CHAPTER I
INTRODUCTION

During the last several years, there has been an increasing interest in the production of energy due to the increasing of human's energy demand for developing their living. In today's energy supply system, electricity, gasoline, diesel fuel, and natural gas serve as energy carriers. These carriers are made by the conversion of the primary sources such as petroleum, coal, and nuclear energy, into an easily transported and delivered in usable energy form. Although the energy plays a very important role in the development, it always comes from these non-renewable sources that are considered to be insufficient in the future. Thus, the increasing in the development of renewable energy technologies is obviously observed. Many scientists try to solve the problems about the energy supply, environment protection and regional development. Their main purpose is to optimize the conventional energy and find new source of energy. Lately, from a higher level of the attention in fuel cell which is an alternative technology for power generation, hydrogen may become an important fuel in the future as an energy carrier for electrical vehicles and electric power plants (Comas *et al.*, 2006).

Hydrogen gas is seen as a future energy carrier by virtue of the fact that it is renewable, does not evolve the "greenhouse gas" CO_2 in combustion, liberates large amounts of energy per unit weight in combustion, and is easily converted to electricity by fuel cells. The use of hydrogen in the chemical and petroleum refining industries is of prime importance. Using hydrogen in petroleum refining includes many processes such as hydrocracking, hydrofinishing of lube oils, hydrodealkylation and hydrodesulfurization of petroleum fractions and residues (Matar *et al.*, 1994). In addition, hydrogen can be used as a precursor of some chemicals such as methanol and ammonia. Production of hydrogen can either be done by the transformation of renewable energy sources or fossil fuels. Using fossil fuels which natural gas acts as a main feedstock is a major way to produce hydrogen at present. It gives a large-scale of production.

Methods to produce hydrogen by the conversion of natural gas which methane is commonly used as a feedstock, are reforming process with steam (SRM) or

CO_2 (CRM), partial oxidation process (POX), and autothermal reforming process (ATR). For CO_2 reforming, the proposed technology converts mixtures (CH_4/CO_2) into synthetic gas (CO/H_2) and solid carbon in filamentous form. It does not minimize the formation of solid carbon and use a greenhouse gas to reform as a result of greenhouse effect and carbon formation which reduces the activity of the catalyst. In steam reforming, steam or water is used to react with methane which can decrease carbon formation. Another process for driving the production of hydrogen is partial oxidation, methane is reacted with a limited amount of oxygen that is not enough to completely oxidize hydrocarbons to CO_2 and water. This process is difficult to remove the heat from the reactor with highly exothermic reaction that causes the problem in controlling. But reforming process is an endothermic reaction. All processes have a water gas shift reaction as a side reaction which can help to increase the formation of hydrogen. Among the various processes and primary fuels that have been proposed for hydrogen production, steam reforming of methane becomes an interesting technology because of a higher ratio of hydrogen to CO. It is a very useful process for hydrogen-rich requirement application. About catalysts, because Ni is economical and highly active in steam methane reforming, Ni-based catalysts have been employed (Oh *et al.*, 2003). The support also plays significant role in Ni-based catalysts. For steam methane reforming which the reactions occur at a high temperature, the supports must stable in high temperature too. Thus, zeolite is used as a support due to its thermal stability.

From previous studies, Ni supported on zeolite catalysts were studied in terms of the activity and stability in both steam and dry reforming. It was found that both Ni/KL and Ni/NaY are suitable for both reactions. In this work, Ni supported on ZSM-5 zeolite was applied for steam reforming process for hydrogen production. The effects of Ni loading, promoter addition, and steam-to-methane ratio on the performance of the Ni supported on ZSM-5 zeolite catalysts were investigated. Furthermore, both fresh and spent catalysts were also characterized to comprehend the relation between their structures and their performances. The H_2/CO ratio and coke formation were incorporated in this study.