# CHAPTER V
# CONCLUSIONS AND RECOMMEDATIONS

## 5.1 Conclusions

The gliding arc discharge is one of promising technologies for converting methane to useful products. The partial oxidation of methane with air was investigated in the present study. A four-stage gliding arc system in series was set up to investigate the effects of stage number, $CH_4/O_2$ feed molar ratio, total feed flowrate, frequency, applied voltage and gap distance on partial oxidation of methane to produce synthesis gas as well as $C_2$ hydrocarbons. With a higher $CH_4/ O_2$ molar ratio, both $CH_4$ and $O_2$ conversions as well as the selectivities of CO and $CO_2$ increased but the selectivities of $C_2H_2$ and $C_2H_6$ increased. This is because at a higher $CH_4/ O_2$ molar ratio, there are more methane molecules available than oxygen resulting in promoting the dimerization or the oxidative coupling reaction of methane as compared to the partial oxidation reaction. The $CH_4$ and $O_2$ conversions decreased with increasing feed flowrate because of decreasing residence time. With a higher frequency, the $CH_4$ and $O_2$ conversions decreased since current decreased resulting to having less electrons generated to initiate the reactions. The $CH_4$ and $O_2$ conversions increased with increasing voltage since the current is increased leading to increasing the probability of collision between $CH_4$ and $O_2$ molecules with electrons. The selectivities of $C_2H_4$ and $C_2H_6$ decreased with increasing voltage. $C_2H_6$ was found as primary products from the oxidative coupling reaction of $CH_4$. At a higher voltage or a lower frequency, $C_2H_6$ is further dehydrogenated to form $C_2H_4$ and then $C_2H_2$ or oxidized to form carbon oxides. With increasing gap distance corresponding to increasing residence time, both $CH_4$ and $O_2$ conversions as well as $CO_2$ and $C_2H_2$ selectivities increased. For any given residence time, both $CH_4$ and $O_2$ conversions increased significantly with increasing stage number while the power consumption decreased. The optimum conditions of the gliding arc system were found at a $CH_4/ O_2$ molar ratio of 3/1, a feed flowrate of 150 $cm^3$/min and a frequency of 300 Hz for the maximum $CH_4$ and $O_2$ conversions and high synthesis gas production with very low power consumption.

## 5.2 Recommendations

The partial oxidation of methane should be studied by using the gliding arc plasma system with catalyst to produce either synthesis gas or $C_2$ hydrocarbons. Other reaction including steam reforming, carbon dioxide reforming, autothermal reaction and VOCs decomposition should be investigated both with and without catalyst.