CHAPTER I
INTRODUCTION

The natural gas is an important energy source for the world because it is one of the cleanest, safest, and most useful of all energy sources. Natural gas has the variety complex mixture containing such as hydrocarbons (light, heavy, and aromatics), sulfur-components (H_2S, mercaptanes), carbon dioxide, nitrogen, mercury, and water. However, the final end-product of natural gas is a relatively homogeneous product, so before it reaches the marketplace, separation processes must occur.

Water is one of the mixtures contained in the natural gas stream, and it acts as an impurity because it causes many problems such as catalyst poisoning, corrosion, water freeze-up in the distillation column, and plugging by hydrate formation in the transportation facilities and pipelines. There are many separation techniques to remove water out of the gas stream. An adsorptive separation technique by using solid adsorbents is one of the widely used techniques. This process is ordinary performed in a packed bed column, especially a multi-layer adsorber, which has been developed for this purpose in order to combine the optimal advantages of each adsorbent. There are many types of solid adsorbents that can be used such as alumina, silica gels, molecular sieves and charcoal. Each adsorbent has essential properties, therefore, the adsorbents which have high affinity and capacity for water must be used.

The equilibrium adsorption of water on solid adsorbents is necessarily studied. However, one of the most insidious problems is the loss of adsorption activity along with the adsorption process called deactivation. The deactivation can be traditionally divided into three categories: sintering (aging), coking (fouling), and poisoning. Each one occurs with different factors. The main type of the deactivation of the adsorbents in the adsorber is sintering. Hydrothermal aging is the main problem, causing a decrease in adsorption capacity and resulting in a decrease of active area especially during the regeneration step. When the sieve is exposed to a combination of high temperatures and high humidity that makes the crystal structures gradually and reversibly breakdowns then lose its crystallinity and active adsorption area. Hence, an activated alumina and molecular sieves are suitable in this work because of their prominent properties. For example, activated alumina has high equilibrium capacity, but can easily be regenerated with low heat level. The molecular sieve is recommended for dehydration where liquid-carry over of water in the system is of concern.

This work focused on the study of equilibrium adsorption of water on solid adsorbents and the effect of hydrothermal sintering on the equilibrium isotherms of adsorbents. Also the physical properties of the adsorbents were studied, such as static adsorption capacity by using TGA, the surface structure of adsorbents observed by SEM, surface area measurement by the BET method, and crystallinity scanning by XRD. Next, the adsorption isotherm model was developed for prediction of water adsorption behavior on solid adsorbents with the deactivation. The adsorption isotherm equation can be obtained by curve fitting technique and compared with various adsorption isotherms from literatures, for example, Langmuir, Freundlich, BET, DRK etc., for prediction water adsorption behavior. Then, after the adsorption equation was obtained, the correlation of the isotherms obtained from fresh and deactivated adsorbents was examined. Finally, the equilibrium adsorption isotherms of the fresh and deactivated adsorbents were used in the previously-developed dynamic model for prediction of the breakthrough time of the multi-layer adsorbers packed with various layers of fresh and deactivated adsorbents.