



CHAPTER I INTRODUCTION

In recent years, hydrogen has been widely interesting to major energy producers because it has been found as a clean energy source. Hydrogen can be produced from several resources that contain hydrogen including fossil fuels such as natural gas (mainly CH₄) and coal, and water. There are several processes to produce hydrogen such as steam reforming, partial oxidation, autothermal reforming, gasification, and pyrolysis. Catalytic partial oxidation of methane (CPOM) is considered as an alternative method to produce hydrogen because it is an exothermic reaction, high efficiency, and affording suitable H₂/CO ratio of 2. However, the main problem is the carbon deposition by methane decomposition (CH₄→C+2H₂) and/or CO disproportionation (2CO→C+CO₂), which lead to the catalyst deactivation.

The deposition of carbon occurs over the metallic sites as well as the acid sites of the support at high temperatures. Ni-based catalysts are attractive for partial oxidation reaction due to their low cost but nickel is deactivated easily by carbon deposition and/or its sintering. Therefore, a number of research groups have investigated several means to reduce carbon deposition on Ni-based catalysts. Pengpanich *et al.* (2004) reported that Ni/Ce_{0.75}Zr_{0.25}O₂ mixed oxide catalysts were active and resistant to carbon formation. However, carbon deposition over the Ni/Ce_{0.75}Zr_{0.25}O₂ mixed oxide catalysts was still high. Therefore, they proposed several additives used to suppress the carbon deposition for Ni/Ce_{0.75}Zr_{0.25}O₂ mixed oxide catalysts such as Sn and Nb (Pengpanich *et al.*, 2006 and 2007).

In addition, the incorporation on of MgO as a promoter into the Ni-based catalysts was found to give a high specific surface area, increase basicity for supported catalysts, improve Ni dispersion at high temperatures, and suppress the growth of Ni crystallites after reduction or catalyst sintering leading to high activity and resist to carbon formation (Yejun *et al.*, 2007; Hu and Ruckenstein, 2002).

In this study, NiO-MgO/Ce_{0.75}Zr_{0.25}O₂ mixed oxide catalysts were prepared via the co-precipitation and sequential incipient wetness impregnation methods. The Ni loading was fixed at 15 wt% whereas the MgO loading was varied with 5, 10, and 15 wt% on the supported catalysts. All the catalysts were investigated for their

catalytic activities and inhibition of carbon deposition on methane partial oxidation (MPO) in the temperature range of 400 to 800 °C at atmospheric pressure. The catalysts were characterized by BET surface area measurements, H₂ chemisorption, X-ray diffraction (XRD) analysis, temperature programmed reduction (TPR) and oxidation (TPO) techniques, and scanning electron microscopy (SEM).