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APPENDIX

APPENDIX A

Table A1 Element concentration of molecular sieve and catalyst type from X-ray fluorescence data

Elements	Concentration (%wt)	
	Molecular sieve	Fe(5%)/Sn(5%)/F(2%) on Molecular sieve
Al	DT	DT
Si	0	DT
Cl	DT	DT
Ca	0.26	0.88
Ti	DT	DT
Cr	DT	DT
Mn	0.24	0.35
Fe	1.14	13.75
Co	DT	0
Ni	DT	DT
Cu	0.24	0.27
Zn	0.12	0.13
Mo	DT	0
Sn	0	3.59
Pt	0	0

Note : DT means that the instrument could detect a component but could not determine quantity.

Table A1 Element concentration of molecular sieve and catalyst type from X-ray fluorescence data (continued)

Elements	Concentration (%wt)	
	Fe(2.5%)/Sn(5%)/F(2%) on Molecular sieve	Fe(5%)/Sn(2.5%)/F(2%) on Molecular sieve
Al	DT	DT
Si	DT	0
Cl	DT	0.10
Ca	1.48	0.50
Ti	DT	DT
Cr	DT	DT
Mn	0.39	0.30
Fe	9.85	12.24
Co	0	0
Ni	DT	DT
Cu	0.28	0.31
Zn	0.14	0.15
Mo	DT	0
Sn	4.01	1.42
Pt	0	0

Note : DT means that the instrument could detect a component but could not determine quantity.

Table A1 Element concentration of molecular sieve and catalyst type from X-ray fluorescence data (continued)

Elements	Concentration (%wt)	
	Co(5%)/Sn(5%)/F(2%) on Molecular sieve	Ni(5%)/Sn(5%)/F(2%) on Molecular sieve
Al	DT	0.13
Si	DT	DT
Cl	DT	0.13
Ca	1.20	0.90
Ti	DT	DT
Cr	DT	DT
Mn	0.34	0.31
Fe	1.20	0.92
Co	5.41	DT
Ni	0.16	8.97
Cu	0.29	0.13
Zn	0.15	0.14
Mo	DT	DT
Sn	3.47	4.79
Pt	0	0

Note : DT means that the instrument could detect a component but could not determine quantity.

Table A2 Element concentration of commercial catalyst

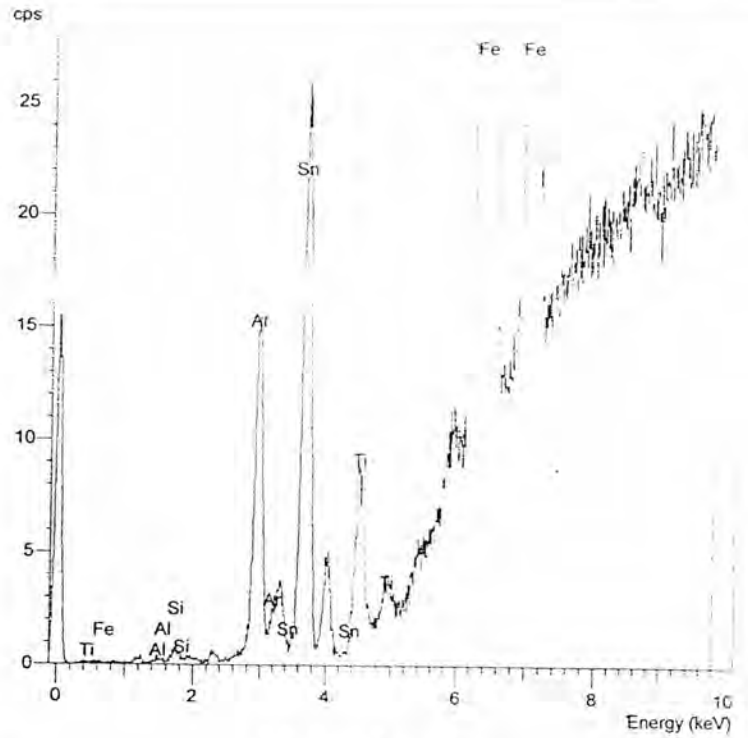
Elements	Concentration (%wt)	
	Commercial Catalyst from Thai Oil	Commercial Catalyst from United Catalyst Ltd.
Al	DT	DT
Si	DT	DT
Cl	DT	DT
Ca	DT	DT
Ti	DT	DT
Cr	DT	DT
Mn	0.44	DT
Fe	0.76	DT
Co	DT	DT
Ni	0.28	5.52
Cu	0.20	0
Zn	DT	0
Mo	DT	DT
Sn	0.74	0
Pt	1.86	0

Note : DT means that the instrument could detect a component but could not determine quantity.

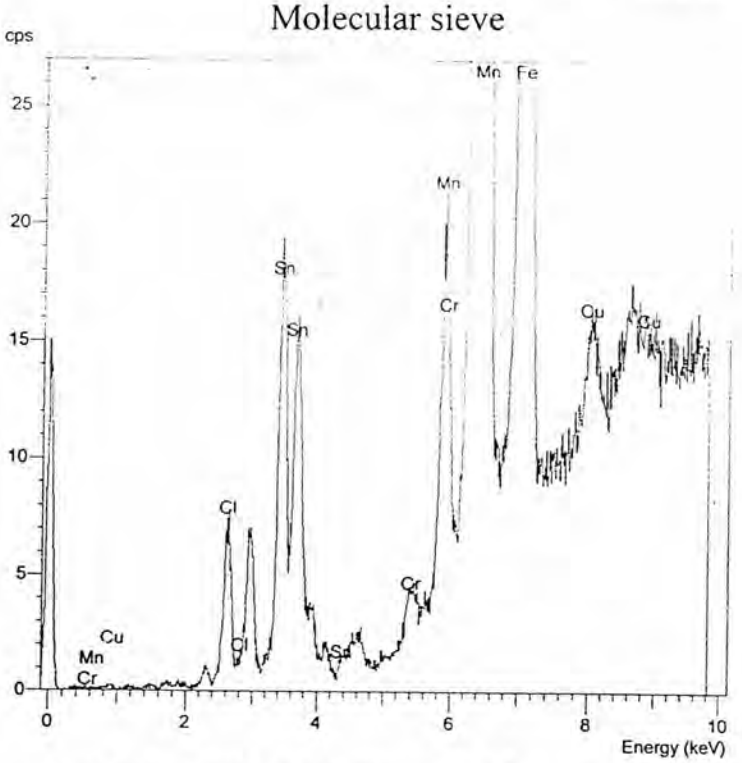
Table A3 Element concentration of alumina support and catalyst type from X-ray fluorescence data

