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## APPENDICES

### Appendix A Raw Data from Gas Chromatography

The raw data are collected from online gas chromatography (Shimadzu, GC-14A with C-R4A Chromatopac). The column conditions start with initial temperature at 50°C hold for 9 minutes after that temperature is heated at a rate of 20°C/min. The final temperature is depending in any feeds, which are 90°C for mixed C<sub>4</sub> and non-BD C<sub>4</sub>, 150°C for mixed C<sub>5</sub> and 180°C for mixed C<sub>6</sub>. All data for all tested are in these following tables.

**Table A1** Raw data from thermal cracking of mixed C<sub>4</sub> and Non-BD C<sub>4</sub>

Peak Time (min)	Species	Area from Mixed C <sub>4</sub>			Area from Non-BD C <sub>4</sub>		
		650°C	700°C	750°C	650°C	700°C	750°C
0.785	methane	3457	17910	29289	3110	20804	34751
1.942	ethylene	3950	13031	81124	1914	14432	100696
2.578	ethane	429	650	3866	-	2128	5486
10.094	propylene	6374	50280	84922	8259	54744	89851
16.844	tran-2-butene	33566	42507	36287	49087	50527	46577
17.516	i-butene	285788	247269	211083	639410	578398	466977
18.157	1,3 butadiene	428413	337373	288001	-	-	-
19.583	* 1-butene	156102	189702	161941	193326	176471	138106
20.642	n-butane	57354	67292	57445	61373	59992	51591
	Total	975655	965793	953957	956479	957496	934036

**Table A2** Raw data from thermal cracking of mixed C<sub>5</sub>

Peak Time (min)	Species	Area from Mixed C <sub>5</sub>		
		650°C	700°C	750°C
0.784	methane	5843	25825	65912
1.916	ethylene	8251	42401	126391
2.508	ethane	1179	4446	8989
9.934	propylene	8537	44904	96448
13.822	cyclo-pentane	22682	2120	1075
14.083	isoprene	46201	76225	67648
14.235	pentadiene	8780	9856	8053
15.53	1-pentene	2527	4534	2569
15.798	cyclo-pentene	2234	1736	1255
16.252	cyclo-pentadiene	197307	148182	142711
16.726	n-pentane	495832	369033	162455
17.275	i-pentane	64397	50425	22660
	Total	865978	824162	711317

**Table A3** Raw data from thermal cracking of mixed C<sub>6</sub>

Peak Time (min)	Species	Area from Mixed C <sub>6</sub>		
		650°C	700°C	750°C
0.79	methane	2544	3963	21502
1.963	ethylene	-	17964	87467
2.604	ethane	-	-	2474
10.059	propylene	-	19014	71896
10.997	propane	-	-	2385
13.973	1-butene	1685	13358	49218
14.383	n-butane	6885	1214	-
15.767	n-pentane	6264	7694	5834.9
16.015	i-pentane	207890	9317	27276.4
16.508	Cyclopentane	103418	175851	116297
17.732	i-hexane	27863	81095	39033
17.991	benzene	18741	11547	11225
18.217	n-hexane	112973	110564	64553
18.483	Cyclo hexane	272351	215413	139834
19.196	i-heptane	34905	34470	63059
19.525	n-heptane	50721	39576	22475
21.864	di-methyl cyclopentane	64396	30120	13427
	Total	865978	759610	726731

**Table A4** Raw data from catalytic cracking of mixed C<sub>4</sub> with ZSM-5 zeolite, Si/Al= 40 at flow rate about 5, 12.5, 25, 50 and 100 ml/min

Peak Time (min)	Species	5ml/min				12.5 ml/min				25ml/min			
		500°C	550°C	600°C	650°C	500°C	550°C	600°C	650°C	500°C	550°C	600°C	650°C
0.785	methane	5290	4860	28724	29480	6246	6143	27896	27184	3945	8567	25274.2	40702.2
1.942	ethylene	104662	118132	202071	207388	149283	132820	239859	261957	122711	178382	257209	267263
2.578	ethane	7562	6442	21263	21822	10588	6778	25675	25154	6863	11719	23430.4	25971.4
10.094	propylene	145192	159143	155718	159816	224642	169206	220395	243698	210535	238598	252783	245186
16.844	tran-2-butene	71061	68654	26311	27004	121597	30868	56035	61666	90576	72675	51833.6	30542.4
17.516	i-butene	40762	43992	57532	59046	87624	54586	26629	28898	73384	52343	27560.4	18761.4
18.157	1,3 butadiene	45402	48213	77619	79661	82278	108052	77594	72181	102011	82363	71321.6	81064.2
19.583	1-butene	81779	81509	24320	24960	161980	127064	80528	89069	145162	116565	76794.2	58377.2
20.642	n-butane	45066	27538	53673	55086	23823	26073	18958	21115	25453	22610	19503.4	18419.8
26.552	heavy H.C.	98848	50274	4551	4670	4559.4	25841	19573	17957	-	-	-	-
30.998	heavy H.C.	79214	75528	44755	45932	-	-	-	-	-	-	-	-
	Total	724837	684284	696536	714866	872620	687431	793142	848877	780640	783824	805710	786288

Peak Time (min)	Species	50 ml/min				100 ml/min			
		500°C	550°C	600°C	650°C	500°C	550°C	600°C	650°C
0.785	methane	5502	5423	12292	25004	1319	3542	7436	7807.8
1.942	ethylene	152103	151127	189344	220311	73341	88392	101852	106945
2.578	ethane	7203	7365	14349	17976	1501	3246	4150	4357.5
10.094	propylene	231051	226453	232398	203722	180495	174043	183449	192621
16.844	tran-2-butene	40212	49668	44697	22237	24090	21538	16009	16809.5
17.516	i-butene	54716	42076	27294	18419	39594	37562	26043	27345.2
18.157	1,3 butadiene	74817	82648	71422	62224	139750	182083	155412	163183
19.583	1-butene	112430	104440	84805	52167	149867	133558	123955	130153
20.642	n-butane	19286	21580	19369	15745	35334	34465	35413	37183.7
	Total	697320	690780	695970	637805	645291	678429	653719	686405

**Table A5** Raw data from catalytic cracking of mixed C<sub>4</sub> over ZSM-5, Si/Al= 20, 40, 190 and 398 with total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	2025	1769	622	6141	4976	504.6	13543	8847	1124	26591	10866	4321
1.942	ethylene	75122	74909	19160	114211	77066	15535	142047	84193	1650	166219	45125	4938
2.578	ethane	14402	1925	387	16301	2593	313.8	10432	2728	-	9397	1775	813
10.094	propylene	273292	136703	67575	242034	135676	54790	220597	223526	2798	225892	119809	7968
10.831	propane	38444	12239	3024	28861	14284	2451.6	18870	6781	-	12115	1441	-
16.844	tran-2-butene	61293	54936	38360	42278	46473	31103	-	-	43157		37367	41957
17.516	i-butene	127203	162615	223145	96736	169422	180928	32178	41350	338705	17144	265354	357235
18.157	1,3 butadiene	115540	135566	304458	75918	61245	246858	55747	192787	579095	69166	190080	535516
19.583	1-butene	126287	183008	171195	103066	158629	138806	94630	167809	204768	88820	195206	195128
20.642	n-butane	20999	47306	60727	16835	42500	49238	15675	54687	79217	20155	75146	71693
	Total	854607	810976	888653	742381	712864	720529	603719	782708	1250514	635499	942169	1219569



