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**APPENDICES**  
**APPENDIX A**  
**ASSUMPTIONS, DEFINITIONS AND CALCULATION**

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 temperature.
5. The flow rate change across the reactor due to the variation in the gaseous composition 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:

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

Where  $q$  = total volumetric flow rate (determine by using soap bubble meter)

$P$  = total pressure of the system (1atm)

$R$  = gas constant (82.051 atm.ml.mol<sup>-1</sup>.min<sup>-1</sup>.K<sup>-1</sup>)

$T$  = 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 generally defined as:

$$\% \text{ Conversion} = \frac{(\text{Mole reactant in} - \text{Mole reactant out})}{\text{Mole reactant in}} \times 100$$

The selectivity of each product is, however, strictly defined on the basis of the amount of carbon converted from the reactant into any specified products. In this case, the product selectivity is defined as follows:

$$\% C_P \text{ Selectivity} = \frac{P \times \text{Mole of } C_P \text{ produced}}{R \times \text{Mole of } C_R \text{ converted}} \times 100$$

where P = number of carbon atom in product

R = number of carbon atom in reactant

$C_P$  = product that has carbon P atom

$C_R$  = reactant that has carbon R atom

**APPENDIX B**  
**EXPERIMENTAL DATA**

**1. The absence of catalyst system**

**1.1 Ethane partial pressure**

**Table B.1** Ethane partial pressure on partial pressure of effluent gases at total flow rate 100 ml/min, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Ethane partial pressure(atm)	Partial pressure (atm)						
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>
0.00		0.1270	0.3542	0.1175	0.1940	0.0143	0.0132
0.04	0.0038	0.1390	0.4034	0.1378	0.2397	0.0235	0.0167
0.08	0.0133	0.1219	0.3968	0.1404	0.2456	0.0290	0.0196
0.11	0.0221	0.1240	0.4020	0.1295	0.2342	0.0320	0.0185
0.14	0.0504	0.1231	0.4104	0.1418	0.2430	0.0480	0.0253

**Table B.2** Ethane partial pressure on conversions and yield at total flow rate 100 ml/min, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Ethane partial pressure(atm)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
0.00		54.82	36.93	10.16
0.04	90.65	54.71	35.01	11.43
0.08	83.63	59.33	35.41	12.52
0.11	76.02	57.26	31.37	13.11
0.14	67.10	59.11	31.88	16.14

**Table B.3** Ethane partial pressure on product selectivities at total flow rate 100 ml/min, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Ethane partial pressure(atm)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
0.00	56.63	46.77	13.83	12.68	0
0.04	47.27	43.91	16.09	11.45	0
0.08	39.65	38.39	16.41	11.09	0
0.11	39.97	40.52	19.75	11.42	0
0.14	35.64	35.07	24.12	12.76	0

### 1.2 Flow rate

**Table B.4** Flow rate on partial pressure of effluent gases at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Flow rate (ml/min)	Partial pressure (atm)						
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>
50	0.0322	0.0781	0.3301	0.1805	0.3042	0.0484	0.0281
75	0.0442	0.0880	0.3465	0.1727	0.3381	0.0381	0.0353
100	0.0504	0.1231	0.4104	0.1418	0.2430	0.0480	0.0254
125	0.0531	0.1331	0.4305	0.1269	0.2215	0.0232	0.0209

**Table B.5** Flow rate on conversions and yield at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Flow rate (ml/min)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
50	78.09	73.49	44.39	17.42
75	71.13	70.68	43.15	16.03
100	67.10	59.11	31.88	16.14
125	65.29	55.37	29.56	9.63

**Table B.6** Flow rate on product selectivities at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and frequency 400 Hz

Flow rate (ml/min)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
50	36.59	34.90	19.61	11.39	0
75	35.90	39.65	15.83	14.69	0
100	35.64	35.07	24.12	12.76	0
125	33.35	33.52	12.20	11.01	0

### 1.3 Frequency

**Table B.7** Frequency on partial pressure of effluent gases at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	Partial pressure (atm)						
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>
400	0.0322	0.0781	0.3301	0.1805	0.3042	0.0484	0.0281
500	0.0411	0.1075	0.3391	0.1483	0.2958	0.0331	0.0391
600	0.0596	0.1223	0.3651	0.1247	0.2842	0.0178	0.0495
700	0.0710	0.1544	0.3858	0.1034	0.2641	0.0199	0.0442

**Table B.8** Frequency on conversions and yield at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
400	78.09	73.49	44.39	17.42
500	72.85	63.70	44.38	15.83
600	60.99	59.07	40.39	14.67
700	52.80	48.26	37.05	14.04