Elements	Concentration (%wt)	
	Alumina	Fe(5%)/Sn(5%)/F(2%) on Alumina
Al	DT	0.16
Si	DT	0
Cl	DT	DT
Ca	DT	1.15
Ti	DT	DT
Cr	DT	DT
Mn	0.25	0.23
Fe	0.28	12.06
Co	DT	0
Ni	DT	DT
Cu	0.23	0.14
Zn	0.13	DT
Mo	DT	DT
Sn	0	9.68
Pt	DT	0

Note : DT means that the instrument could detect a component but could not determine quantity.

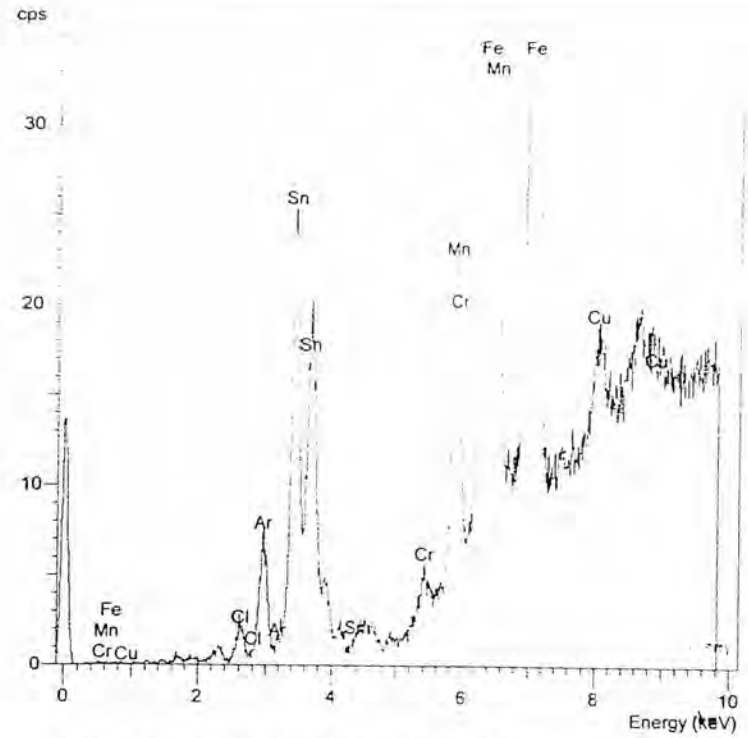


Molecular sieve

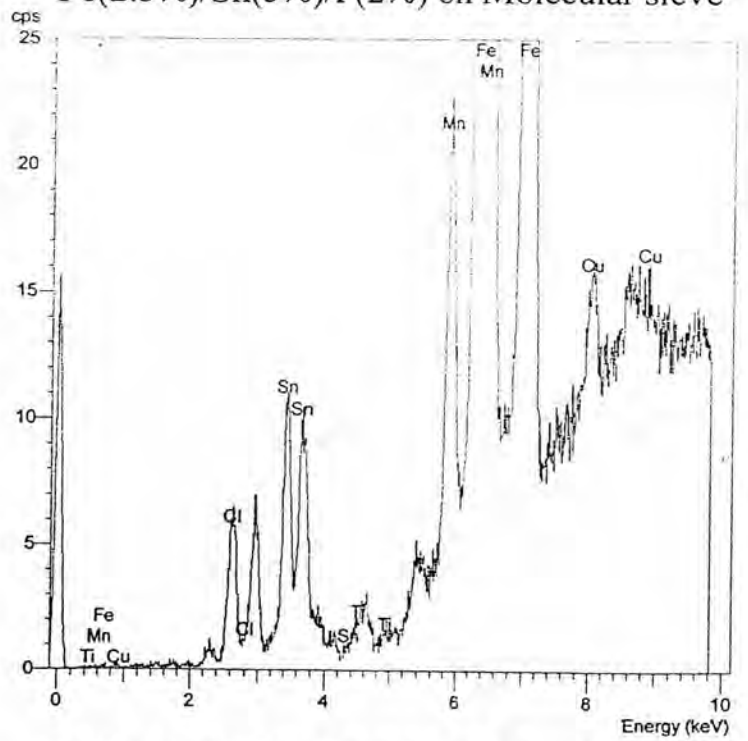


Fe(5%)/Sn((5%)/F(2%) on Molecular sieve

Figure A1 Plots of X-ray fluorescence data of molecular sieve and catalyst type



Fe(2.5%)/Sn(5%)/F(2%) on Molecular sieve



Fe(5%)/Sn(2.5%)/F(2%) on Molecular sieve

Figure A1 Plots of X-ray fluorescence data of molecular sieve and catalyst type (continued)

