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APPENDICES

Appendix A Physical properties of chemicals.

Component	M.W.	density	M.P.	B.P.	Vap press.	Kinetic diameter	Ignition temp.
	g/mol	g/cm ³	°C	°C	mmHg at 20°C	Å	°C
Toluene	92.14	0.87	-95	110.6	21.76	5	535
Benzene	78.11	0.88	5.5	80.1	75.77	4.8	555
O-Xylene	106.17	0.88	-25	144.4	5.03	5.6	465
M-Xylene	106.17	0.86	-48	139	6.00	5.5	525
P-Xylene	106.17	0.86	13	138.4	6.53	5.4	525
Ethylbenzene	106.17	0.87	-95	136	3.68	5.6	430
Tetraethoxysilane (TEOS)	208.33	0.933	-86	168	1.50	8.9	230
ammonia	17	-	-	-	-	2.4	-
pyridine	79.1	0.98	-42	115	15.00	5.1	550
4-methylquinoline (4-MQ)	143.2	1.063	-	259	-	7.3	-

Appendix B GC conditions and raw data.

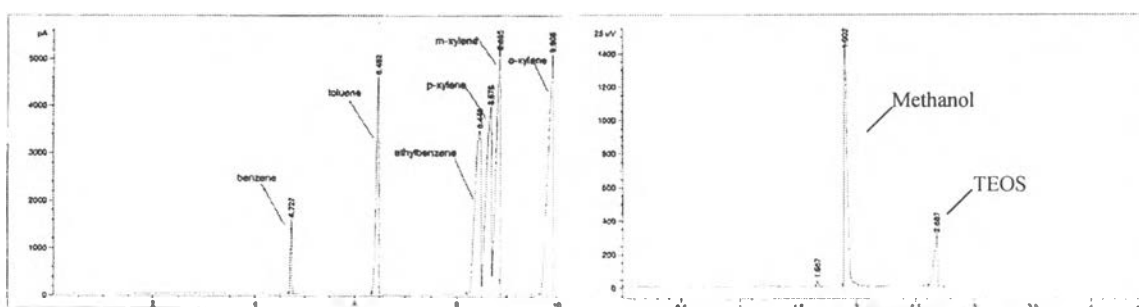
1. GC conditions

1.1. Toluene Disproportionation Reaction

Column	:	DBWAX 30 m length I.D. 0.25 mm
Inlet Temperature	:	250 °C
Oven Temperature	:	Temperature programmed 50 °C hold for 2 min then ramp with rate 5°C/min to 90 °C and hold for 0.5 min
Detector Temperature	:	300 °C
Detector Type	:	FID
He Flowrate	:	1 ml/min (constant flow)
Split Ratio	:	100 : 1

1.2. Chemical Vapor Deposition (CVD) of TEOS

Column	:	DBWAX 30 m length I.D. 0.25 mm
Inlet Temperature	:	250 °C
Oven Temperature	:	100 °C
Detector Temperature	:	300 °C
Detector Type	:	TCD
He Flowrate	:	1 ml/min (constant flow)
Split Ratio	:	100 : 1



Toluene Disproportionation

Chemical Vapor Deposition

2. Constructing Calibration of Aromatic Compounds

From

$$f_i = \frac{A_{std} * G_i * f_{std}}{A_i * G_{std}}$$

and

$$m_i = \frac{f_i * A_i}{\sum f_i * A_i}$$

When

f_i = response factor of component

f_{std} = response factor of standard component

A_i = GC peak area of component

A_{std} = GC peak area of standard component

G_i = mass of component

G_{std} = mass of standard component

m_i = unknown mass of component

We set $f_{std} = 1$ and use toluene as a standard component

component	f_i
Benzene	1.0951
Toluene	1
P-xylene	1.007
M-xylene	0.9949
O-xylene	1.0246
Ethylbenzene	0.9951

