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APPENDICES

APPENDIX A

Experimental Data

Table A.1 Methane conversion, carbon dioxide conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 80% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	Product Selectivities (%)						Carbon dioxide Conversion (%)
		acetylene	ethylene	ethane	CO	methanol	H2	
5,500	16.00	0.23	0.20	23.11	76.41	0.05	1.72	9.04
6,600	24.34	0.11	0.14	12.69	87.00	0.06	1.07	14.00
7,700	30.21	0.24	0.09	17.16	82.43	0.09	7.34	17.75

Table A.2 Methane conversion, carbon dioxide conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 80% helium concentration and space time of 6 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity						Carbon Dioxide Conversion (%)
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen	
5,500	24.24	0.46	3.75	17.51	78.21	0.07	2.35	14.55
6,600	33.66	0.20	0.09	17.94	81.70	0.07	7.35	18.49
7,700	39.14	0.18	0.07	15.04	84.65	0.06	11.01	22.50

Table A.3 Methane conversion, carbon dioxide conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:2 , 80% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity						Carbon Dioxide Conversion (%)
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen	
5,500	21.86	0.62	0.44	65.06	33.86	0.02	9.16	15.58
6,600	25.22	1.11	0.38	66.89	31.59	0.03	9.62	16.00
7,700	29.49	0.63	0.29	65.11	33.93	0.04	12.04	20.57

Table A.4 Methane conversion, carbon dioxide conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:2 , 80% helium concentration and space time of 6 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity						Carbon Dioxide Conversion (%)
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen	
5,500	29.40	0.79	0.34	65.94	32.90	0.03	12.20	22.88
6,600	37.68	0.41	0.26	65.75	33.55	0.03	14.73	25.77
7,700	41.17	0.33	0.29	63.08	36.27	0.03	16.46	29.19

Table A.5 Methane conversion, carbon dioxide conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 2:1 , 80% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity						Carbon Dioxide Conversion (%)
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen	
5,500	28.33	0.19	0.22	65.33	34.24	0.026	13.72	12.87
6,600	34.42	0.32	0.31	33.70	65.63	0.046	16.46	14.73
7,700	39.64	0.22	0.21	31.41	68.11	0.049	19.67	18.18

Table A.6 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 0:1 , 80% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
7,700	14.87	0.58	0.72	98.70	0.00	0.00	3.83

Table A.7 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 50% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	6.07	0.69	0.65	68.92	29.65	0.08	2.33
6,600	14.79	0.48	0.41	67.96	31.08	0.07	4.85
7,700	17.94	0.52	0.47	68.16	30.78	0.07	6.55

Table A.8 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 50% helium concentration and space time of 6 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	14.83	0.26	0.29	64.36	35.00	0.08	5.12
6,600	22.08	0.33	0.14	61.97	37.50	0.06	7.93
7,700	25.21	0.11	0.14	63.21	36.47	0.07	9.70

Table A.9 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 50% helium concentration and space time of 8 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	12.13	0.41	0.38	52.40	46.72	0.09	4.36
6,600	24.49	0.05	71.28	18.53	10.12	0.02	7.98
7,700	26.49	0.17	0.17	61.41	38.18	0.07	19.96

Table A.10 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 20% helium concentration and space time of 4 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	0.25	5.94	4.46	89.58	0.00	0.03	0.02
6,600	3.20	1.07	1.28	69.50	28.06	0.09	1.15
7,700	9.87	1.15	1.03	64.39	33.35	0.09	3.37

Table A.11 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , 20% helium concentration and space time of 6 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	0.94	5.36	3.08	91.56	0.00	0.00	0.28
6,600	3.98	0.74	0.67	60.09	38.38	0.11	1.92
7,700	16.86	0.46	0.46	59.43	39.58	0.08	5.24

Table A.12 Methane conversion and product selectivities at different voltage (CO_2 : CH_4 ratio of 1:1 , free helium in feed and space time of 6 minutes)

Voltage (V)	Methane Conversion (%)	%selectivity					
		Acetylene	Ethylene	Ethane	CO	Methanol	Hydrogen
5,500	0.38	7.03	1.42	91.55	0.00	0.00	0.02
6,600	0.32	18.58	18.69	62.73	0.00	0.00	0.06
7,700	6.61	0.30	0.27	64.21	35.12	0.10	2.28

APPENDIX B

Calculation Procedures

To facilitate the calculations, some valid assumptions were made as follows:

1) All the gaseous behaviors obey the ideal gas law.
2) Pressure drop across the system is very small and can be negligible.
3) The pressure in the system equals atmospheric pressure (1 atm.)
4) The temperature change due to the reactions is very small and can be negligible. All experiments are assumed to be carried out at the ambient temperature.
5) The flow rate change across the reactor due to the variation in the gaseous compositions during the reaction time is very small and is assumed to be negligible.

The total molar flow rate of the gaseous stream can be calculated from the following equation:

$$N = \left(\frac{P}{RT}\right) \times q$$

where

P = Total pressure of the system (i.e., 1 atm)

q = Total volumetric flow rate (determined by using soap bubble meter)

R = Gas constant

T = Absolute ambient temperature (K)

With this, the molar flow rate of each component can also be determined by multiplying its percent volume derived from the GC analysis with the total molar flow rate.

The conversion is defined generally as:

$$\%Conversion = \left(\frac{\text{Mole reactant In} - \text{Mole reactant Out}}{\text{Mole reactant In}} \right) \times 100$$

Since there are two reactant, consisted of carbon atom in each molecule, so the percent selectivity of each hydrocarbon product is defined on the basis of the amount of carbon produced in each product relative with total carbon produced . The hydrocarbon product selectivity was defined as follows,

$$\% \text{ C2 Selectivity} = 2 \times \left(\frac{C_2 \text{ produced}}{\text{Total Carbon Occured}} \right) \times 100$$

$$\% \text{ CO Selectivity} = \left(\frac{\text{CO produced}}{\text{Total Carbon Occured}} \right) \times 100$$

$$\% \text{ } CH_3OH \text{ Selectivity} = \left(\frac{CH_3OH \text{ produced}}{\text{Total Carbon Occured}} \right) \times 100$$

Whereas ;

$$\% \text{ } H_2 \text{ Selectivity} = \left(\frac{H_2 \text{ produced}}{CH_4 \text{ Reacted}} \right) \times 100$$

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