**Table B.9** Frequency on current at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	Current (A)
400	0.86
500	0.84
600	0.77
700	0.74



**Table B.10** Frequency on product selectivities at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
400	36.59	34.90	19.61	11.93	0
500	30.20	33.93	13.49	15.93	0
600	28.75	36.70	8.23	22.83	0
700	26.80	38.16	10.31	22.93	0

#### 1.4 Applied Voltage

**Table B.11** Voltage on partial pressure of effluent gases at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	Partial pressure (atm)						
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>
5,500	0.0757	0.1593	0.3938	0.1005	0.2550	0.0149	0.0439
6,000	0.0668	0.1414	0.3478	0.1233	0.2922	0.0149	0.0498
7,000	0.0538	0.1252	0.3419	0.1338	0.2869	0.0293	0.0413
8,000	0.0411	0.1075	0.3391	0.1483	0.2958	0.0331	0.0391

**Table B.12** Voltage on conversions and yield at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
5,500	50.44	46.21	35.56	12.82
6,000	56.63	53.35	43.16	14.07
7,000	64.51	57.81	43.03	15.63
8,000	72.85	63.70	44.38	15.83

**Table B.13** Voltage on current at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	Current (A)
5,500	0.60
6,000	0.66
7,000	0.72
8,000	0.84

**Table B.14** Voltage on product selectivities at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
5,500	27.08	38.31	8.00	23.64	0
6,000	28.13	36.99	6.79	22.72	0
7,000	29.46	35.41	12.92	18.19	0
8,000	30.20	33.93	13.49	15.93	0

## 2 The presence of catalyst system

### 2.1 Frequency

**Table B.15** Frequency on partial pressure of effluent gases at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	Partial pressure (atm)							
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
400	0.0632	0.0059	0.2966	0.1681	0.2966	0.0653	0.0340	0.0342
500	0.0704	0.0081	0.3255	0.1507	0.2650	0.0792	0.0262	0.0443
600	0.0876	0.0016	0.3229	0.1196	0.2614	0.0785	0.0158	0.0724
700	0.1186	0.0181	0.4063	0.0528	0.1914	0.0680	0.0088	0.0568

**Table B.16** Frequency on conversions and yield at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
400	56.72	98.03	51.52	21.98
500	51.20	97.05	48.06	23.04
600	41.30	99.46	47.34	20.69
700	22.42	93.82	32.45	16.92

**Table B.17** Frequency on current at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	Current (A)
400	0.86
500	0.79
600	0.73
700	0.69

**Table B.18** Frequency on product selectivities at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, applied voltage 8,000 V and total flow rate 50 ml/min

Frequency (Hz)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
400	34.98	33.76	27.18	14.14	7.12
500	34.72	33.44	35.30	11.67	9.87
600	28.91	34.16	37.96	7.66	17.51
700	20.03	38.81	51.53	6.68	21.54

## 2.2 Applied Voltage

**Table B.19** Voltage on partial pressure of effluent gases at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	Partial pressure (atm)							
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
5,500	0.1228	0.0214	0.3933	0.0463	0.1956	0.0634	0.0007	0.0695
6,000	0.0859	0.0006	0.3835	0.1324	0.2223	0.0757	0.0032	0.0291
7,000	0.0805	0.0004	0.2894	0.1715	0.2941	0.0868	0.0053	0.0545
8,000	0.0704	0.0081	0.3255	0.1507	0.2650	0.0792	0.0262	0.0443

**Table B.20** Voltage on conversions and yield at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	% Conversion			% C <sub>2</sub> Yield
	C <sub>2</sub> H <sub>6</sub>	O <sub>2</sub>	CH <sub>4</sub>	
5,500	17.58	92.74	35.81	14.08
6,000	40.25	99.81	37.97	17.42
7,000	47.97	99.87	53.09	19.89
8,000	51.20	97.05	48.06	23.04

**Table B.21** Voltage on current at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	Current (A)
5,500	0.56
6,000	0.59
7,000	0.70
8,000	0.79

**Table B.22** Voltage on product selectivities at methane, oxygen and ethane ratio 4:2:1, gap width 1.3 cm, frequency 500 Hz and total flow rate 50 ml/min

Voltage (Volt)	% Product selectivity				
	CO	H <sub>2</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	CO <sub>2</sub>
5,500	17.04	37.79	46.66	0.52	25.57
6,000	37.76	34.56	43.22	1.8	8.29
7,000	36.03	33.51	36.48	2.23	11.45
8,000	34.72	33.44	35.30	11.67	9.87

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