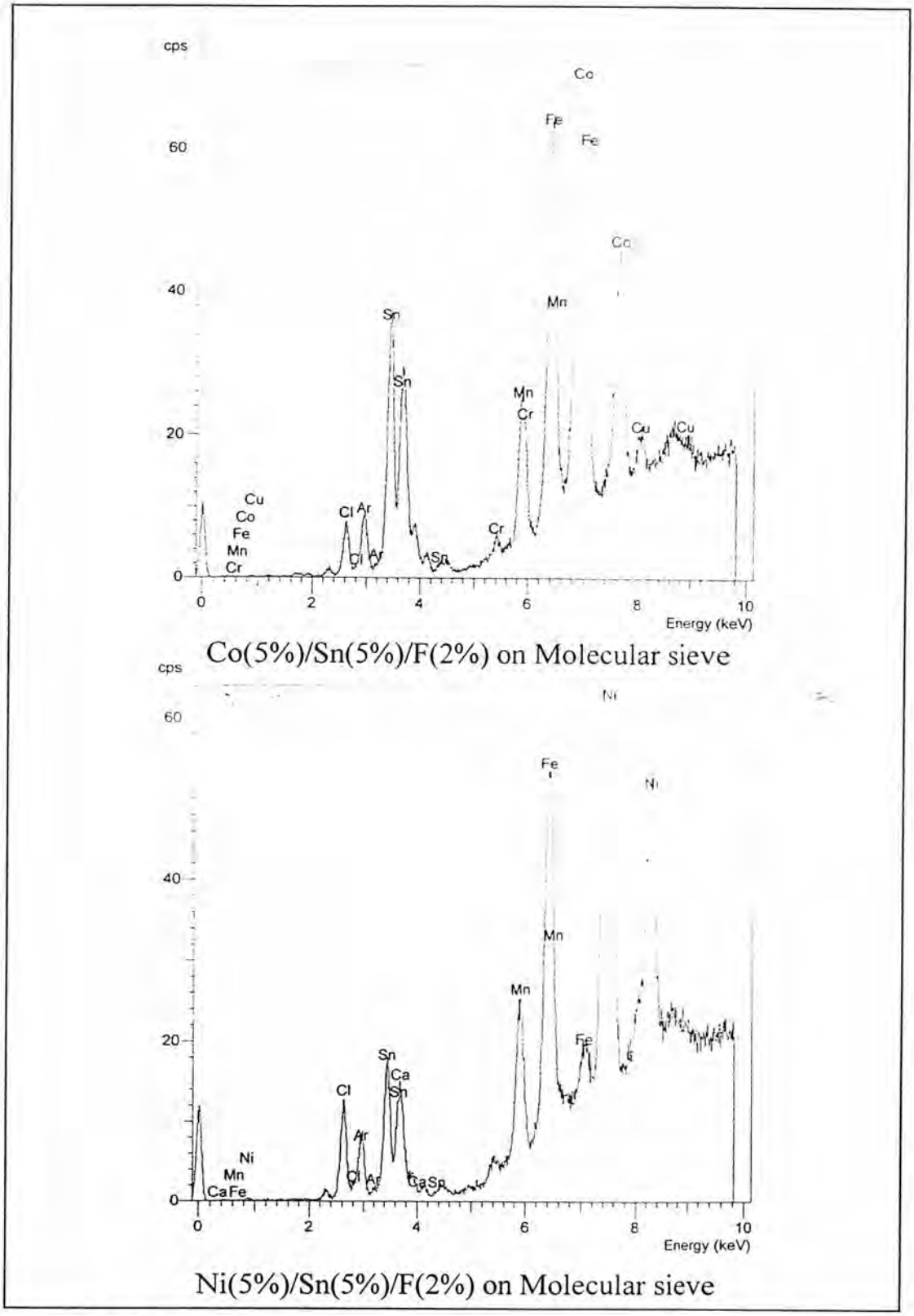
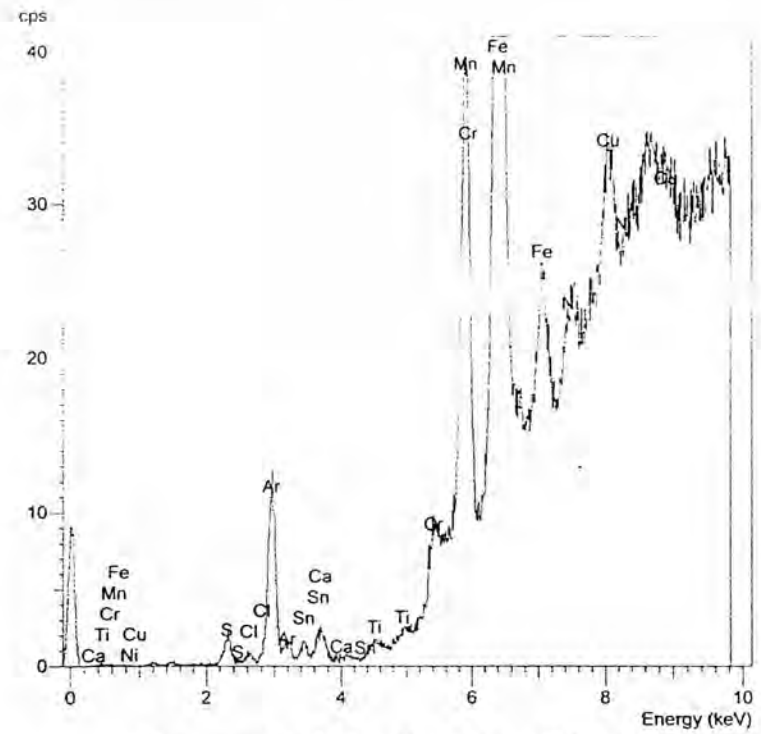
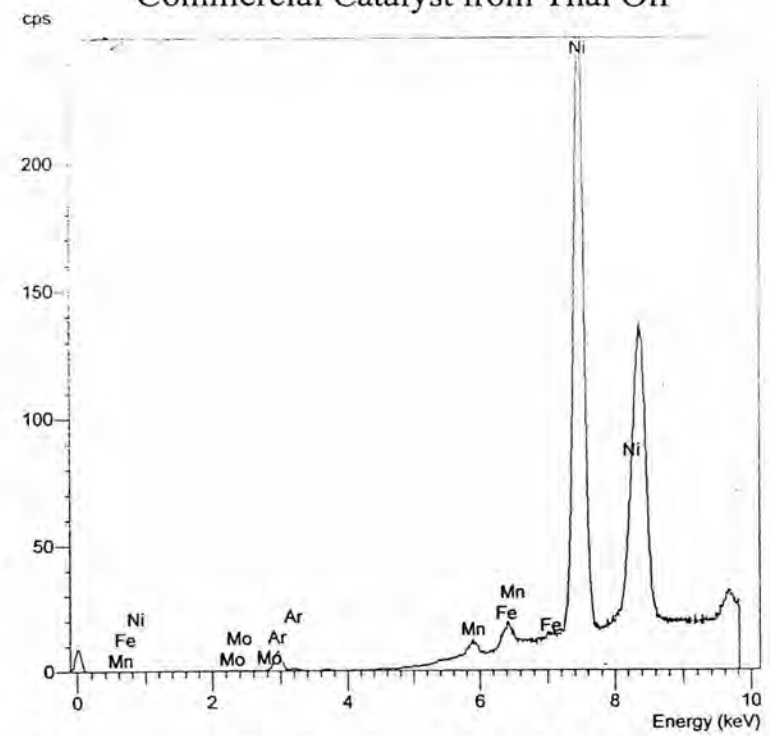


Figure A1 Plots of X-ray fluorescence data of molecular sieve and catalyst type (continued)



Commercial Catalyst from Thai Oil



Commercial Catalyst from United Catalyst Inc.

