CHAPTER III
EXPERIMENTAL

3.1 Materials

3.1.1 Reactant Gases

Methane (CH_4) with 99.99% purity and air zero grade were obtained from Thai Industry Gas (Public) Co., Ltd. Helium (He) with 99.95% purity, carrier gas, was supplied by Thai Industry Gas (Public) Co., Ltd.

3.2 Experimental Set-up

The schematic diagram of the gliding arc discharge system is shown in Figure 3.1. The system can be classified into 3 sections as follows:

3.2.1 Feed Gases Mixing Section

Reactant gases, methane and air zero, were controlled by a set of mass flow controllers and transducers supplied by SIERRA® Instrument, Inc. The 7-micron stainless steel filters were placed upstream of all mass flow controllers in order to trap any solid particles in the reactant gases. The check valves were also placed downstream of the mass flow controllers to prevent any back flow. All of the reactant gases were well mixed and introduced upward into the first reactor at ambient temperature and atmospheric pressure.

3.2.2 Reaction Section

3.2.2.1 Reactor Units

The schematic diagram of each reactor is illustrated in Figure 3.2. The gliding arc reactors were made of 9 cm OD and 8.5 cm ID glass tubes. Each reactor consists of two diverging knife-shaped electrodes that were made from a stainless steel sheet. The width of each electrode was 12 mm. The gap distance between each electrode pair was adjustable. Two teflon sheets were placed at top and bottom of the electrodes to allow the feed gas for passing through the reaction zone.

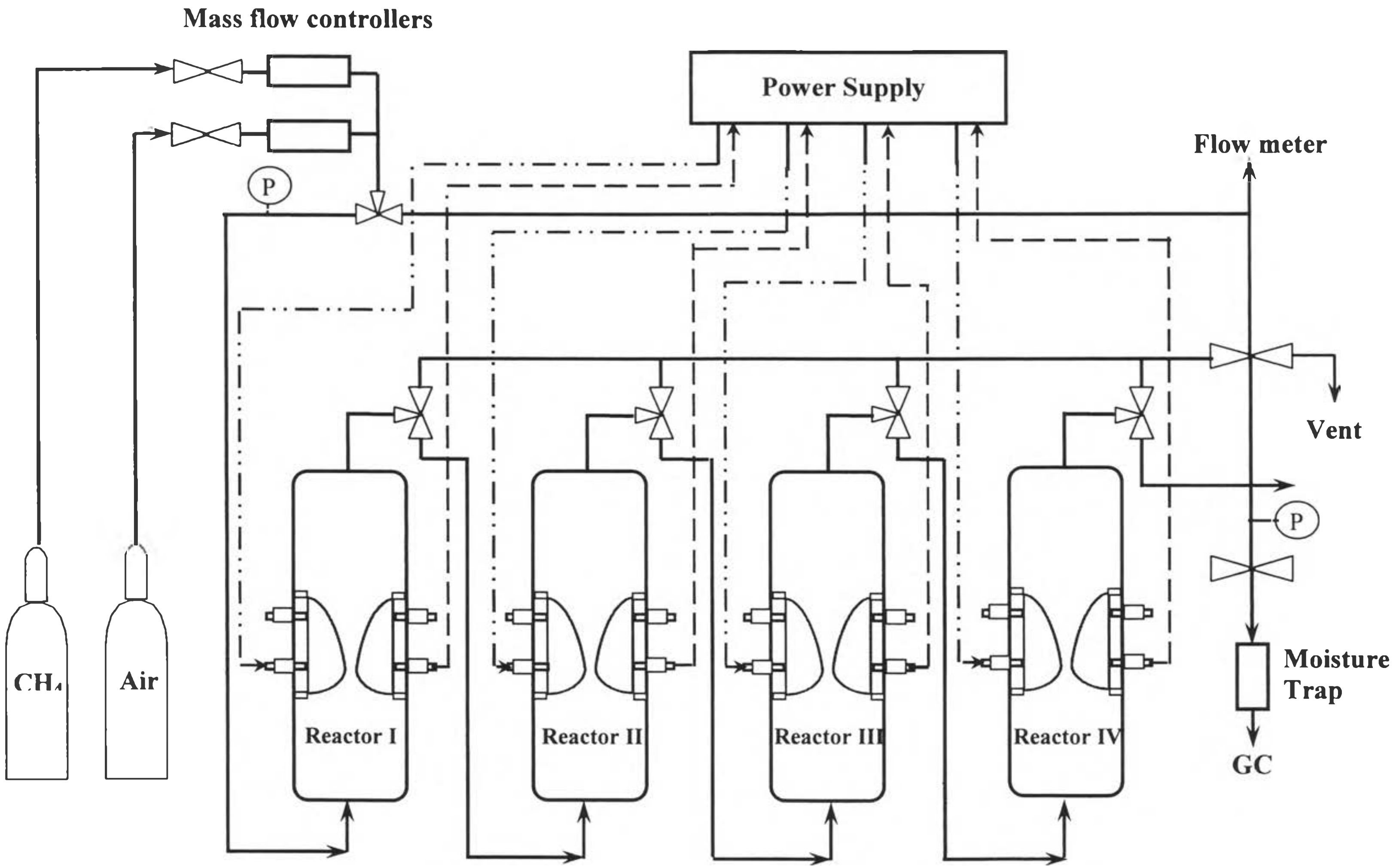

Figure 3.1 The schematic diagram of the gliding arc discharge system.

