material in petrochemical industry. Natural gas produced from reservoir is unavoidably saturated with water. The water content of a gas depends on pressure, temperature, and the composition of the gas. Water is one of impurity that can cause many problems such as the decrease of catalyst activity or poisoning of catalyst, corrosion, and plugging by hydrate formation in the transportation facilities.

Although there are several techniques for water removal from natural gas, an adsorption process using solid desiccants has been proven to be one of the best alternatives for water vapor removal because of their great drying. Adsorption column packed with a suitable hydrophilic adsorbent is the basic principle of this separation system. Adsorbents with high affinity and capacity for water can be used for selective adsorption of water from natural gas. The amount of adsorbed water per unit of surface area depends on the surface site reactivity of adsorbents. As a result, a high polar surface and a high specific area are the main requirements for an efficient desiccant. The natural gas, chemical, and cryogenic industries use molecular sieve zeolites, silica gel, and activated alumina to dry streams. Alumina and silica gel have the advantages of having higher equilibrium capacity and being more easily regenerated with low level heat. However, the much lower dew point and longer life attainable with 4A molecular sieve make zeolites useful adsorbents where a very low humidity or dew point is required. At present, a multi-layer adsorber has been developed for natural dehydration. It combines optimally the advantages of each adsorbent to improve the adsorption capacity, purification capability, and lifetime of the adsorbent.

Mathematical models are needed to understand the dynamics of adsorbers, thereby controlling and predicting the separation results. In this study, sensitivity analysis was initially performed in order to analyze the existing model. The mathematical model was developed to predict the experimental breakthrough time of water in the multi-layer adsorber, aiming to further predict the lifetime of the adsorbents in the future. The adsorption isotherm of water on each adsorbent was determined on an experimental apparatus set up for this specific case. The isotherm equations were obtained by curve fitting technique using the dynamic adsorption capacity data at different feed concentrations. The theoretical breakthrough curves for adsorption of water vapor from natural gas in a multi-bed adsorber can be obtained by solving the set of mathematical equations. The method of lines (MOLs) with central finite difference approximation and fourth-order Runge-Kutta method were employed to solve the partial differential equations. FORTRAN language was utilized in numerically solving.