Figure A2 Plots of X-ray fluorescence data of commercial catalyst

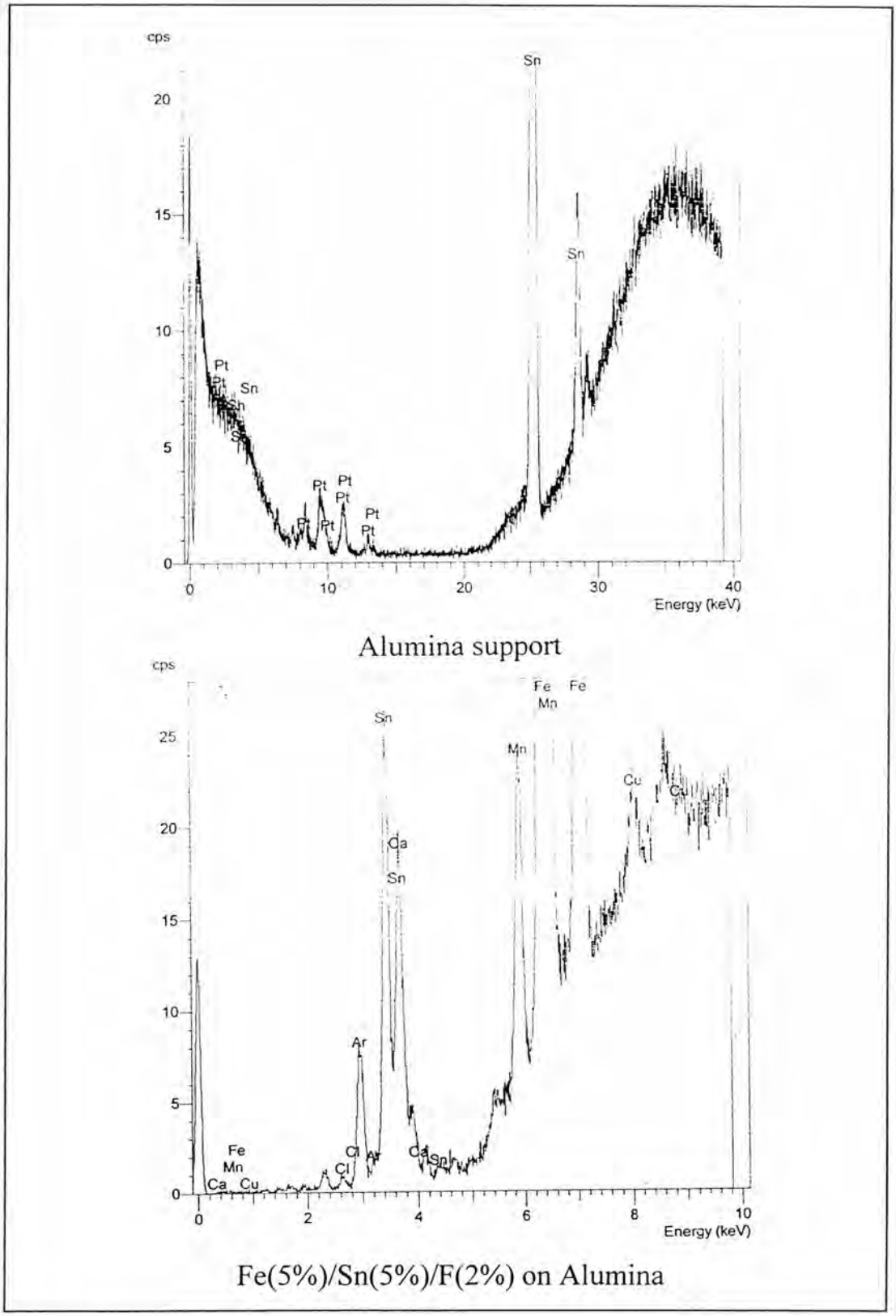


Figure A3 Plots of X-ray fluorescence data of alumina and catalyst type

APPENDIX B

Table B1 Composition of products from hydrocracking as a function of catalyst type

Component	Retention Time (min)		
	Type 2	Type 4	Type 5
cyclohexane	6.156	6.025	6.025
n-heptane		10.100	
1,2-dimethylcyclohexane	12.519	12.385	12.396
1,2,4-trimethylcyclohexane	15.868		
n-nonane	16.760		
n-undecane	25.818	25.820	
isomerC11		31.421	31.415
benzene	31.440	31.508	31.506
toluene	31.698	31.705	31.707
isomerC7	32.050		
polynaphthene	34.379	34.380	
polynaphthene	34.609		
isomerC8	39.974		
isomerC8	41.802	41.789	41.784
ethylbenzene	42.164	42.154	42.148
iso-propylbenzene	42.507	42.500	42.497
n-propylbenzene	42.687	42.686	42.680
1,2,4-trimethylbenzene	43.239	43.238	43.234
isomerC9	44.373		
isomerC9	54.967		
isomerC9	57.105	57.107	57.095
isomerC9		57.247	57.235

Table B1 Composition of products from hydrocracking as a function of catalyst type (continued)

Component	Retention Time (min)		
	Type 2	Type 4	Type 5
isomerC9	57.465	57.468	57.457
isomerC9		57.880	57.869
isomerC9		58.352	
isomerC9	58.757	58.760	58.751
isomerC10	61.361		
isomerC11	69.455		

Table B2 %Peak area of products from hydrocracking as a function of catalyst type