3. Raw Data obtained from Toluene Disproportionation Reaction

Toluene conversion

Toluene conversion (%) = 100 – mol% of toluene in product

Para-selectivity

Para-selectivity (%) = (mol% of p-xylene / mol% of total xylene) x 100

B/X ratio

B/X ratio = mol% of benzene / mol% of total xylene

Zeolite	SiO ₂ /Al ₂ O ₃	Temp (oC)	Time (min)	mol%						conv. (%)	p-sel. (%)	B/X ratio
				benzene	toluene	p-xylene	m-xylene	o-xylene	total			
Com. H-ZSM-5	25	400	4	9.37	83.5	3.93	2.55	0.62	100	16.46	55.33	1.32
			19	2.68	94.9	1.7	0.56	0.13	100	5.07	71.13	1.12
			34	1.22	97.7	0.86	0.19	0.04	100	2.31	78.90	1.12
			49	1.12	97.9	0.79	0.18	0.04	100	2.13	78.22	1.11
			64	1.07	98.0	0.75	0.16	0.04	100	2.02	78.95	1.13
Com. H-ZSM-5	25	500	4	16.71	70.9	6.91	3.11	2.36	100	29.09	55.84	1.35
			19	1.01	98.2	0.71	0.09	0	100	1.81	88.75	1.26
			34	0.95	98.3	0.72	0.07	0	100	1.74	91.14	1.20
			49	1.54	97.3	1.07	0.12	0	100	2.73	89.92	1.29
			64	0.81	98.5	0.59	0.06	0	100	1.46	90.77	1.25
Syn. H-ZSM-5	25	400	4	13.73	76.4	2.60	5.91	1.36	100	23.60	26.37	1.39
			19	3.72	93.2	1.15	1.93	0	100	6.80	37.39	1.21
			34	1.91	96.5	0.62	1.01	0	100	3.54	38.13	1.17
			49	1.97	96.4	0.62	1.02	0	100	3.61	37.63	1.20
			64	2.37	95.6	0.76	1.02	0.24	100	4.40	37.59	1.17
Syn. H-ZSM-5	25	500	4	20.40	63.7	4.90	6.45	4.58	100	36.33	30.76	1.28
			19	2.32	95.8	0.76	1.14	0	100	4.22	40.15	1.22
			34	1.39	97.5	0.46	0.69	0	100	2.54	40.32	1.21
			49	1.34	97.6	0.44	0.65	0	100	2.43	40.48	1.23
			64	1.35	97.5	0.47	0.67	0	100	2.49	41.17	1.19
Syn. H-ZSM-5	50	500	4	11.26	80.4	2.58	3.21	2.55	100	19.60	30.94	1.35
			19	1.47	97.3	0.48	0.53	0.20	100	2.68	39.67	1.21
			34	1.32	97.6	0.46	0.52	0.15	100	2.45	40.90	1.17
			49	1.28	97.7	0.43	0.46	0.18	100	2.35	40.19	1.20
			64	1.28	97.7	0.43	0.46	0.18	100	2.35	40.19	1.20
Syn. H-ZSM-5	100	500	4	3.63	93.8	0.77	1.20	0.60	100	6.20	30.10	1.41
			19	0.98	98.2	0.34	0.46	0	100	1.79	42.36	1.22
			34	0.74	98.7	0.26	0.35	0	100	1.35	42.17	1.22
			49	0.70	98.7	0.25	0.33	0	100	1.28	42.31	1.21
			64	0.70	98.7	0.25	0.33	0	100	1.28	42.31	1.21

Zeolite	SiO ₂ /Al ₂ O ₃	Temp (oC)	Time (min)	mol%						conv. (%)	p-sel. (%)	B/X ratio	
				benzene	toluene	p-xylene	m-xylene	o-xylene	total				
Syn. H-ZSM-5	150	500	4	2.12	96.4	0.49	0.89	0.14	100	3.65	32.30	1.39	
			19	0.68	98.8	0.24	0.30	0.00	100	1.22	45.02	1.26	
			34	0.28	99.5	0.10	0.13	0.00	100	0.51	44.78	1.23	
			49	0.10	99.8	0.04	0.05	0.00	100	0.19	44.63	1.22	
Syn. H-ZSM-5	200	500	4	1.33	97.7	0.27	0.54	0.17	100	2.31	27.90	1.36	
			19	0.30	99.5	0.11	0.15	0.00	100	0.55	42.11	1.18	
			34	0.04	99.9	0.01	0.02	0.00	100	0.07	42.15	1.19	
			49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Syn. H-ZSM-5	250	500	4	0.47	99.2	0.11	0.20	0.04	100	0.82	30.50	1.35	
			19	0.08	99.9	0.03	0.04	0.00	100	0.15	43.65	1.24	
			34	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVD.mod.ZSM-5	50	500	4	7.82	85.6	5.90	0.63	0.10	100	14.45	88.97	1.18	
			19	0.19	99.7	0.15	0.01	0	100	0.35	95.54	1.21	
			34	0.17	99.7	0.14	0	0	100	0.32	95.89	1.16	
			49	0.17	99.7	0.14	0	0	100	0.32	96.55	1.17	
CVD.mod.ZSM-5	150	500	4	1.95	96.4	0.92	0.47	0.27	100	3.61	55.49	1.18	
			19	0.28	99.5	0.18	0.06	0.00	100	0.52	75.41	1.20	
			34	0.05	99.9	0.03	0.01	0.00	100	0.09	76.29	1.19	
			49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVD.mod.ZSM-5	250	500	4	0.42	99.2	0.21	0.10	0.04	100	0.77	60.14	1.20	
			19	0.06	99.9	0.04	0.01	0	100	0.11	78.89	1.21	
			34	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Seeding mod. ZSM-5	100	500	4	10.63	80.8	6.31	1.52	0.74	100	19.20	73.60	1.24	
			19	1.70	96.9	1.32	0.10	0	100	3.12	92.90	1.19	
			34	1.39	97.4	1.11	0.06	0	100	2.56	94.50	1.18	
			49	1.46	97.3	1.17	0.07	0	100	2.70	94.10	1.18	

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