CHAPTER I
INTRODUCTION

Synthesis gas, primarily a mixture of H_2 and CO, is the starting material for the manufacture of ammonia and its derivatives and methanol, as well as for other-synthesis processes. It is a source for CO component in the manufacture of such chemicals as acetic acid and acrylates, and a source of H_2 for hydrocracking, and hydrodesulfurization in petroleum refining. The production of synthesis gas is currently carried out via steam reforming (Eq.1.1). However, steam reforming has the disadvantages of requires a large amount of energy to drive the reaction, and produces high H_2/CO ratio resulting in poor selectivity for CO which is not suitable for methanol synthesis and Fischer-Tropsch process. The partial oxidation reaction of methane (Eq.1.2) though has several advantages over steam reforming.

$$CH_4 + H_2O \rightarrow CO + 3H_2 \qquad \Delta H_{298} = 206 \text{ kJ/mol} \qquad (1.1)$$

$$2CH_4 + O_2 \rightarrow 2CO + 4H_2 \qquad \Delta H_{298} = -71 \text{ kJ/mol} \qquad (1.2)$$

The major advantage is that this process can produce more desirable H_2/CO ratio. However, this process is exothermic reaction so it is difficult to remove heat from the reactor become hazardous and still coke formation.

Therefore, the CO_2 reforming of the CH_4 is a proposed alternative for synthesis gas production with lower H_2/CO ratio of around 1, which is suitable for production of higher hydrocarbons and oxygenated derivatives. This process converts two of the cheapest carbon-containing gases (CH_4 and CO_2) to useful product (Eq.1.3) due to both CO_2 and CH_4 are abundant materials. CO_2 is a byproduct of many industrial processes. Natural gas contains a large CO_2 content. Landfill gas commonly consists of CH_4 and CO_2. Waste water can produce CH_4 and CO_2.

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2 \qquad \Delta H_{298} = 247 \text{ kJ/mol} \qquad (1.3)$$

However, this process has serious problem of catalyst deactivation by coke formation. Coke originates mainly from two reactions, i.e., methane decomposition ($CH_4 \rightarrow C + 2H_2$) and CO disproportion ($2CO \rightarrow C + CO_2$).

Noble metal-based catalysts were reported to be less sensitive for coking. However, due to the availability and cost of noble metals, nickel-based are often preferred. Ni catalysts are active and commonly used in industries due to its low cost but Ni catalyst can easily induce carbon deposition which is caused of catalyst deactivation and plugging of a reactor tube. Therefore, many researchers have been trying to develop Ni based catalysts to high activity, stability and less carbon deposition. However, the catalyst support has an important influence on catalytic activity as well as on the extent and nature of carbon deposition.

In this work, KL and KH zeolites were selected to use as the catalyst support due to its basicity and contained K might act as the promoter to enhance the catalyst stability. Therefore, Calcium (Ca) and Magnesium (Mg) were selected as the catalyst promoter to improve the catalyst stability because adding basicity could increase the CO_2 adsorbed and resulting in a decrease of the coke formation on the catalyst.