Component	% Peak Area		
	Type 2	Type 4	Type 5
cyclohexane	0.0185	0.0519	0.1238
n-heptane		0.0333	
1,2-dimethylcyclohexane	0.3073	0.0613	0.0600
1,2,4-trimethylcyclohexane	0.0494		
n-nonane	0.0353		
n-undecane	0.0218	0.0218	
isomerC11		0.1572	0.3630
benzene	0.0895	0.2638	0.1627
toluene	5.9634	19.0910	19.0495
isomerC7	0.0327		
polynaphthene	0.0188	0.0064	
polynaphthene	0.0065		
isomerC8	0.0123		
isomerC8	0.4647	1.3981	1.4790
ethylbenzene	78.5024	64.3516	61.9543
iso-propylbenzene	13.4687	12.7422	15.2329
n-propylbenzene	0.6541	0.9148	0.7241
1,2,4-trimethylbenzene	0.0836	0.1730	0.1661
isomerC9	0.0162		
isomerC9	0.0123		
isomerC9	0.1335	0.0912	0.0896
isomerC9		0.2037	0.1739

Table B2 %Peak area of products from hydrocracking as a function of catalyst type (continued)

Component	% Peak Area		
	Type 2	Type 4	Type 5
isomerC9	0.0411	0.0383	0.0347
isomerC9		0.3020	0.3153
isomerC9		0.0253	
isomerC9	0.0444	0.0731	0.0712
isomerC10	0.0137		
isomerC11	0.0099		

Table B3 Composition of products from hydrocracking as a function of % component of Fe/Sn/F on molecular sieve

Component	Retention time (min)		
	Component A	Component B	Component C
cyclohexane	6.025		6.148
n-hexane			7.142
n-heptane			10.293
1,2-dimethylcyclohexane	12.396		12.503
n-octane			13.586
n-nonane			16.420
n-undecane		25.815	25.826
isomerC11	31.415		31.407
benzene	31.506		31.507
toluene	31.707	31.677	31.709
polynaphthene		34.608	34.608
isomerC8		39.973	39.973
isomerC8			41.543
isomerC8	41.784	41.741	41.791
ethylbenzene	42.148	42.086	42.155
iso-propylbenzene	42.497	42.445	42.502
n-propylbenzene	42.680	42.652	42.685
1,2,4-trimethylbenzene	43.234		43.240
isomerC9			44.368
isomerC9	57.095	57.085	57.112
isomerC9	57.235		57.251
isomerC9	57.457		57.473

Table B3 Composition of products from hydrocracking as a function of % component of Fe/Sn/F on molecular sieve (continued)

Component	Retention time (min)		
	Component A	Component B	Component C
isomerC9	57.869		57.884
isomerC9			58.356
isomerC9	58.751		58.766
isomerC10		61.360	61.359
isomerC10			64.014
isomerC11		69.453	69.453

Table B4 %Peak area of products from hydrocracking as a function of % component of Fe/Sn/F on molecular sieve

Component	%Peak area		
	Component A	Component B	Component C
cyclohexane	0.1238		0.2000
n-hexane			0.0314
n-heptane			0.0396
1,2-dimethylcyclohexane	0.0600		0.0383
n-octane			0.0210
n-nonane			0.0200
n-undecane		1.2073	0.0206
isomerC11	0.3630		0.6770
benzene	0.1627		0.3052
toluene	19.0495	10.9708	20.3308
polynaphthene		0.3721	0.0062
isomerC8		1.0590	0.0184
isomerC8			0.0328
isomerC8	1.4790	1.0618	1.3246
ethylbenzene	61.9543	63.1263	62.2105
iso-propylbenzene	15.2329	17.4446	12.5300
n-propylbenzene	0.7241	1.0205	0.7640
1,2,4-trimethylbenzene	0.1661		0.1608
isomerC9			0.0305
isomerC9	0.0896	0.8687	0.0707
isomerC9	0.1739		0.3739
isomerC9	0.0347		0.0256

Table B4 %Peak area of products from hydrocracking as a function of % component of Fe/Sn/F on molecular sieve (continued)

Component	%Peak area		
	Component A	Component B	Component C
isomerC9	0.3153		0.5394
isomerC9			0.0360
isomerC9	0.0712		0.0694
isomerC10		1.8674	0.0409
isomerC10			0.0638
isomerC11		1.0315	0.0188

Table B5 Composition of products from hydrocracking as a function of reaction time

Component	Retention time (min)	
	1.5 hours	2 hours
n-pentane	4.363	
cyclohexane	6.161	6.043
n-hexane	7.174	7.018
n-heptane	10.320	10.090
1,2-dimethylcyclohexane	12.576	12.410
n-octane	13.442	
n-nonane		16.327
n-undecane	25.827	25.827
isomerC11	31.409	31.407
benzene	31.506	
toluene	31.709	31.708
isomerC7		32.068
polynaphthene	34.608	34.608
isomerC8	39.973	39.973
isomerC8		41.535
isomerC8	41.790	41.790
ethylbenzene	42.155	42.154
iso-propylbenzene	42.504	42.502
n-propylbenzene	42.689	42.687
1,2,4-trimethylbenzene	43.244	43.241
isomerC9		
isomerC9	56.760	56.760

Table B5 Composition of products from hydrocracking as a function of reaction time (continued)

Component	Retention time (min)	
	1.5 hours	2 hours
isomerC9	57.113	57.113
isomerC9	57.252	57.251
isomerC9	57.475	57.474
isomerC9	57.888	57.886
isomerC9	58.361	
isomerC9	58.771	58.770
isomerC10	61.359	61.359
isomerC10		
isomerC11	69.453	69.453

Table B6 %Peak area of products from hydrocracking as a function of reaction time

Component	%Peak Area	
	1.5 hours	2 hours
n-pentane	0.0224	
cyclohexane	0.1233	0.2157
n-hexane	0.0323	0.0290
n-heptane	0.0383	0.0310
1,2-dimethylcyclohexane	0.0415	0.0681
n-octane	0.0139	
n-nonane		0.0195
n-undecane	0.0198	0.0204
isomerC11	0.4456	0.9369
benzene	0.2948	
toluene	21.4006	18.6756
isomerC7		0.0446
polynaphthene	0.0059	0.0061
isomerC8	0.0171	0.0174
isomerC8		0.0114
isomerC8	1.5138	1.3340
ethylbenzene	62.0752	64.1589
iso-propylbenzene	12.3848	12.8811
n-propylbenzene	0.7190	0.6640
1,2,4-trimethylbenzene	0.1449	0.1311
isomerC9		
isomerC9	0.0115	0.0116

