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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. 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:

$$N = q\,(P/RT)$$

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

   P = total Pressure of the system (1 atm)

   R = gas constant   (82.051 atm.ml.mol^{-1}.min^{-1}.K^{-1})

   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 toal molar flow rate.

The conversion is generally defined as:

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

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

Table B.1   Pure methane system at constant voltage of 5,625 V

Flow rate (ml/min)	Conv. (%)	% Selectivity					
		Ethane	Propane	Butane	Ethylene	Acetylene	Propylene
20	7.752	43.927	12.457	6.214	4.335	3.294	0.600
40	3.952	43.758	11.550	8.660	6.591	4.404	1.184
60	3.090	41.806	9.750	8.932	7.495	4.657	1.427
70	2.607	39.276	7.520	7.455	10.989	2.931	0.985

Table B.2   Pure methane system at constant voltage of 6,250 V

Flow rate (ml/min)	Conv. (%)	% Selectivity					
		Ethane	Propane	Butane	Ethylene	Acetylene	Propylene
30	6.554	42.895	13.413	8.180	4.909	4.087	0.691
40	5.415	40.771	12.524	7.684	5.232	4.053	0.738
60	3.349	47.557	10.026	6.421	7.559	4.364	0.968
80	2.879	40.462	9.189	5.464	8.349	4.741	1.206

Table B.3   Pure methane system at constant flow rate of 40 ml/min

Voltage (V)	Conv. (%)	% Selectivity					
		Ethane	Propane	Butane	Ethylene	Acetylene	Propylene
4,625	1.512	43.086	10.197	5.808	11.458	5.571	0.000
5,125	2.834	42.897	10.580	7.117	8.780	5.356	1.133
5,625	3.952	43.758	11.550	8.660	6.591	4.404	1.184
6,250	5.415	40.771	12.524	7.684	5.232	4.053	0.738

Table B.4   Methane-ethane system at constant voltage of 5,625 V and at flow rate of 40 ml/min

Ratio	%met.	%eth.	% Selectivity compared with ethane					
M:E	conv.	conv.	Propane	Butane	Ethylene	Acetylene	Propylene	Butene
9:1	2.634	13.190	31.139	17.059	19.953	11.553	3.483	0.000
7:3	3.998	5.735	29.331	16.228	24.444	13.879	3.049	0.000
1:1	5.602	2.606	40.192	33.507	43.998	22.232	4.737	8.505
1:9	10.523	2.140	11.402	18.631	28.682	9.830	1.605	7.789

Table B.5   Methane-ethane system at M:E ratio of 8:2 at constant voltage of 5,625 V

Flow rate	% met.	% eth.	% Selectivity compared witih ethane				
(ml/min)	conv.	conv.	Propane	Butane	Ethylene	Acetylene	Propylene
20	7.052	2.691	202.577	93.225	87.058	67.250	15.933
40	1.662	12.055	19.382	9.999	13.608	8.613	1.961
60	1.585	7.287	20.203	13.155	18.746	9.575	2.988
80	1.388	3.040	35.470	25.380	39.323	19.736	3.886

Table B.6   Methane-ethane system at M:E ratio of 2:8 at constant voltage of 5,625 V

Flow rate	%met.	%eth.	% Selectivity compared with ethane					
	conv.	conv.	Propane	Butane	Ethylene	Acetylene	Propylene	Butene
20	4.648	5.460	16.338	19.434	23.093	10.477	2.032	14.370
25	3.170	5.161	14.651	16.770	24.490	9.707	1.733	13.396
30	1.070	4.703	13.674	16.553	20.826	8.984	1.771	13.785
40	-	3.814	12.437	15.662	22.578	9.533	1.966	13.359

Table B.7   Pure ethane system at constant voltage of 5,625 V

Flow rate	Conv. (%)	% Selectivity						
		Meth.	Propane	Butane	Ethylene	Acetylene	Propylene	Butene
20	7.675	7.404	9.293	13.404	16.384	7.022	1.143	9.741
25	5.131	8.513	10.543	12.665	19.295	7.522	1.000	8.794
30	3.813	7.965	10.348	11.952	21.963	7.742	1.215	7.920

Table B.8   Methane-propane system at constnat voltage of 5,625 V and at flow rate of 40 ml/min

Ratio M:P	% met. conv.	% prop. conv.	% Selectivity compared with propane			
			Ethane	Ethylene	Acetylene	Propylene
50:50	-	3.162	9.427	12.574	4.354	17.837
70:30	1.513	5.680	15.024	14.123	6.028	16.922
83:17	1.956	8.126	25.728	15.930	8.224	15.160
92:08	2.278	15.373	33.259	14.300	8.353	9.036

Table B.9   Methane-propane system at constant voltage of 6,250 V and at flow rate of 40 ml/min

Ratio M:P	%met. conv.	%prop. conv.	% Selectivity compared with propane					
			Ethane	Butane	Ethylene	Acetylene	Propylene	Butene
8:2	2.599	10.990	24.529	12.352	12.923	7.54	12.378	14.541
7:3	2.771	7.858	15.814	10.318	12.716	6.559	15.666	11.340
1:1	1.295	4.769	11.132	7.465	14.291	5.845	19.023	7.875

Table B.10   Methane-propane system at M:P ratio of 9:1 at constant voltage of 5,625 V

Flow rate (ml/min)	% met. conv.	% prop. conv.	% Selectivity compared with propane			
			Ethane	Ethylene	Acetylene	Propylene
50	2.102	14.464	27.212	12.585	6.639	8.628
60	1.590	12.802	23.116	12.797	6.160	9.342
70	1.222	10.495	26.251	13.319	6.072	9.993
80	0.851	9.925	26.406	13.579	5.144	9.254

Table B.11   Methane-propane system at M:P ratio of 65:35 at constant voltage of 5,625 V

Flow rate (ml/min)	% met. conv.	% prop. conv.	% Selectivity compared with propane			
			Ethane	Ethylene	Acetylene	Propylene
40	1.606	6.603	12.737	11.330	5.522	13.795
50	1.273	4.773	12.349	12.802	6.204	15.719
60	1.069	3.361	15.831	15.887	6.992	20.676
70	0.972	2.166	15.227	18.824	7.485	26.151

Table B.12   Pure propane system at constant voltage of 5,625 V

Flow rate (ml/min)	Conv. (%)	% Selectivity				
		Methane	Ethane	Ethylene	Acetylene	Propylene
20	1.680	5.380	5.074	11.443	3.462	9.845
25	1.180	3.639	5.816	11.735	3.258	10.345
30	0.884	-	6.348	13.254	2.642	11.311
40	0.000	-	-	-	-	-

Table B.13 Pure propane system at constant voltage of 6,250 V

Flow rate	Conv. (%)	% Selectivity						
		Meth.	Ethane	Butane	Ethylene	Acetylene	Propylene	Butene
23	5.033	4.646	5.524	2.974	10.750	4.267	12.820	3.622
30	3.368	5.166	5.379	3.650	11.162	4.241	13.731	3.457
40	2.834	5.023	5.179	3.499	11.252	4.118	13.257	3.155

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