CHAPTER I
INTRODUCTION

The unstable market of petroleum-based fuels and progressively severe environmental regulations have recently accelerated research efforts towards alternative fuels (Arami-Niya *et al.*, 2011). The progress of the international energy demand shows a 1.7% average annual growth in the 2005-2020 period. This growth concerns all energy sources, although petroleum-based fuels will still rule the energy scene for the next 10-15 years. Among all energy sources, natural gas demand will account for the highest growth rate in 2020 (Tagliabue *et al.*, 2009).

Natural gas, composing of 85-95% methane, is one of the alternatives, which is available abundantly in many countries. Also, it is environmentally preferable to liquid fuels because of its cleaner combustion as well as emitting fewer hydrocarbons and 90% less carbon monoxide (Zhang *et al.*, 2010). Nevertheless, it is necessary to find the safe and economical method to facilitate the large scale storage of natural gas. A good proportion of vehicles employ compressed natural gas (CNG) at a very high pressure (3,000-4,500 psi). This implies high manufacturing and filling costs and also represents a safety concern. Liquefied natural gas (LNG) is another storage and transportation technology, which requires large energy for cryogenic cooling of the gas to a very low temperature (-163 °C) (Rahman *et al.*, 2010). Adsorbed natural gas (ANG) is a promising innovative technology, in which natural gas is adsorbed by a porous adsorbent material at a relatively low pressure (500-600 psi) with similar methane capacity as that of compressed natural gas (CNG); thus, improving the safety criteria and considerably reducing the compression costs incurred by traditional storage (Esteves *et al.*, 2008).

At the same pressure, when a natural gas storage vessel is filled with a suitable microporous adsorbent material, the gas capacity will be greater than that of the same vessel without the adsorbent. The use of adsorbed natural gas (ANG) has focused on the development of carbon-based adsorbents, like activated carbons, which could provide high adsorption capacity and delivery (Arami-Niya *et al.*, 2011). The synthesis of inexpensive activated carbons with high specific surface area

and high volumetric storage capacity can be done by using agricultural waste materials, such as walnut shells, coconut shells, cherry stones, olive and peach stones, which contain high carbon and low ash content (Bagheri and Abedi, 2011). The physical characteristics of activated carbons such as BET surface area, micropore volume, packing density, and pore size distribution, significantly affect the amount of methane capacity (Lozano-Castelló *et al.*, 2002). An ideal microporous material must ensure a rapid charge process and deliver a sufficient methane capacity, which is close to 150 v/v (Biloé *et al.*, 2002).

Due to carbon dioxide is also present in natural gas and has higher adsorption property in microporous activated carbon than that of methane (Yang *et al*, 2011). So carbon dioxide decreases the quantity of adsorbed methane on activated carbon that causes to the lower energy density. In this work, the investigation of methane adsorption with the presence of carbon dioxide on the coconut shell activated carbon (CSAC) was studied in a packed bed column. The adsorption kinetics of methane and carbon dioxide were examined at atmospheric pressure and room temperature. The dynamic adsorption of 75 to 85 vol% methane and 5 to 20 vol% carbon dioxide were first carried out in a packed bed column with approximately 5.0 g of the CSAC. The competitive adsorption of the two species on the CSAC was then studied at 10 vol% methane and 10 to 30 vol% carbon dioxide. After that, the comparison of competitive adsorption on different adsorbents including the untreated CSAC, the CSAC treated by sulfuric acid, the CSAC treated by potassium hydroxide, and the untreated palm shell activated carbon (PSAC) were studied at 10 vol% methane and carbon dioxide. Moreover, the 3-cycle adsorption-desorption was used to investigate the adsorbent stability. BET and SEM techniques were used to characterize the adsorbents. The composition of methane and carbon dioxide was determined by gas chromatography.