Table B6 %Peak area of products from hydrocracking as a function of reaction time(continued)

Component	%Peak Area	
	1.5 hours	2 hours
isomerC9	0.0864	0.1014
isomerC9	0.1764	0.2235
isomerC9	0.0400	0.0475
isomerC9	0.2543	0.2670
isomerC9	0.0211	
isomerC9	0.0634	0.0524
isomerC10	0.0362	0.0343
isomerC10		
isomerC11	0.0175	0.0173

Table B7 Composition of products from hydrocracking as a function of catalyst concentration

Component	Retention Time (min)		
	15%	20%	40%
n-pentane	4.361	4.277	4.363
cyclohexane	6.170	6.026	6.161
n-hexane	7.189	7.010	7.174
n-heptane	10.337	10.112	10.320
isomerC7		11.230	
1,2-dimethylcyclohexane	12.599	12.392	12.576
n-octane			13.442
1,2,4-trimethylcyclohexane		15.508	
n-nonane	16.581	16.124	
n-undecane	25.827	25.828	25.827
isomerC11	31.411	31.413	31.409
benzene	31.507	31.508	31.506
toluene	31.711	31.712	31.709
polynaphthene	34.608	34.609	34.608
isomerC8	39.973	39.973	39.973
isomerC8	41.792	41.791	41.790
ethylbenzene	42.155	42.154	42.155
iso-propylbenzene	42.506	42.504	42.504
n-propylbenzene	42.686	42.690	42.689
1,2,4-trimethylbenzene	43.242	43.246	43.244
isomerC9	44.369		
isomerC9	56.765	56.765	56.760

Table B7 Composition of products from hydrocracking as a function of catalyst concentration (continued)

Component	Retention Time (min)		
	15%	20%	40%
isomerC9	57.118	57.117	57.113
isomerC9	57.258	57.258	57.252
isomerC9	57.479	57.480	57.475
isomerC9	57.890	57.894	57.888
isomerC9	58.360	58.367	58.361
isomerC9	58.771	58.780	58.771
isomerC10	61.360	61.360	61.359
isomerC10	63.998		
isomerC11	69.453	69.453	69.453

Table B8 %Peak area of products from hydrocracking as a function of catalyst concentration

Component	%Peak Area		
	15%	20%	40%
n-pentane	0.0143	0.0153	0.0224
cyclohexane	0.0891	0.1273	0.1233
n-hexane	0.0234	0.0220	0.0323
n-heptane	0.0284	0.0295	0.0383
isomerC7		0.0695	0.0415
1,2-dimethylcyclohexane	0.0357	0.0469	0.0139
n-octane			
1,2,4-trimethylcyclohexane		0.0459	0.0198
n-nonane	0.0266	0.0221	0.4456
n-undecane	0.0203	0.0198	0.2948
isomerC11	0.4014	0.3997	21.4006
benzene	0.3027	0.2727	
toluene	21.9641	24.5662	0.0059
polynaphthene	0.0061	0.0059	0.0171
isomerC8	0.0173	0.0174	
isomerC8	1.4137	1.7082	1.5138
ethylbenzene	57.3030	58.9266	62.0752
iso-propylbenzene	16.1816	11.9847	12.3848
n-propylbenzene	0.6944	0.6923	0.7190
1,2,4-trimethylbenzene	0.1840	0.1524	0.1449
isomerC9	0.0299		
isomerC9	0.0127	0.0159	0.0115

Table B8 %Peak area of products from hydrocracking as a function of catalyst concentration (continued)

Component	%Peak Area		
	15%	20%	40%
isomerC9	0.0812	0.0992	0.0864
isomerC9	0.3293	0.2190	0.1764
isomerC9	0.0425	0.0448	0.0400
isomerC9	0.5063	0.3474	0.2543
isomerC9	0.0340	0.0267	0.0211
isomerC9	0.0806	0.0692	0.0634
isomerC10	0.0391	0.0364	0.0362
isomerC10	0.1212		
isomerC11	0.0171	0.0170	0.0175

Table B9 Composition of products from hydrocracking as a function of hydrogen pressure

Component	Retention Time (min)	
	400 psig	500 psig
n-pentane		4.361
cyclohexane		6.170
n-hexane		7.189
n-heptane		10.337
1,2-dimethylcyclohexane	12.544	12.599
n-nonane	16.547	16.581
isomerC9	16.873	
n-undecane	25.817	25.827
isomerC11		31.411
benzene	31.512	31.507
toluene	31.699	31.711
isomerC7	32.055	
polynaphthene	34.609	34.608
isomerC8	39.973	39.973
isomerC8	41.792	41.792
ethylbenzene	42.157	42.155
iso-propylbenzene	42.514	42.506
n-propylbenzene	42.688	42.686
1,2,4-trimethylbenzene	43.240	43.242
isomerC9	44.369	44.369
isomerC9		56.765
isomerC9	57.110	57.118

Table B9 Composition of products from hydrocracking as a function of hydrogen pressure (continued)

Component	Retention Time (min)	
	400 psig	500 psig
isomerC9	57.250	57.258
isomerC9	57.471	57.479
isomerC9	57.881	57.890
isomerC9	58.394	58.360
isomerC9	58.761	58.771
isomerC10	59.642	
isomerC10	59.840	
isomerC10	60.561	
isomerC10	61.299	
isomerC10	61.359	61.360
isomerC10	64.008	63.998
isomerC11	69.453	69.453

Table B10 %Peak area of products from hydrocracking as a function of hydrogen pressure

Component Name	%Peak Area	
	400 psig	500 psig
n-pentane		0.0143
cyclohexane		0.0891
n-hexane		0.0234
n-heptane		0.0284
1,2-dimethylcyclohexane	0.0372	0.0357
n-nonane	0.0353	0.0266
isomerC9	0.0165	
n-undecane	0.0198	0.0203
isomerC11		0.4014
benzene	0.0218	0.3027
toluene	6.3002	21.9641
isomerC7	0.0206	
polynaphthene	0.0060	0.0061
isomerC8	0.0170	0.0173
isomerC8	0.5288	1.4137
ethylbenzene	62.7817	57.3030
iso-propylbenzene	26.6070	16.1816
n-propylbenzene	1.2814	0.6944
1,2,4-trimethylbenzene	0.3919	0.1840
isomerC9	0.0377	0.0299
isomerC9		0.0127
isomerC9	0.0851	0.0812