Peak Time (min)	Species	Si/Al = 40											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	5502	1638	-	5423	1950	2117	12292	4676	693	25004	9181	11648
1.942	ethylene	152103	89258	1385	151127	73948	12024	189344	84928	2611	220311	63738	11925
2.578	ethane	7203	2235	-	7365	2285	602	14349	3943	-	17976	3567	2136
10.094	propylene	231051	165593	5177	226453	136727	27471	232398	142668	5390	203722	98737	22097
10.831	propane	40212	22389	-	49668	16781	853	44697	13723	-	-	5053	570
16.844	tran-2-butene	-	-	38996	-	37296	39633	-	37863	40110	22237	35984	33635
17.516	i-butene	54716	112583	303312	42076	190825	315796	27294	217080	343882	18419	257988	327468
18.157	1,3 butadiene	74817	142414	567489	82648	235979	451448	71422	236532	568719	62224	299558	411038
19.583	1-butene	112430	134324	200065	104440	150188	182652	84805	161514	184832	52167	159763	181793
20.642	n-butane	19286	27276	71733	21580	46442	69041	19369	54353	65863	15745	57919	80824
	Total	697320	697710	1188157	690780	892421	1101637	695970	957280	1212100	637805	991488	1083134

Peak Time (min)	Species	Si/Al =190											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	838	586	510	1996	1914	2368	4400	4359	2836	10447	11584	10674
1.942	ethylene	50151	30277	21071	65777	49204	50874	75490	56190	25088	96289	70040	49251
2.578	ethane	-	-	-	946	798	1164	1710	1483	590	3504	3192	2726
10.094	propylene	231408	149800	109703	243968	199664	179759	245436	187977	97154	238084	177772	121244
10.831	propane	4049	2041	1221	4253	3168	4226	3240	2566	1096	2872	2782	1671
16.844	tran-2-butene	-	43961	49664	-	48929	48330	-	44225	42402	-	44488	43570
17.516	i-butene	44425	249385	293487	40286	279712	251546	41327	262807	312273	42045	248274	263636
18.157	1,3 butadiene	209833	165857	308157	251969	146799	143131	255487	139656	374272	238480	147400	255621
19.583	1-butene	185375	198421	216476	194506	236481	194938	185672	208603	214894	161376	193972	191142
20.642	n-butane	54112	67218	76973	61565	87179	68889	63495	76848	83125	56713	72849	76408
	Total	780191	907546	1077262	865266	1053848	945225	876257	984714	1153730	849810	972353	1015943

Peak Time (min)	Species	Si/Al =398			
		500°C	550°C	600°C	650°C
0.785	methane	-	-	-	4321
1.942	ethylene	-	-	-	4948
2.578	ethane	-	-	-	759
10.094	propylene	-	-	-	6968
10.831	propane	-	-	-	-
16.844	tran-2-butene	34942	20700	34179.6	41875
17.516	i-butene	282933	335774	344189	352753
18.157	1,3 butadiene	549330	603207	569505	536515
19.583	1-butene	190208	151558	131475	192518
20.642	n-butane	71776	42453	35620.7	71396
	Total	1129189	1153692	1114969	1212053

**Table A6** Raw data from catalytic cracking of non-BD C<sub>4</sub> over ZSM-5, Si/Al= 20, 40, 190 and 398 with total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	2514	2547	2620	4950	4899	5168	13642	12870	12671	24544	25690	23894
1.942	ethylene	101066	103388	103928	132174	138961	136094	187876	142938	135009	171272	149854	129066
2.578	ethane	13308	6801	5103	14435	6454	4431	7625	5507	4991	9343	7574	6596
10.094	propylene	184269	206636	215510	213031	249949	255351	325613	264815	261909	238712	222676	209523
10.831	propane	60986	51282	47484	43347	37850	33049	32788	20262	17787	14458	9513	7494
16.844	tran-2-butene	90696	80536	81254	62390	57049	63685	65842	40585	43315	19733	18628	22354
17.516	i-butene	76624	88229	84105	65466	80847	81949	119802	106303	106479	96257	116190	132697
19.583	1-butene	150295	155229	147160	116581	141010	130610	153784	141213	132847	107544	117752	123730
20.642	n-butane	23792	25829	23941	17563	25216	24792	33953	32699	32983	30284	36859	40620
	Total	703550	720477	711105	669937	742235	735129	940925	767192	747991	712147	704736	695974

Peak Time (min)	Species	Si/Al = 40											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	1394	1470	1827	6748	7473	7632	20497	26208	25107	33725	23066	23493
1.942	ethylene	85431	85250	93846	141773	139542	140122	202022	210003	206555	232237	162488	159502
2.578	ethane	2357	2425	2814	6454	6388	6389	13797	15489	11219	21230	12495	12395
10.094	propylene	204452	205127	216634	223202	227490	232104	270566	280552	274269	264720	190923	191694
10.831	propane	48247	46844	46939	48684	45383	44469	48500	49351	45716	40179	21882	21654
16.844	tran-2-butene	79534	76848	77126	60440	58717	59266	31935	22689	23072	41153	21596	20491
17.516	i-butene	143333	140036	141076	102932	99282	101071	109893	115543	113805	154338	146766	135823
19.583	1-butene	162650	164478	159617	120288	122723	128839	117845	121692	118465	162747	115381	106590
20.642	n-butane	38682	38503	37765	27062	26712	30601	29843	31691	35162	67605	45053	39344
	Total	766080	760981	777644	737583	733710	750493	844898	873218	853370	1017934	739650	710986

Peak Time (min)	Species	Si/Al =190											
		500°C			550°C			600°C			650°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.785	methane	-	-	-	507	564	569	2052	2195	2236	6862	7937	8177
1.942	ethylene	13376	13135	13227	24905	24655	24454	43141	42791	42417	60939	60450	58664
2.578	ethane	-	-	-	-	-	-	811	860	836	2076	2438	2627
10.094	propylene	167355	168141	168125	144380	144175	143989	137498	134627	134410	130485	127643	126313
10.831	propane	3036	3032	3056	2430	2430	2307	2181	2015	2144	1914	1790	1876
16.844	tran-2-butene	57777	63127	64228	52957	59211	58393	58639	55426	55380	49876	46645	48594
17.516	i-butene	278785	277142	270216	322523	326039	314620	360036	339725	342909	311627	312297	313921
19.583	1-butene	229024	215336	202485	241161	233779	222243	266067	237278	245514	212711	213836	212400
20.642	n-butane	83613	76358	74732	98464	99169	92257	124084	100612	111651	97183	94954	96822
	Total	832966	816271	796069	887327	890022	858832	994509	915529	937497	873673	867990	869394

Peak Time (min)	Species	Si/Al =398			
		500°C	550°C	600°C	650°C
0.785	methane	-	-	-	2659
1.942	ethylene	-	-	-	2422
2.578	ethane	-	-	-	-
10.094	propylene	-	-	-	6905
10.831	propane	-	-	-	-
16.844	tran-2-butene	50975	44865	47588	49860
17.516	i-butene	753240	652343	678668	572287
19.583	1-butene	241403	205631	203067	196504
20.642	n-butane	69804	58235	57861	89862
	Total	1115422	961074	987184	920499

**Table A7** Raw data from catalytic cracking of mixed C<sub>5</sub> over ZSM-5, Si/Al= 20, 40, 190 and 398 with total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20											
		550°C			600°C			650°C			700°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.784	methane	3533	3247	3379	8022	8500	9459	7670	8633	8417	10985	9980	7896
1.916	ethylene	74183	66978	63881	77797	86991	89669	71482	86490	85985	82234	76651	65175
2.508	ethane	8430	6283	6145	11620	11415	11644	10490	11543	10969	13398	9381	7248
9.734	propylene	98963	90167	85339	96484	111805	115081	89760	110844	111534	98026	99331	87526
13.822	cyclo-pentane	14223	10186	9206	8573	9360	8473	7050	8967	8777	5559	4047	3082
14.083	isoprene	29881	25349	2282	-	-	-	1519	-	-	16517	685	-
14.235	pentadiene	60973	51470	20652	19027	23796	24135	16980	24426	25351	19974	18739	20886
15.53	1-pentene	1167	980	48219	32865	39852	40552	30211	39450	39972	2419	23554	2964
15.798	cyclo-pentene	2632	122513	114482	48644	59862	58184	45019	62133	65086	37411	4669	37933
16.252	cyclo-pentadiene	146715	212013	192737	85006	104075	114157	82066	104102	109686	66873	42392	62875
16.726	n-pentane	233852	1470	24123	1190	-	15957	1571	24123	27830	4159	73534	16546
17.275	i-pentane	30785	38263	29856	4656	26853	6374	4758	-	-	-	4408	4536
	Total	705337	628919	600301	393884	482509	484226	368576	385588	493607	357555	367371	308771



