CHAPTER I
INTRODUCTION

Natural gas is widely used as a fuel for electricity generation or as a fuel in several industries as well as for the vehicle fuel. There are many contaminants present in the natural gas. Water is one of impurity that causes many problems such as the water freeze-up in the distillation column and transportation facilities, corrosion, and catalyst poisoning. Adsorptive gas separation process is widely used for natural gas dehydration. The process is carried in the fixed-bed adsorbers packed with a suitable hydrophilic adsorbent. There are three types of adsorbents that can be used: silica gel, activated alumina, and molecular sieve zeolites. The selection of a suitable adsorbent for different gas humidity level is very important. Each adsorbent has dominant properties. Molecular sieve zeolites have high affinity and high capacity at low partial pressures or low humidity, but they are usually more expensive. Activated aluminas are the c heapest adsorbents with more robust than zeolites and less sensitive to deactivation by organics, but they are less suitable when applied at a very low humidity stream and required larger tower for a given water loading. The affinity of the silica gel for moisture adsorption is lower than either alumina or the zeolites, but it has good capacity at high relative humidity and relative low regeneration temperature is required.

Nowadays, a multi-layer adsorber has been developed for natural dehydration to provide the combination of adsorbents to optimize the drying or purification process. The concept of a multi-layer adsorber is to combine optimally the advantages of each adsorbent when dealing with water saturated in a feed stream. Silica gel has higher water adsorption capacity at high humidity (such as at adsorber inlet condition), while molecular sieve zeolites display higher water adsorption capacity at relatively low humidity. Since condensed water destroys the bond between the binder and zeolites causing the adsorbent pellets break up into small particles, creating pressure drop problems. Silica gel adsorbs condensed water and acts as a guard bed on the top of the adsorber, improving the lifetime of other co-adsorbents. The remaining water leaving from the silica layer will be further adsorbed by zeolite to achieve the ultra-low humidity specification.

To properly design and optimally operate a fixed-bed adsorption process, the adsorption isotherm and dynamic behavior of the fixed-bed system such as a water breakthrough curve must be understood. So, the main focus of this work was to study the dynamics adsorption of water in the multi-layer adsorber. The adsorber used in this study was constructed and packed in layers with three types of commercial adsorbents. The physical properties of all adsorbents were determined: TGA for the static adsorption capacity determination and XRD for crytallinity scanning. In the scope of adsorption study, adsorption isotherm of water on the multi-layer of adsorbents has been determined on the experimental apparatus. The isotherm equation can be obtained by curve fitting technique using the dynamic adsorption capacity data at different feed concentrations. The factors which affected the characteristic of breakthrough curves, water inlet concentration and contact times were examined. Furthermore, the theoretical simulation breakthrough curve obtained from mathematical modeling was compared with the experimental breakthrough curve. The method of lines (MOL) with central finite difference and Runge-Kutta 4^{th} order method were used to solve the partial differential equation. In addition, FORTRAN language was utilized for numerical solving.