CHAPTER I
INTRODUCTION

Natural gas reserves are found in abundant quantities in different parts of the world, which is primarily source of methane. Because methane is not only a low price fuel but also an environmental safe fuel, attempts of converting methane to useful chemicals with alternatives of new technology have been increasingly studied in the last few decades. The most important route of methane utilization is conversion to synthesis gas (syngas) that is a crucially important building block of the chemical industry. Syngas, a combination of carbon monoxide and hydrogen, is used in a variety of petrochemical processes such as methanol or via the so-called Fischer-Tropsch synthesis to liquid hydrocarbon.

The development of methane conversion, though commercial techniques available, still has to be based upon the multi-step reaction process starting with steam reforming that is the reaction between steam and methane. Typically this reaction takes place over catalysts at high temperatures about 425-550 °C. The following reaction is highly endothermic and thus consumes a great deal of energy. (Supat *et.al.*, 2003)

Steam reforming

$$CH_4 + H_2O \longrightarrow CO + 3H_2 \qquad \Delta H_{298K} = 206.2 \text{ kJ / mol}$$

A second route to syngas production is carbon dioxide reforming with methane. This reaction has similar thermodynamic and equilibrium characteristics to the steam reforming process, which is strongly endothermic, but it produces syngas with a lower H_2/CO ratio. The principle difficulty is from the deactivation of the catalyst used because the deposition of carbon under the normal reaction conditions. (Wang *et.al.*, 1996)

Carbon dioxide reforming

$$CH_4 + CO_2 \longrightarrow 2CO + 2H_2 \qquad \Delta H_{298K} = 247 \text{ kJ / mol}$$

Partial oxidation (POX) of methane is another way to produce syngas with a H_2/CO ratio close to 2. This reaction utilizes a small amount of oxygen to give the reaction highly exothermic without the use of catalyst. Because of the following reaction generates heat, the temperature may rise to 1,300-1,400 °C. However the steam reforming produce the most hydrogen-rich syngas product. (Bhatnagar, 1993)

Partial oxidation (POX)

$$CH_4 + 0.5O_2 \longrightarrow CO + 2H_2 \qquad \Delta H_{298K} = -38 \text{ kJ / mol}$$

For the use of plasma chemistry based technologies, the reaction starts with high-temperature equilibrium plasma when the electrons and neutral species have the same kinetic energy, but the power cost of equilibrium plasma process are quite high. When the electron kinetic energies as much higher than the neutral species energies, the plasma is considered to be non-equilibrium. Because of non-equilibrium plasma effectiveness in the activation of methane at a low gas temperature under the atmospheric pressure so it is chosen to convert methane into useful products such as higher hydrocarbons, organic oxygenate liquid and synthesis gas. (Eliasson *et.al.*, 1991).

The main objective of this work was to investigate a multi-stage gliding arc system for partial oxidation of methane to produce valuable products. It was hypothesized that the gliding arc system is more energy efficient than the corona discharge system with pin and plate electrodes.