Peak Time (min)	Species	Si/Al = 40											
		550°C			600°C			650°C			700°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.784	methane	3353	5039	4705	9839	7946	8190	10943	13600	8818	14424	22481	20511
1.916	ethylene	58821	78632	76201	101828	85306	96438	89556	115924	81762	88517	134303	118405
2.508	ethane	7593	11249	10616	17493	14294	15371	15169	19482	12697	12292	21211	18827
9.734	propylene	67253	90353	86917	99043	88370	104299	78814	112703	98300	59575	104535	107223
13.822	cyclo-pentane	11345	19507	18037	13670	11096	12083	6444	9661	6384	2942	7092	7281
14.083	isoprene	15432	21821	21517	19093	15548	18714	10792	17466	15100	6435	13685	16208
14.235	pentadiene	27261	37409	35493	25028	21073	26411	12249	21379	25746	7094	13527	14864
15.53	1-pentene	1742	1366	715	-	1306	1564	1057	896	1928	-	-	1336
15.798	cyclo-pentene	60926	81661	75805	43431	36433	50620	16300	33608	37514	14547	22037	23581
16.252	cyclo-pentadiene	98867	133950	116925	61921	50116	71262	22406	49138	55179	27394	44506	46206
16.726	n-pentane	3641	591	850	1520	2156	2388	1096	1933	16528	1112	1792	-
17.275	i-pentane	11751	24819	22306	5390	15052	17104	1710	17790	6482	2078	40355	50891
	Total	367985	506397	470087	398256	348696	424444	266536	413580	366438	221986	425524	425333

Peak Time (min)	Species	Si/AI = 190											
		550°C			600°C			650°C			700°C		
		5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min	5 min	30 min	60 min
0.784	methane			531	1168	1457	882	1867	3822	4702	10159	15532	12871
1.916	ethylene	16966	23547	28772	30857	42060	30441	23041	50689	62302	60043	88580	76034
2.508	ethane	511	706	979	1877	2448	1278	2139	4741	5663	7204	10562	8858
9.734	propylene	27323	38344	46483	46762	65270	47075	33417	73585	90143	73376	104666	93135
13.822	cyclo-pentane	8349	12578	634	859	1385	690	829	2025	2554	2421	3921	3492
14.083	isoprene	20558	26608	14978	9942	14645	11418	7484	15478	19560	20961	1069	924
14.235	pentadiene			29104	17515	25755	24752	9782	21159	26373	14498	32027	27349
15.53	1-pentene	614	815	744	574	1528	1172	509	1852	1981	820	19358	17141
15.798	cyclo-pentene	2117	3299	3765	1051	1984	3354	30363	1053	1668	40771	1432	2278
16.252	cyclo-pentadiene	95749	126324	137189	68497	101500	115523	47359	76451	98910	69515	57061	52369
16.726	n-pentane	218192	263387	268731	122248	183226	209366	2501	131354	177103	2758	101673	95095
17.275	i-pentane	31784	41793	3276	18628	31011	19326	5974	7031	2567	6916	4979	3985
	Total	422163	537401	44215	319978	472269	465277	165265	389240	493526	309446	440860	393531

Peak Time (min)	Species	Si/Al = 398			
		550°C	600°C	650°C	700°C
0.784	methane	-	608	4717	8811
1.916	ethylene	-	805	7090	16789
2.508	ethane	-	-	1294	1255
9.734	propylene	-	4189	8226	15225
10.818	propane	-	-	3204	1183
13.822	cyclo-pentane	2655	13964	18176	28829
14.083	isoprene	30157	2630	14433	9492
14.235	pentadiene	5497	-	-	-
15.53	1-pentene	2248	4284	-	-
15.798	cyclo-pentene	7189	186621	177883	60828
16.252	cyclo-pentadiene	147728	454720	437389	150782
16.726	n-pentane	351653	4127	1435	1586
17.275	i-pentane	45517	89497	88675	34739
	Total	592644	761445	762522	329519

**Table A8** Raw data from catalytic cracking of mixed C<sub>6</sub> over ZSM-5, Si/Al= 20, 40, 190 and 398 with total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20			
		550°C		600°C	
		5 min	60 min	5 min	60 min
0.79	methane	3037	3447	5390	6929
1.963	ethylene	49621	51813	55160	63690
2.604	ethane	6325	5020	5264	5615
10.059	propylene	93668	106447	107747	124121
10.997	propane	13234	12358	7888	9197
13.703	i-butene	-	-	1471	-
13.973	1-butene	21116	24574	16289	21362
14.383	n-butane	16449	19408	14844	18512
15.767	n-pentane	5098	6680	2833	7256
16.015	i-pentane	7590	9514	5176	9674
16.508	Cyclopentane	43573	53526	23965	34211
17.732	i-hexane	56492	68413	29947	37701
18.217	n-hexane	75859	94899	50628	68775
18.483	Cyclo hexane	45922	46360	24270	26705
19.196	i-heptane	44386	51306	-	-
19.525	n-heptane	15103	19067	9200	12922
20.934	aromatic	16270	18990	56100	91591
21.864	di-methyl cyclopentane	2656	3220	10683	2311
	Total	516399	595042	426855	540572

Peak Time (min)	Species	Si/Al = 20			
		650°C		700°C	
		5 min	60 min	5 min	60 min
0.79	methane	9261	10332	14815	13570
1.963	ethylene	72560	75704	85989	69229
2.604	ethane	7588	6777	6468	5381
10.059	propylene	115812	137436	117933	122978
10.997	propane	8133	8723	6592	5927
13.703	i-butene	-	-	-	-
13.973	1-butene	13789	18879	10899	17557
14.383	n-butane	10993	15632	8405	10654
15.767	n-pentane	1295	8460	-	11839
16.015	i-pentane	3627	6377	4190	10544
16.508	Cyclopentane	9309	10987	6316	12483
17.732	i-hexane	13599	17109	4964	11891
18.217	n-hexane	24279	36694	15455	37557
18.483	Cyclo hexane	13535	6882	9830	6791
19.196	i-heptane	-	-	-	-
19.525	n-heptane	-	-	-	-
20.934	aromatic	98478	124723	146541	194000
21.864	di-methyl cyclopentane	6381	7122	4510	6321
	Total	408639	491837	442907	536722

Peak Time (min)	Species	Si/Al = 40			
		550°C		600°C	
		5 min	60 min	5 min	60 min
0.79	methane	2830	3758	6675	7741
1.963	ethylene	50822	63821	87073	84975
2.604	ethane	5177	6670	9299	8727
10.059	propylene	79241	99074	112459	115022
10.997	propane	11378	17295	15336	15363
13.703	i-butene	1937	3225	-	2991
13.973	1-butene	14580	19973	20900	19386
14.383	n-butane	12722	18163	15780	16654
15.767	n-pentane	4242	57362	3636	3672
16.015	i-pentane	5722	54641	5199	5652
16.508	Cyclopentane	59385	60157	33110	24723
17.732	i-hexane	51216	70861	36603	30376
18.217	n-hexane	68335	57511	48164	42044
18.483	Cyclo hexane	82545	60666	48633	28071
19.196	i-heptane	36714	1996	49466	-
19.525	n-heptane	26008	-	13244	11851
20.934	aromatic	32207	20629	16105	67695
21.864	di-methyl cyclopentane	16891	-	2104	-
	Total	561952	615802	523786	484943