Table B10 %Peak area of products from hydrocracking as a function of hydrogen pressure (continued)

Component	%Peak Area	
	400 psig	500 psig
isomerC9	0.2668	0.3293
isomerC9	0.0710	0.0425
isomerC9	0.8412	0.5063
isomerC9	0.0796	0.0340
isomerC9	0.2095	0.0806
isomerC10	0.0503	
isomerC10	0.0345	
isomerC10	0.0568	
isomerC10	0.0472	
isomerC10	0.0347	0.0391
isomerC10	0.1036	0.1212
isomerC11	0.0169	0.0171

Table B11 Composition of products from cracking under nitrogen pressure as a function of reaction time

Component	Retention Time (min)	
	5.5 hours	6 hours
n-pentane		4.322
cyclohexane		6.252
n-hexane		7.065
isomerC6		9.307
n-heptane		10.188
1,2-dimethylcyclohexane	12.411	12.476
isomerC8		13.336
n-octane		13.544
n-nonane		16.490
isomerC9		16.744
n-undecane	25.815	25.827
benzene		31.511
toluene	31.689	31.709
polynaphthene	34.609	34.609
isomerC8	39.973	39.973
isomerC8	41.746	41.790
ethylbenzene	42.094	42.153
iso-propylbenzene	42.455	42.499
n-propylbenzene		42.685
1,2,4-trimethylbenzene		43.237
isomerC9		56.762
isomerC9	57.102	57.113

Table B11 Composition of products from cracking under nitrogen pressure as a function of reaction time (continued)

Component	Retention Time (min)	
	5.5 hours	6 hours
isomerC9		57.254
isomerC9		57.474
isomerC9		57.891
isomerC9		58.766
isomerC10	61.360	61.360
isomerC11	69.453	69.453

Table B12 %Peak area of products from cracking under nitrogen pressure as a function of reaction time

Component	%Peak Area	
	5.5 hours	6 hours
n-pentane		0.0287
cyclohexane		0.0193
n-hexane		0.0722
isomerC6		0.0392
n-heptane		0.0822
1,2-dimethylcyclohexane	5.8045	0.0527
isomerC8		0.0474
n-octane		0.0389
n-nonane		0.0372
isomerC9		0.0306
n-undecane	4.8142	0.0197
benzene		0.7328
toluene	9.4724	22.4902
polynaphthene	1.4727	0.0059
isomerC8	4.1391	0.0168
isomerC8	3.2489	1.6326
ethylbenzene	42.2042	62.0904
iso-propylbenzene	10.3042	11.0900
n-propylbenzene		0.9206
1,2,4-trimethylbenzene		0.1478
isomerC9		0.0124
isomerC9	6.7193	0.0831

Table B12 %Peak area of products from cracking under nitrogen pressure as a function of reaction time (continued)

Component	%Peak Area	
	5.5 hours	6 hours
isomerC9		0.0599
isomerC9		0.0323
isomerC9		0.0978
isomerC9		0.0628
isomerC10	7.7313	0.0401
isomerC11	4.0892	0.0163

Table B13 Composition of products from cracking under nitrogen pressure as a function of catalyst concentration

Component	Retention Time (min)		
	5%	10%	20%
n-heptane			11.896
1,2-dimethylcyclohexane	12.446	12.371	
n-octane		13.196	
1,2,4-trimethylcyclohexane		13.404	
n-nonane		16.047	
n-undecane	25.814	25.817	25.814
benzene		31.498	31.501
toluene		31.690	31.699
isomerC7			32.017
polynaphthene	34.608	34.609	34.608
isomerC8	39.973	39.973	39.973
isomerC8		41.772	41.778
ethylbenzene	42.070	42.133	42.138
iso-propylbenzene	42.434	42.477	42.485
n-propylbenzene		42.658	42.664
1,2,4-trimethylbenzene		43.204	43.212
isomerC9		44.396	44.368
isomerC9			56.746
isomerC9	57.079	57.091	57.096
isomerC9		57.235	57.235
isomerC9	57.437	57.448	57.453
isomerC9		57.862	57.861

Table B13 %Peak area of products from cracking under nitrogen pressure as a function of catalyst concentration (continued)

Component	%Peak Area		
	5%	10%	20%
isomerC9		58.728	58.732
isomerC10	61.360	61.359	61.359
isomerC11	69.453	69.453	69.453

Table B14 %Peak area of products from cracking under nitrogen pressure as a function of catalyst concentration

Component	%Peak Area		
	5%	10%	20%
n-heptane			0.0277
1,2-dimethylcyclohexane	14.0298	0.0392	
n-octane		0.0250	
1,2,4-trimethylcyclohexane		0.0296	
n-nonane		0.0216	
n-undecane	9.4319	0.0197	0.0224
benzene		0.0873	0.1772
toluene		14.2354	21.4634
isomerC7			0.0349
polynaphthene	2.8910	0.0061	0.0066
isomerC8	8.3294	0.0172	0.0204
isomerC8		1.3428	1.5936
ethylbenzene	15.5009	67.3839	59.1631
iso-propylbenzene	6.6114	14.9334	15.8566
n-propylbenzene		1.1584	0.6735
1,2,4-trimethylbenzene		0.2104	0.1762
isomerC9		0.0300	0.0345
isomerC9			0.0308
isomerC9	13.7516	0.0933	0.1705
isomerC9		0.0594	0.1129
isomerC9	6.2571	0.0432	0.0769
isomerC9		0.1235	0.2339

Table B14 %Peak area of products from cracking under nitrogen pressure as a function of catalyst concentration (continued)

Component	%Peak Area		
	5%	10%	20%
isomerC9		0.0919	0.0696
isomerC10	14.5472	0.0319	0.0360
isomerC11	8.6497	0.0170	0.0192

