CHAPTER I
INTRODUCTION

The chemical utilization of natural gas, one of the world's abundant resources, to produce basic chemicals is one of the desirable goals in the current chemical industry. However, because of the chemical inertness of methane, the main constituent of natural gas, the chemical transformation of natural gas directly into useful chemicals as industrial starting materials is a great challenge. The conversion of methane to useful chemicals has attracted much attention in recent years and many methods and technologies have been reported (Bhatnagar, 1993).

One technique that could prove to be a favorable alternative technology is the direct oxidative coupling of methane (OCM) to C_2-hydrocarbons such as ethylene and acetylene. Ethylene is the largest volume building block for manufacturing many petrochemicals. This olefin is used to produce many commercial products such as plastics, resins, fiber, etc. Acetylene is also a commercially important hydrocarbon. It is used in metal working (cutting and welding) and in chemical manufacture.

Abundant literature can be cited to illustrate a number of attempts to develop direct methane conversion processes particularly the partial oxidation of methane and oxidative coupling of methane reactions. Most of these sources indicate that oxygen is required in the reactions to activate methane molecules. These reactions must be operated at very high temperatures where the desired products tend to be far more reactive than the very stable methane molecule. If oxygen is induced in the reaction system, it causes further oxidation of those intermediates, yet desired, to CO_2, H_2O and to lesser extent CO. In order to suppress the deep oxidation reactions and to gain substantial yields from the desired reactions, the introduction of catalysts and the establishment of the proper reaction conditions are required to selectively

convert methane into the desired products. The yields and efficiencies required for a useful process based on thermal/catalytic approaches have not yet been achieved (Thanyachotpaiboon, 1996).

A plasma technique is a promising route to activate methane molecules to form desired products. This technique is already being used to study different possible applications in control of NO_x, SO_x, toxic gases, volatile organic compounds (VOCs), hazardous emissions and for ozone synthesis. The plasma reactors can create either equilibrium or non-equilibrium plasma. Plasma is in equilibrium when the kinetic energy of the charged particles and neutral species are the same. Non-equilibrium plasmas are plasmas in which the electrons have a much higher kinetic energy than the ions and neutral species (Leethochawalit, 1998). These non-equilibrium plasmas can be created at ambient temperatures by discharge systems, such as the corona discharge. The non-thermal corona discharge is usually generated by strong electric fields associated with a small-diameter rod, wire, or needle electrode and a second plate electrode at or near atmospheric pressure. Because the corona is particularly easy to establish, it has had wide application in a variety of processes, including synthesis of chemicals (Lui *et al.*, 1996).

In this study, a corona electric discharge reactor to generate non-equilibrium plasma was employed to carry out the direct oxidative coupling of methane. The reactor was operated at ambient temperature and atmospheric pressure by using a combination of gaseous plasma environment and zeolite catalysts in which ethane was included in the feed along with methane and oxygen in the plasma reactor packed with and without zeolite catalysts. The aim of this work was to determine conversions and product selectivities under studied conditions.