Peak Time (min)	Species	Si/Al = 40			
		650°C		700°C	
		5 min	60 min	5 min	60 min
0.79	methane	9873	13405	16775	19810
1.963	ethylene	88458	97013	106226	98716
2.604	ethane	8132	8736	7596	8337
10.059	propylene	102663	115386	89735	89840
10.997	propane	10237	11851	6278	7347
13.703	i-butene	1099	-	-	-
13.973	1-butene	12672	15973	7826	8790
14.383	n-butane	9961	11577	5144	5649
15.767	n-pentane	1263	1420	658	-
16.015	i-pentane	2941	3745	2836	5903
16.508	Cyclopentane	13102	8757	14544	7621
17.732	i-hexane	13518	10436	10163	7302
18.217	n-hexane	20423	17726	17750	14090
18.483	Cyclo hexane	21174	8358	24976	9426
19.196	i-heptane	-	-	-	-
19.525	n-heptane	-	-	-	-
20.934	aromatic	82675	102454	145703	205174
21.864	di-methyl cyclopentane	7995	6680	8075	6600
	Total	406186	433517	464285	494605

Peak Time (min)	Species	Si/Al = 190			
		550°C		600°C	
		5 min	60 min	5 min	60 min
0.79	methane	-	-	1237	1296
1.963	ethylene	6874	8092	18545	19124
2.604	ethane	637	757	1859	1911
10.059	propylene	31881	36797	62956	66382
10.997	propane	805	1068	2030	2118
13.703	i-butene	-	-	-	-
13.973	1-butene	4549	5292	8913	9527
14.383	n-butane	3585	4264	6779	7021
15.767	n-pentane	7061	8890	606	1157
16.015	i-pentane	11651	13676	8850	10873
16.508	Cyclopentane	115385	143528	100870	17197
17.732	i-hexane	77211	96715	104425	117726
18.217	n-hexane	106807	129644	111690	88545
18.483	Cyclo hexane	136876	187332	123989	112976
19.196	i-heptane	24746	33582	32696	112999
19.525	n-heptane	32891	45343	34095	30174
20.934	aromatic	24335	32035	25015	29723
21.864	di-methyl cyclopentane	5240	7014	5489	23170
	Total	590534	754029	650044	651919



Peak Time (min)	Species	Si/Al = 190			
		650°C		700°C	
		5 min	60 min	5 min	60 min
0.79	methane	2859	3208	7703	8083
1.963	ethylene	32824	35105	55869	52410
2.604	ethane	3473	3763	5442	5385
10.059	propylene	90518	99401	115807	110117
10.997	propane	3273	3562	4429	4749
13.703	i-butene	-	-	-	811
13.973	1-butene	13699	16127	21383	22111
14.383	n-butane	9045	10560	10272	9449
15.767	n-pentane	-	7912	-	5557
16.015	i-pentane	18800	14393	16886	14838
16.508	Cyclopentane	67970	73862	42953	41924
17.732	i-hexane	67769	73715	48094	48413
18.217	n-hexane	87630	99226	66875	67466
18.483	Cyclo hexane	86870	88214	58913	55385
19.196	i-heptane	34637	39315	51896	65494
19.525	n-heptane	22958	25558	14844	13881
20.934	aromatic	21481	23175	16303	29496
21.864	di-methyl cyclopentane	4300	4637	3270	3121
	Total	568106	621733	540939	558690

Peak Time (min)	Species	Si/Al = 398			
		550°C	600°C	650°C	700°C
0.79	methane	-	-	5861	12566
1.963	ethylene	-	1395	9298	35663
2.604	ethane	-	-	-	-
10.059	propylene	-	-	9765	38894
10.997	propane	-	-	-	-
13.703	i-butene	-	-	-	-
13.973	1-butene	-	1125	5558	12569
14.383	n-butane	-	856	2369	9865
15.777	n-pentane	4461	4167	1295	998
16.029	i-pentane	4109	1858	3627	2236
16.524	Cyclopentane	134625	178637	168547	159663
17.717	i-hexane	67284	95703	95106	77966
17.82	benzene	18138	26531	27135	27003
18.196	n-hexane	71226	100121	100253	86056
18.501	Cyclo hexane	170311	274104	272149	250098
19.121	i-heptane	20012	31946	30998	30559
19.476	n-heptane	31049	51227	49528	45511
20.346	di-methyl cyclopentane	18966	36621	35985	33659
	Total	540181	804291	817474	823306

**Table A9** Raw data from non-BD C<sub>4</sub> stability test over ZSM-5 with Si/Al= 20 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time	Species	Time on Stream (TOS)										
		5 min	60 min	120 min	180 min	240 min	300 min	360 min	420 min	480 min	540 min	600 min
0.785	methane	18916	18468	17353	16832	18136	10233	15812	16562	14323	15266	15900
1.942	ethylene	300286	266539	249264	243437	233893	170154	247428	222585	206993	196486	191680
2.578	ethane	18080	11186	10157	9753	10750	4790	8912	8386	7661	7610	7773
10.094	propylene	490004	520457	532004	546685	515980	506410	603304	588166	564482	550388	547779
10.831	propane	93151	60341	51872	48992	50423	26786	47724	40632	36758	32285	30684
16.844	tran-2-butene	138308	142461	144584	150420	141475	156455	168948	160718	147597	142629	142930
17.516	i-butene	243910	263967	290011	307509	274843	489638	343758	389049	344801	350848	364858
19.583	1-butene	356757	301540	317531	329354	301640	408726	372253	405310	363548	352053	361906
20.642	n-butane	99364	88648	98428	100498	84665	154447	109044	161582	121786	110893	113608
	Total	1758776	1673607	1711204	1753480	1631805	1927639	1917183	1992990	1807949	1758458	1777118

Peak Time	Species	Time on Stream (TOS)										
		660 min	720 min	780 min	840 min	900 min	960 min	1020 min	1080 min	1140 min	1200 min	1260 min
0.785	methane	14639	16103	16396	16835	14421	11551	12760	12319	11864	10123	10656
1.942	ethylene	170887	187976	191393	196520	130849	148684	123733	108199	97768	73482	77349
2.578	ethane	6422	7064	7193	7385	5291	5126	4559	4029	3709	2802	2949
10.094	propylene	517110	568821	579163	594677	456709	526634	451821	409793	380986	304426	320448
10.831	propane	25927	28520	29038	29816	17862	21650	15521	12456	10661	7268	7650
16.844	tran-2-butene	136675	150343	153076	157176	140390	138408	130260	127075	122961	109355	115111
17.516	i-butene	387928	426721	434479	446117	593500	502587	555116	615062	650425	700192	737044
19.583	1-butene	356560	392216	399347	410044	484398	456605	457373	496572	509121	542742	571307
20.642	n-butane	104243	114667	116752	119879	194715	159723	158285	226059	195194	287617	302755
	Total	1720391	1892430	1926838	1978450	2038135	1970968	1909428	2011564	1982689	2038006	2145269

