CHAPTER I
INTRODUCTION

In recent years, the demand for energy around the world has been markedly increased. As a result, many countries have realized the shortage of fuels in the near future and have tried to increase the use of alternative energy sources in order to cut down the demand of fossil fuels. Among the available fossil fuels, natural gas is currently considered to be an economical and substantially available resource, and it becomes the most interesting alternative fuel for both community and industry. Natural gas is the cleanest energy and the most environmentally safe fuel. Moreover, natural gas is the most crucial source as chemical feedstock for producing many petrochemicals, such as ammonia, methanol, and synthesis gas.

Natural gas typically consists of 70–90 % of methane, 0–20 % of ethane, propane, and butane, and 0–20 % of carbon dioxide. However, the chemical composition of natural gas varies considerably according to the phase present in the reservoir and the reservoir conditions (www.naturalgas.org). It is widely reported that natural gas, with a high concentration of carbon dioxide, has been found in Asia. Hence, the reforming of natural gas with carbon dioxide should be a promising way to directly utilize natural gas. The direct reforming of carbon dioxide-containing natural gas will by-pass any separation processes, which, in turn, results in cutting down the high cost of separation process and reducing the net emission of carbon dioxide.

The reforming of natural gas to more valuable products is a very challenging task, since natural gas is extremely difficult to activate. A number of research works on the natural gas conversion to valuable chemicals and fuels have been investigated extensively. Nevertheless, these studies still encounter two main problems: (1) the conventional catalytic processes require high operation temperatures and pressures because methane, a major component of natural gas, has a very strong C-H bond, and (2) the formation of coke deposition on the catalyst surface commonly occurs (Rueangjitt *et al.*, 2008). Additionally, until now, no efficient supported metal catalyst has been clearly reported.

Recently, non-thermal plasma has been proposed by several studies as an alternative technique to convert natural gas to more valuable products. Because the high energy generated by non-thermal plasma can initiate several chemical reactions, it provides high efficiency and high selectivity for the wide range of chemical processes (Rueangjitt *et al.*, 2008). Among many non-thermal types of plasma available, the gliding arc discharge is a promising choice to use for reforming natural gas. Gliding arc discharge occurs when the plasma is generated between two or more diverging electrodes. The strong points of gliding arc discharge are high-energy efficiency and environmental friendliness. Therefore, it was selected for the natural gas reforming in this research.

In this research, the new technique of combining a steam reforming with partial oxidation of CO_2-containing natural gas in gliding arc discharge plasma was examined. The main objective of this research was to determine the roles of the plasma, as well as steam and O_2 addition, on the CO_2-containing natural gas reforming reaction to produce synthesis gas. The experiments were carried out to investigate the effects of several operating parameters, including hydrocarbons (HCs)/O_2 feed molar ratio, applied voltage, input frequency, and electrode gap distance, on reactant conversions, product selectivities and yields, and power consumptions in the presence of steam addition in natural gas feed. Moreover, the optimum conditions for a maximum synthesis gas production were examined.