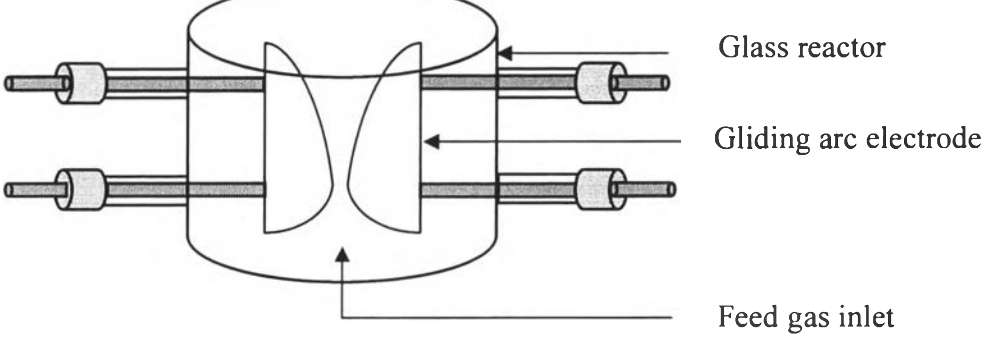

Figure 3.2 Schematic diagram of the reactor.

3.2.2.2 Power Supply Unit

The schematic diagram of the power supply unit is depicted in Figure 3.3. The domestic AC input of 220 Volt, 50 Hz was connected to the DC power supply converter to convert to DC current of 70 Volt. The DC current was supplied through a 500-watt power amplifier, which was connected to the Instek function generator to generate waveform and to amplify voltage and frequency. The signal of alternative current was a sinusoidal waveform. The output passed through the transformer to convert to 230 Volt AC current. Thereafter, the variable output was transmitted to a high voltage current by nominal factor 130 times of low side voltage (input). A Lutron power analyzer was used to measure power, power factor, current, frequency and voltage at the low side voltage of the power supply unit.

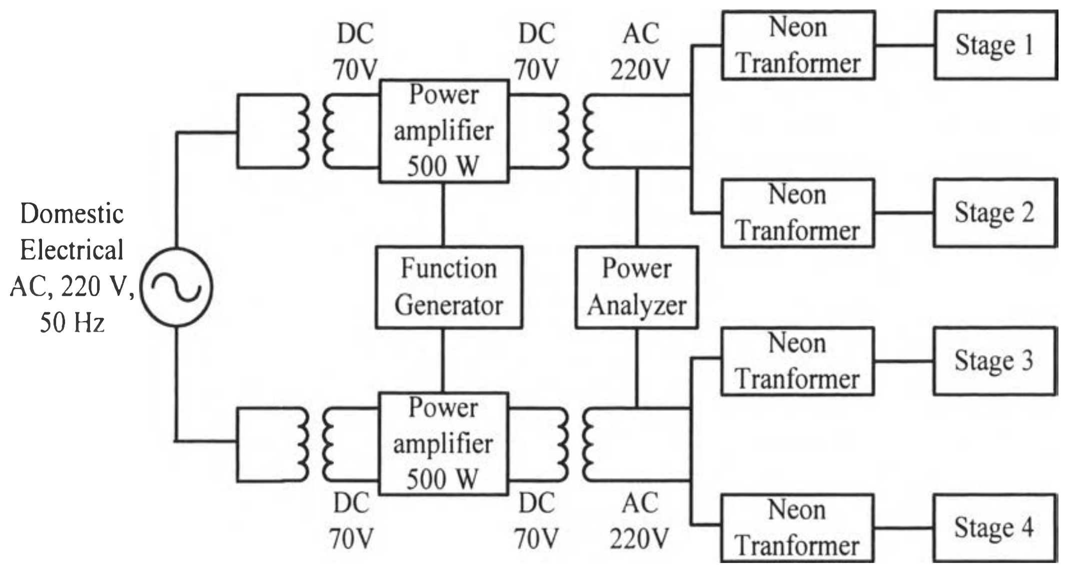

Figure 3.3 Schematic diagram of the power supply unit.

3.2.3 Analytical Section

The feed mixture and the effluent gas were analyzed by an on-line gas chromatograph (HP5890) equipped with a thermal conductivity detector (TCD). The GC conditions were summarized as follows:

Injection temperature:	120 °C
Oven temperature:	50 °C for 5 min, then ramp up at 24 °C /min to 170 °C (hold 2 min for feed mixture analysis, hold for 30 min for effluent analysis)
Carrier gas:	High purity helium
Carrier gas flow rate:	30 ml/min
Column type:	Carboxen 1000 (15'x 1/8") packed column
Detector temperature:	190 °C

3.3 Studied Conditions

A standard ratio of methane and air was set at ratio of 3/4.8 with corresponding to a methane to oxygen ratio of 3/1. After the composition of the feed mixture was constant, the power supply unit was turned on. After 40 min, the composition of the effluent gas was analyzed for every time interval of 40 min until the exhaust gas composition was constant. The plasma reactors were turning off one by one with the fourth one first for study the effect of the stage number of the plasma reactors on the methane conversion and product selectivity.

All parameters studied were summarized in Table 3.1.

Table 3.1 Experimental conditions

Effects	Number of plasma reactor(s)	CH_4:O_2 mole ratio	Gas flow rate (ml/min)	Frequency (Hz)	Voltage (kV)	Gap width (cm)
Plasma	1-4	2:1-5:1	50-300	50-700	15-25	0.4 -1.0