**Table A10** Raw data from non-BD C<sub>4</sub> stability test over ZSM-5 with Si/Al= 40 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time	Species	Time on Stream (TOS)										
		5 min	60 min	120 min	180 min	240 min	300 min	360 min	420 min	480 min	540 min	600 min
0.785	methane	51533	52466	48350	49000	45085	43940	43274	41148	39581	39455	39251
1.942	ethylene	377750	338634	307402	296740	273898	256633	261054	250305	244537	243518	239068
2.578	ethane	27484	19435	17274	16620	15121	13424	13574	12853	12291	12175	11904
10.094	propylene	517175	577389	524750	519864	486448	464533	497458	484762	486669	490609	487143
10.831	propane	110697	91203	69486	65032	53264	50059	46231	43422	40368	39163	36404
16.844	tran-2-butene	86627	103147	81328	79500	63104	57904	69290	69377	71567	72825	72920
17.516	i-butene	265651	337799	300011	298492	277471	269112	310547	311090	325722	335359	348363
19.583	1-butene	335702	409063	362710	359333	333301	316031	349186	342485	354243	364270	363866
20.642	n-butane	105331	104249	95697	96154	102820	87744	103734	97273	103144	103383	104020
	Total	1877950	2033385	1807008	1780735	1650512	1559380	1694348	1652715	1678122	1700757	1702939

Peak Time	Species	Time on Stream (TOS)										
		660 min	720 min	780 min	840 min	900 min	960 min	1020 min	1080 min	1140 min	1200 min	1260 min
0.785	methane	37294	36513	36464	33557	40299	33177	31906	31103	28414	34055	27969
1.942	ethylene	231609	225422	222140	212832	209703	201844	196828	192962	185500	190416	172498
2.578	ethane	11450	10879	11528	10202	10107	8986	8719	8882	8304	8551	7464
10.094	propylene	483133	475526	468764	471802	434620	453925	450740	446456	449316	430318	419615
10.831	propane	33735	34277	32365	32221	28016	26835	25784	24727	25417	22539	20538
16.844	tran-2-butene	76419	76184	66516	79542	61527	77557	78662	81174	92069	71057	87348
17.516	i-butene	363049	375342	388957	400409	395638	424869	436733	447929	486621	507122	514246
19.583	1-butene	368059	381325	408347	393787	387797	402138	407878	410573	431369	459806	434464
20.642	n-butane	107228	114125	129552	128623	129690	141121	137591	139218	160960	158070	161284
	Total	1711976	1729593	1764633	1762975	1697397	1770452	1774841	1783024	1867970	1881934	1845426

**Table A11** Raw data from non-BD C<sub>4</sub> stability test over ZSM-5 with Si/Al= 190 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time	Species	Time on Stream (TOS)										
		5 min	60 min	120 min	240 min	360 min	480 min	600 min	720 min	840 min	960 min	1080 min
0.785	methane	597	556	3012	608	652	695	869	654	-	458	627
1.942	ethylene	54024	53694	93014	54244	58118	61993	77491	54641	44540	38249	59811
2.578	ethane	508	551	2027	722	773	825	1031	568	-	398	719
10.094	propylene	394354	403975	376630	395692	423956	452219	565274	395465	333603	276826	474929
10.831	propane	14601	15653	12295	19125	20491	21857	27321	15215	10025	10651	19855
16.844	tran-2-butene	130902	123182	104737	125524	134490	143456	179320	116573	563799	81601	176952
17.516	i-butene	608793	622866	688555	732739	785078	837416	1046770	618080	426185	432656	1204139
19.583	1-butene	503276	526509	538777	553552	593091	632630	790788	488428	160850	341900	821394
20.642	n-butane	181118	182251	209530	205185	219842	234498	293122	181478	64662	127035	447885
	Total	1888173	1929237	2028577	2087390	2236490	2385589	2981986	1871102	1603664	1309771	3206311

Peak Time	Species	Time on Stream (TOS)										
		1200 min	1320 min	1440 min	1560 min	1680 min	1800 min	1920 min	2040 min	2160 min	2280 min	2400 min
0.785	methane	522	-	608	-	524	-	-	616	593	652	534
1.942	ethylene	48792	45844	51983	27682	53976	19207	36888	53175	51768	56945	46591
2.578	ethane	513	-	613	-	560	-	-	549	528	581	475
10.094	propylene	358848	339692	383018	207367	422567	153446	285063	394312	391758	430934	352582
10.831	propane	12704	11777	15860	6201	16177	3820	7893	17743	20941	23035	18847
16.844	tran-2-butene	106946	111853	115719	70203	121844	46201	86259	115236	121203	133323	109083
17.516	i-butene	607863	570919	641751	428479	857402	369036	520003	643800	672448	739693	605203
19.583	1-butene	468796	418532	492435	296011	660103	273666	389771	493849	510577	561635	459519
20.642	n-butane	196685	161804	193894	116668	244930	107060	145167	175551	183969	202366	165572
	Total	1801669	1660421	1895881	1152611	2378083	972436	1471044	1894831	1953785	2149164	1758407



Peak Time	Species	Time on Stream (TOS)										
		2400 min	2520 min	2640 min	2760 min	2880 min	3000 min	3120 min	3240 min	3360 min	3480 min	3600 min
0.785	methane	713	1609	4295	-	-	736	662	589	552	626	607
1.942	ethylene	71053	79597	95427	42805	44447	54358	48922	43486	40769	46204	44845
2.578	ethane	935	1155	2436	-	-	700	630	560	525	595	578
10.094	propylene	468354	384812	321016	336353	345676	400121	360109	320097	300091	340103	330100
10.831	propane	21179	12792	13448	12217	12302	14364	12928	11491	10773	12209	11850
16.844	tran-2-butene	148515	118695	95281	101287	100715	115106	103595	92085	86329.5	97840	94962
17.516	i-butene	823777	640037	590744	591648	600720	849531	764578	679625	637148	722101	700863
19.583	1-butene	617541	501554	448958	448563	459317	681358	613222	545086	511019	579154	562120
20.642	n-butane	225301	187405	204850	173115	166107	277925	250133	222340	208444	236236	229288
	Total	2377368	1927656	1776455	1705988	1729284	2394199	2154779	1915359	1795649	2035069	1975214

Peak Time	Species	Time on Stream (TOS)							
		3720 min	3840 min	3960 min	4080 min	4200 min	4320 min	4440 min	4560 min
0.785	methane	-	-	524	-	-	498	511	448
1.942	ethylene	42056	45670	47875	42802	43062	45481	46678	40933
2.578	ethane	-	-	520	517	-	494	507	445
10.094	propylene	330733	358570	370220	320007	330802	351709	360965	316538
10.831	propane	12345	13875	14445	11905	12010	13723	14084	12350
16.844	tran-2-butene	122823	130463	134044	111456	116596	127342	130693	114608
17.516	i-butene	660511	693288	706356	601569	633765	671038	688697	603934
19.583	1-butene	461050	492732	490985	425473	446043	466436	478710	419792
20.642	n-butane	185583	197761	190582	167569	163994	181053	185817	162948
	Total	1815101	1932359	1955551	1681298	1746272	1857773	1906662	1671996

**Table A12** Raw data from mixed C<sub>5</sub> stability test over ZSM-5 with Si/Al= 20 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20									
		5 min	60 min	120 min	180 min	240 min	300 min	360 min	420 min	480 min	540 min
0.784	methane	18532	17630	15974	14752	13718	12631	11514	11318	9787	9680
1.916	ethylene	191582	197126	186128	177530	172054	160747	148988	186128	148134	149732
2.508	ethane	33637	28700	24023	21783	19850	17969	15971	15562	14786	13321
9.734	propylene	214891	238554	233956	226971	223482	210696	196674	201871	197852	204633
13.822	cyclo-pentane	41144	39047	32007	28957	25616	22009	18690	18684	18479	17006
14.083	isoprene	54618	62832	62387	62679	57751	53679	49331	50354	45923	50646
14.235	pentadiene	-	-	-	-	-	-	-	-	-	-
15.53	1-pentene	95706	112114	108871	114898	101193	89861	82966	82905	74210	78752
15.798	cyclo-pentene	611	6494	1689	1700	1337	-	-	-	761	1640
16.252	cyclo-pentadiene	189352	245259	256031	302219	270664	278421	288801	301526	243394	288373
16.726	n-pentane	255462	352335	381743	456286	429477	422267	414031	442723	379936	488515
17.275	i-pentane	19647	27491	36077	39589	41622	59174	68851	66906	41268	63118
	Total	1115182	1327582	1338886	1447364	1356764	1327454	1295817	1377977	1174530	1365416

Peak Time (min)	Species	Si/Al = 20							
		600 min	660 min	720 min	780 min	840 min	900 min	960 min	1020 min
0.784	methane	9173	8339	7754	7385	7053	6348	6700.35	6248
1.916	ethylene	151694	137904	132940	110678	106764	96088	101426	97461
2.508	ethane	11342	10311	9341	8615	7987	7188	7587.65	6703
9.734	propylene	211855	192595	187154	154540	149644	134680	142162	138111
13.822	cyclo-pentane	13382	12165	10934	9466	8713	7842	8277.35	6980
14.083	isoprene	50162	45602	43157	37028	35045	31541	33292.8	30915
14.235	pentadiene	-	-	-	-	-	-	-	-
15.53	1-pentene	75332	68484	62555	56752	52624	47362	49992.8	41996
15.798	cyclo-pentene	1484	1349	1373	-	3000	2700	2850	3140
16.252	cyclo-pentadiene	301859	274417	262967	359909	326100	293490	309795	314531
16.726	n-pentane	533137	484670	465767	621765	647873	583086	615479	643976
17.275	i-pentane	76269	69335	68724	124109	140182	126164	133173	143575
	Total	1435688	1305171	1252666	1490247	1484985	1336487	1410736	1433636

**Table A13** Raw data from mixed C<sub>5</sub> stability test over ZSM-5 with Si/Al= 40 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 40									
		5 min	60 min	120 min	180 min	240 min	300 min	360 min	420 min	480 min	540 min
0.784	methane	26928	25910	24547	22963	20769	19383	17807	17576	16028	12362
1.916	ethylene	217603	217791	212429	206893	195131	188375	175535	176185	166558	142735
2.508	ethane	42035	38949	36376	33974	31013	28870	26146	25912	23493	17878
9.734	propylene	225887	237108	240109	240627	232468	228162	215282	217587	209339	185662
13.822	cyclo-pentane	68160	59732	55869	52076	46909	43711	38480	38866	34914	26228
14.083	isoprene	12506	11814	69635	69954	57928	64795	60586	61657	59804	52421
14.235	pentadiene	-	-	-	-	-	-	-	-	-	-
15.53	1-pentene	84917	55425	94350	98033	95024	92624	85850	89424	87780	79528
15.798	cyclo-pentene	863	1560	1527	1616	1396	-	-	-	2500	2581
16.252	cyclo-pentadiene	139923	156516	171323	202754	199187	209315	201829	239229	237549	235421
16.726	n-pentane	197241	235942	264575	300000	327150	329704	318299	449663	446332	395029
17.275	i-pentane	16588	19679	23361	26000	32281	32141	37854	40000	41268	54153
	Total	1032651	1060426	1194101	1254890	1239256	1237080	1177668	1356099	1325565	1203998

Peak Time (min)	Species	Si/Al = 40								
		600 min	660 min	720 min	780 min	840 min	900 min	960 min	1020 min	1080 min
0.784	methane	12312	11115	9652	8805	7904	7218	6280	5639	5035
1.916	ethylene	147447	138563	127833	120951	113255	104473	93104	87520	78780
2.508	ethane	17443	15279	12953	11333	10049	8656	7032	6066	5106
9.734	propylene	195462	186557	174661	168048	159163	148669	134295	128176	116584
13.822	cyclo-pentane	25611	21904	17805	15919	13566	11241	8993	7437	5884
14.083	isoprene	57033	54172	52037	49929	47913	45211	41407	40582	38300
14.235	pentadiene	-	-	-	-	-	-	-	-	-
15.53	1-pentene	87387	83885	81238	79258	79419	73159	68431	69351	64374
15.798	cyclo-pentene	4191	4530	4940	-	-	6725	7257	9462	-
16.252	cyclo-pentadiene	284832	284605	298104	304822	334061	318520	317387	350390	344040
16.726	n-pentane	477922	480032	512567	511438	593853	569661	579807	658451	649034
17.275	i-pentane	67950	67676	76677	72923	80000	89288	94237	107966	106634
	Total	1377590	1348318	1368467	1343426	1439183	1382821	1351950	1471040	1408736

**Table A14** Raw data from mixed C<sub>5</sub> stability test over ZSM-5 with Si/Al= 190 at 600°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 190										
		5 min	60 min	120 min	180 min	240 min	300 min	360 min	420 min	480 min	540 min	600 min
0.784	methane	4897	5065	5280	4937	5002	4934	4940	4628	4708	6882	4475
1.916	ethylene	101263	101288	107302	99075	100461	99297	98849	94925	97798	119994	91772
2.508	ethane	7359	7495	7929	7405	7591	7383	7498	7267	7479	11076	7011
9.734	propylene	156712	157100	166895	154050	155957	154345	153694	147491	152774	182492	143016
13.822	cyclo-pentane	4982	5021	5465	5110	4939	5032	5018	4676	4983	7530	4568
14.083	isoprene	44861	44425	48747	43372	44165	43139	42305	41630	41590	47221	37396
15.53	1-pentene	67466	65966	72432	62331	62494	60460	59041	57256	57175	59821	49543
15.798	cyclo-pentene	6034	6513	7685	6641	6936	-	-	-	7581	5045	9664
16.252	cyclo-pentadiene	318237	318780	366838	318243	323166	328449	326046	321882	337357	298514	308507
16.726	n-pentane	570750	577039	695361	591061	598808	599159	600552	595208	643689	557654	571289
17.275	i-pentane	87255	87485	112531	91446	92095	92001	93374	92626	104528	88175	90382
	Total	1369816	1376177	1596465	1383671	1401614	1394199	1391317	1367589	1459662	1384404	1317623

Peak Time (min)	Species	Si/Al = 190										
		660 min	720 min	780 min	840 min	900 min	960 min	1020 min	1080 min	1140 min	1200 min	1260 min
0.784	methane	4656	4472	5059	4983	4750	3814	4145	4079	4851	4449	4096
1.916	ethylene	95681	93034	101985	101544	98854	81542	87321	86098	98082	92853	87051
2.508	ethane	7312	7098	8206	8207	7765	6255	6775	6693	8043	7420	6753
9.734	propylene	148541	144902	158126	157553	153704	126571	135399	133603	150993	143823	135429
13.822	cyclo-pentane	4839	4720	5503	5787	5204	4015	4644	4485	5464	5010	4607
14.083	isoprene	38666	37868	40249	40648	39286	30533	32757	33172	36448	33950	34124
15.53	1-pentene	50583	48393	50068	49381	49005	36737	39644	38060	41182	37930	38630
15.798	cyclo-pentene	7257	7529	-	7142	8104	5808	7445	-	6583	6441	6410
16.252	cyclo-pentadiene	316462	310160	310471	311971	332514	246446	277102	276249	278885	280415	274351
16.726	n-pentane	607513	599276	580471	609579	660296	487716	541798	538107	553754	552725	558996
17.275	i-pentane	96239	96803	89146	95661	109549	81471	89191	89188	100710	91952	34290
	Total	1377749	1354255	1349284	1392456	1469031	1110908	1226221	1209734	1284995	1256968	1184737



Peak Time (min)	Species	Si/Al = 190										
		1320 min	1380 min	1440 min	1500 min	1560 min	1620 min	1680 min	1740 min	1800 min	1860 min	1920 min
0.784	methane	4128	4130	4101	4412	4054	4045	4087	4211	4974	4572	3887
1.916	ethylene	89017	88248	88141	92129	87560	87237	88127	90797	100261	95270	84698
2.508	ethane	6836	6861	6798	7377	6791	6699	6768	6973	8460	7832	6509
9.734	propylene	138552	137037	136538	142532	137404	135781	137166	141323	154442	147371	131503
13.822	cyclo-pentane	4875	4732	4639	5195	4747	4778	4826	4973	6008	6052	4688
14.083	isoprene	34070	34810	33010	33683	31870	33389	33729	34751	35183	33379	32304
15.53	1-pentene	37003	37712	35675	35512	33752	36263	36633	37743	33684	31654	30764
15.798	cyclo-pentene	6735	7610	6757	-	-	6600	6668	6870	-	6392	7344
16.252	cyclo-pentadiene	284715	276571	272797	266784	287286	279021	281868	290409	270274	257099	253121
16.726	n-pentane	583966	564030	560308	554980	606931	572287	578126	595645	568438	545719	556985
17.275	i-pentane	96997	96425	95599	95609	108267	95057	96027	98937	97950	95361	103003
	Total	1286894	1258166	1244363	1238213	1308662	1261156	1274025	1312632	1279674	1230701	1214806

Peak Time (min)	Species	Si/Al = 190										
		1980 min	2040 min	2160 min	2280 min	2400 min	2520 min	2640 min	2760 min	2880 min	3000 min	3120 min
0.784	methane	4111	3929	3704	4271	3963	3900	4667	4101	4492	4019	3896
1.916	ethylene	90220	77639	75349	84949	80948	80577	92611	84669	89970	82976	80436
2.508	ethane	6904	6253	5900	6823	6358	6275	7636	6652	7372	6519	6319
9.734	propylene	139791	123635	120760	133343	129910	126707	145002	133001	140677	130341	126351
13.822	cyclo-pentane	4929	4299	4105	4682	4496	4291	5384	4638	5161	4545	4406
14.083	isoprene	30862	37890	37032	39633	39216	44889	46860	44651	39411	43758	42418
15.53	1-pentene	30052	66721	61065	62539	62211	68206	71285	69833	58426	68436	66341
15.798	cyclo-pentene	34939	9213	8713	-	7652	7919	7055	7671	-	7518	7287
16.252	cyclo-pentadiene	283438	267423	289438	283954	286245	290004	298596	300536	297490	294525	285509
16.726	n-pentane	616856	528420	538842	532422	556187	553775	563527	590095	615979	578293	560590
17.275	i-pentane	114564	91280	118711	90300	94940	95690	94812	101887	104903	99849	96793
	Total	1356666	1216702	1263619	1242916	1272126	1282233	1337435	1347734	1363881	1320779	1280347

Peak Time (min)	Species	Si/Al = 190							
		3240 min	3360 min	3480 min	3600 min	3720 min	3840 min	3960 min	4080 min
0.784	methane	4008	6154	3848	3863	3529	5464	3489	3427
1.916	ethylene	82572	109880	81416	80736	75046	102304	73845	72891
2.508	ethane	6426	10389	6225	6143	5665	9038	5585	5275
9.734	propylene	129663	168420	127047	126697	118971	156446	114484	114869
13.822	cyclo-pentane	4648	8472	4384	4384	4229	6555	3780	3868
14.083	isoprene	34535	43588	36808	33080	30251	38647	27563	28367
15.53	1-pentene	46885	54356	49576	42393	37230	43650	33014	36227
15.798	cyclo-pentene	7080	6500	8298	7878	7894	5958	6849	8710
16.252	cyclo-pentadiene	280789	285284	286125	274351	260681	255335	240293	254369
16.726	n-pentane	576628	591144	595679	567317	554682	516260	500277	541332
17.275	i-pentane	106000	112575	108444	104435	103679	86631	96210	106147
	Total	1279234	1396762	1307850	1251277	1201857	1226288	1105389	1175482

**Table A15** Raw data from mixed C<sub>6</sub> stability test over ZSM-5 with Si/Al= 20 at 650°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 20				
		5 min	60 min	120 min	180 min	240 min
0.79	methane	19911	15733	15110	15897	14670
1.963	ethylene	155716	109545	74902	60704	50491
2.604	ethane	14717	9394	5746	4674	4010
10.059	propylene	193452	218513	163206	125766	99549
10.997	propane	12373	10203	5595	3974	3015
13.703	i-butene	2104	-	2422	912	866
13.973	1-butene	27622	41851	38559	40446	39890
14.383	n-butane	24626	32651	24208	20141	18996
15.767	n-pentane	-	14499	-	9681	10766
16.015	i-pentane	-	27234	130818	96191	92720
16.508	Cyclopentane	88978	9910	200721	25382	236411
17.732	i-hexane	36032	77957	100424	173166	133775
18.217	n-hexane	25554	116175	153706	101194	186185
18.483	Cyclo hexane	11669	48997	89539	164466	171590
19.196	i-heptane	-	-	-	-	-
19.525	n-heptane	150787	197702	267622	260057	284436
20.934	aromatic	-	24741	32253	29743	48922
21.864	di-methyl cyclopentane	145845	4079	6662	6542	11030
	Total	909386	959184	1311493	1138936	1407322

**Table A16** Raw data from mixed C<sub>6</sub> stability test over ZSM-5 with Si/Al= 40 at 650°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 40				
		5 min	60 min	120 min	180 min	240 min
0.79	methane	20835	24601	25243	23445	17205
1.963	ethylene	189422	173385	151255	129485	93397
2.604	ethane	21730	18924	16470	13513	8747
10.059	propylene	192759	195878	190045	189170	173125
10.997	propane	23986	25862	25999	22050	13321
13.703	i-butene	2558	2621	-	-	-
13.973	1-butene	29274	29811	30814	31628	31949
14.383	n-butane	23388	25057	24524	23624	22935
15.767	n-pentane	-	729	-	19415	796
16.015	i-pentane	3369	17862	33881	19415	34460
16.508	Cyclopentane	13881	35248	172298	67648	103623
17.732	i-hexane	2953	59431	5000	57707	69591
18.217	n-hexane	30884	42348	52647	104681	92945
18.483	Cyclo hexane	10126	53942	108435	105383	130318
19.196	i-heptane	26747	31778	-	-	100922
19.525	n-heptane	139890	262012	347686	234274	185375
20.934	aromatic	-	-	34439	38868	30379
21.864*	di-methyl cyclopentane	15956	25823	2939	6551	3886
	Total	747758	1025312	1221675	1086857	1112974

Peak Time (min)	Species	Si/Ai = 40		
		300 min	360 min	420 min
0.79	methane	14042	13340	4828
1.963	ethylene	72382	68763	20587
2.604	ethane	6218	5907	2049
10.059	propylene	150655	143122	52981
10.997	propane	8823	8382	1674
13.703	i-butene	1544	1467	548
13.973	1-butene	29010	27560	16261
14.383	n-butane	21494	20419	9538
15.767	n-pentane	982	933	1003
16.015	i-pentane	45697	43412	44671
16.508	Cyclopentane	156281	148467	100797
17.732	i-hexane	96289	91475	174307
18.217	n-hexane	111119	105563	230739
18.483	Cyclo hexane	159284	151320	169472
19.196	i-heptane	137049	130197	114197
19.525	n-heptane	176403	167583	90880
20.934	aromatic	33615	31934	9067
21.86 <sup>4</sup>	di-methyl cyclopentane	5453	5180	8898
	Total	1226340	1165023	1052497

**Table A17** Raw data from mixed C<sub>6</sub> stability test over ZSM-5 with Si/Al= 190 at 650°C with 50% vol. feed concentration at total flow rate 50 ml/min

Peak Time (min)	Species	Si/Al = 190				
		5 min	60 min	120 min	180 min	240 min
0.79	methane	4541	5456	5713	5699	5466
1.963	ethylene	49590	51806	50702	50833	49379
2.604	ethane	5479	6021	6111	6161	6028
10.059	propylene	137771	148245	147705	148882	147558
10.997	propane	5611	6261	6248	6674	6192
13.703	i-butene	-	-	-	-	-
13.973	1-butene	24728	27007	26809	27358	26566
14.383	n-butane	17488	19004	18188	18282	18649
15.767	n-pentane	956	1175	1234	1208	1194
16.015	i-pentane	11471	39848	40702	13853	40920
16.508	Cyclopentane	20947	7702	146870	164493	152929
17.732	i-hexane	114953	144604	2225	-	1294
18.217	n-hexane	36688	145436	141315	198283	147661
18.483	Cyclo hexane	118501	188529	204238	186108	205179
19.196	i-heptane	50217	90612	-	-	96875
19.525	n-heptane	35299	52682	101807	168920	62407
20.934	aromatic	29948	50764	56511	15963	59426
21.864	di-methyl cyclopentane	5115	11100	3316	-	12825
	Total	669303	996252	959694	1012717	1040548

Peak Time (min)	Species	Si/Al = 190				
		300 min	360 min	420 min	480 min	540 min
0.79	methane	5692	3396	4415	5617	4754
1.963	ethylene	49554	33254	43230	48514	46556
2.604	ethane	6094	3922	5099	6162	5491
10.059	propylene	149239	96179	125033	144969	134651
10.997	propane	6334	3761	4889	6304	5265
13.703	i-butene	-	-	-	-	-
13.973	1-butene	26385	17999	23399	25251	25199
14.383	n-butane	17495	12490	16237	17104	17486
15.767	n-pentane	1366	770	1001	1090	1078
16.015	i-pentane	13040	18157	23604	34995	25420
16.508	Cyclopentane	143942	97226	126394	120146	136116
17.732	i-hexane	-	93843	121996	891	131380
18.217	n-hexane	173076	30289	39376	121178	42405
18.483	Cyclo hexane	193042	99261	129039	173976	138965
19.196	i-heptane	187566	114977	149470	187535	160968
19.525	n-heptane	12363	39589	51466	78523	55425
20.934	aromatic	51478	26149	33994	48893	36609
21.864	di-methyl cyclopentane	9652	19299	25089	9658	27019
	Total	1046318	710561	923729	1030806	994785



Peak Time (min)	Species	Si/Al = 190				
		480 min	540 min	600 min	660 min	720 min
0.79	methane	5617	5505	5289	5818	5553
1.963	ethylene	48514	47544	45193	49712	47453
2.604	ethane	6162	6039	5767	6344	6055
10.059	propylene	144969	142070	138389	152228	145308
10.997	propane	6304	6178	5963	6559	6261
13.703	i-butene	-	-	-	-	-
13.973	1-butene	25251	24746	24036	26440	25238
14.383	n-butane	17104	16762	16784	18462	17623
15.767	n-pentane	1090	1068	1516	1668	1592
16.015	i-pentane	34995	34295	40664	44730	42697
16.508	Cyclopentane	120146	117743	143233	157556	150395
17.732	i-hexane	891	873	-	-	-
18.217	n-hexane	121178	118754	187348	206083	196715
18.483	Cyclo hexane	173976	170496	165336	181870	173603
19.196	i-heptane	187535	183784	14252	15677	14965
19.525	n-heptane	78523	76953	65480	72028	68754
20.934	aromatic	48893	47915	65000	71500	68250
21.964	di-methyl cyclopentane	9658	9465	41305	45436	43370
	Total	1030806	1010190	965555	1062111	1013833

Peak Time (min)	Species	Si/Al = 190			
		780 min	840 min	900 min	960 min
0.79	methane	5210	5366	5728	5561
1.963	ethylene	44158	45483	46870	45505
2.604	ethane	5707	5878	6220	6039
10.059	propylene	138049	142190	143892	139701
10.997	propane	6006	6186	5665	5500
13.703	i-butene	-	-	-	-
13.973	1-butene	23742	24454	24340	23631
14.383	n-butane	16439	16932	16341	15865
15.767	n-pentane	1142	1176	1037	1007
16.015	i-pentane	11512	11857	31019	30116
16.508	Cyclopentane	141352	145593	115305	111947
17.732	i-hexane	-	-	117309	113892
18.217	n-hexane	135668	139738	171202	166216
18.483	Cyclo hexane	187733	193365	175079	169980
19.196	i-heptane	-	-	26304	25538
19.525	n-heptane	224651	231391	71351	69273
20.934	aromatic	81905	84362	46955	45587
21.864	di-methyl cyclopentane	11997	12357	48237	46832
	Total	1035271	1066329	1052856	1022190

## Appendix B Converting Gas Chromatography Area Method

Area under the curve from online gas chromatography (Shimadzu, GC-14A with C-R4A Chromatopac) can be convert to mass percent by using the following formula which used to calculaied the flame ionization detector respond factors that obtained from the ASTM D 5443 standard method.

$$Fi = \frac{(Caw \times Cn) + (Haw \times Hn) \times 0.7487}{Caw} \quad (1)$$

Where:

$Fi$  = relative response factor for a hydrocarbon type group of a particular carbon number,

$Caw$  = atomic weight of carbon, 12.011,

$Cn$  = number of carbon molecules in the group,

$Haw$  = atomic weight of hydrogen, 1.008,

$Hn$  = number of hydrogen molecules in the group, and

0.7478 = corrects the response of methane to unity.

Multiple the area associated with each of the identifield groups by the appropriate response factor to produce a corrected area for each of the group:

$$Aic = Ai \times Fi \quad (2)$$

Where:

$Aic$  = corrected area of an identified group, and

$Ai$  = raw area of identified group.

Add all of the individual, corrected areas from equation (2):

$$T = \sum A_{ic} \quad (3)$$

Where:

$T$  = total of corrected areas.

Divide each of the identified groups by the total corrected area determined in equation (3) to produce the normalized mass percent for each group:

$$M_i = \frac{A_{ic}}{T} \quad (4)$$

Where:

$M_i$  = normalized mass % of an identified group.

From these method the relative response factor ( $F_i$ ) can be calculating and presenting in Table B1

**Table B1** The relative response factor ( $F_i$ ) of any hydrocarbons in this experiment

Species	$C_n$	$H_n$	$F_i$	Species	$C_n$	$H_n$	$F_i$
methane	1	4	1.0000	1,3-pentadiene	5	8	0.8492
ethane	2	6	0.9372	1-pentene	5	10	0.8744
ethylene	2	4	0.8744	benzene	6	6	0.8115
propane	3	8	0.9163	cyclo-pentadiene	5	10	0.8744
propylene	3	6	0.8744	i-hexene	6	12	0.8744
i-butane	4	10	0.9058	n-hexane	6	14	0.8953
n-butane	4	10	0.9058	1-hexene	6	12	0.8744
tran-2-butene	4	8	0.8744	2-hexene	6	12	0.8744
1-butene	4	8	0.8744	i-hexane	6	14	0.8953
i-butene	4	8	0.8744	cyclo-hexene	6	10	0.8534
cis-2-butene	4	8	0.8744	cyclo-hexane	6	12	0.8744
1,2-butadiene	4	6	0.8429	MCP	6	12	0.8744
1,3-butadiene	4	6	0.8429	i-heptane	7	16	0.8923
i-pentane	5	12	0.8995	n-heptane	7	16	0.8923
n-pentane	5	12	0.8995	DCP	7	14	0.8744

## CURRICULUM VITAE

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