Table B15 Composition of products from cracking under nitrogen pressure as a function of nitrogen pressure

Component	Retention Time (min)	
	100 psig	150 psig
1,2-dimethylcyclohexane	12.359	12.371
n-octane		13.196
1,2,4-trimethylcyclohexane		13.404
n-nonane	16.279	16.047
n-undecane	25.816	25.817
benzene	31.508	31.498
toluene	31.705	31.690
isomerC7	32.058	
polynaphthene	34.608	34.609
isomerC8	39.973	39.973
isomerC8	41.782	41.772
ethylbenzene	42.144	42.133
iso-propylbenzene	42.492	42.477
n-propylbenzene	42.671	42.658
1,2,4-trimethylbenzene	43.224	43.204
isomerC9	44.368	44.396
isomerC9	56.754	
isomerC9	57.103	57.091
isomerC9	57.243	57.235
isomerC9	57.463	57.448
isomerC9	57.872	57.862
isomerC9	58.751	58.728

Table B15 Composition of products from cracking under nitrogen pressure as a function of nitrogen pressure (continued)

Component	Retention Time (min)	
	100 psig	150 psig
isomerC10	61.359	61.359
isomerC10	64.010	
isomerC11	69.453	69.453

Table B16 %Peak area of products from cracking under nitrogen pressure as a function of nitrogen pressure

Component	%Peak Area	
	100 psig	150 psig
1,2-dimethylcyclohexane	0.0569	0.0392
n-octane		0.0250
1,2,4-trimethylcyclohexane		0.0296
n-nonane	0.0227	0.0216
n-undecane	0.0199	0.0197
benzene	0.1340	0.0873
toluene	22.6771	14.2354
isomerC7	0.0256	
polynaphthene	0.0060	0.0061
isomerC8	0.0171	0.0172
isomerC8	1.7261	1.3428
ethylbenzene	58.6731	67.3839
iso-propylbenzene	15.1295	14.9334
n-propylbenzene	0.5862	1.1584
1,2,4-trimethylbenzene	0.1617	0.2104
isomerC9	0.0296	0.0300
isomerC9	0.0104	
isomerC9	0.0824	0.0933
isomerC9	0.1327	0.0594
isomerC9	0.0467	0.0432
isomerC9	0.2634	0.1235
isomerC9	0.0680	0.0919

Table B16 %Peak area of products from cracking under nitrogen pressure as a function of nitrogen pressure (continued)

Component	%Peak Area	
	100 psig	150 psig
isomerC10	0.0386	0.0319
isomerC10	0.0752	
isomerC11	0.0171	0.0170

Table B17 Composition of products from hydrocracking as a function of catalyst type (second time)

Component	Retention Time (min)		
	Type 2	Type 4	Type 5
n-pentane	8.914		
cyclohexane	29.049		
isomerC7		11.896	
1,2-dimethylcyclohexane			12.526
1,2,4-trimethylcyclohexane			15.906
n-nonane			16.881
n-undecane		25.816	25.818
benzene	28.030	31.504	31.507
toluene	41.147	31.689	31.697
isomerC7		32.014	32.058
polynaphthene		34.598	34.609
isomerC8			39.973
isomerC8		41.796	41.787
ethylbenzene	53.434	42.146	42.152
iso-propylbenzene	59.347	42.493	42.499
n-propylbenzene	61.653	42.657	42.678
1,2,4-trimethylbenzene	66.320	43.212	43.230
isomerC9	69.615	44.368	44.369
isomerC9		56.746	
isomerC9		57.096	57.107
isomerC9		57.235	57.247
isomerC9		57.453	57.468

Table B17 %Peak area of products from hydrocracking as a function of catalyst concentration (continued) (second time)

Component	Retention Time (min)		
	Type 2	Type 4	Type 5
isomerC9		57.861	57.880
isomerC9		58.732	58.760
isomerC9			61.360
isomerC10			64.007
isomerC11			69.453

Table B18 %Peak area of products from hydrocracking as a function of catalyst type (second time)

Component	%Peak Area		
	Type 2	Type 4	Type 5
n-pentane	0.0100		
cyclohexane	0.0200		
isomerC7		0.0153	
1,2-dimethylcyclohexane			0.1358
1,2,4-trimethylcyclohexane			0.0409
n-nonane			0.0249
n-undecane		0.0198	0.0195
benzene	0.0100	0.2057	0.1229
toluene	7.0800	18.3251	17.5123
isomerC7		0.0532	0.0292
polynaphthene		0.0052	0.0059
isomerC8			0.0164
isomerC8		18.325	0.9447
ethylbenzene	75.7200	64.9685	63.8440
iso-propylbenzene	15.862	13.2359	15.7148
n-propylbenzene	0.7140	0.5926	0.8353
1,2,4-trimethylbenzene	0.0100	0.1324	0.1424
isomerC9	0.0100	0.0285	0.0283
isomerC9		0.0197	
isomerC9		0.1583	0.1063
isomerC9		0.1027	0.0842
isomerC9		0.0583	0.0576

Table B18 %Peak area of products from hydrocracking as a function of catalyst type (continued) (second time)

Component	%Peak Area		
	Type 2	Type 4	Type 5
isomerC9		0.1992	0.1514
isomerC9		0.0471	0.0707
isomerC9			0.0355
isomerC10			0.0606
isomerC11			0.0164

Table B19 Composition of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve (second time)

Component	Retention Time (min)		
	Component A	Component B	Component C
n-pentane		8.925	
cyclohexane		29.067	29.056
isomerC7			
1,2-dimethylcyclohexane	12.526		
1,2,4-trimethylcyclohexane	15.906		
n-nonane	16.881		
n-undecane	25.818		
benzene	31.507	28.057	28.027
toluene	31.697	41.239	41.352
isomerC7	32.058		
polynaphthene	34.609		
isomerC8	39.973		
isomerC8	41.787		
ethylbenzene	42.152	53.411	53.344
iso-propylbenzene	42.499	59.379	59.347
n-propylbenzene	42.678	61.689	61.672
1,2,4-trimethylbenzene	43.230	63.723	63.695
isomerC9	44.369	66.355	66.347
isomerC9			
isomerC9	57.107		
isomerC9	57.247		
isomerC9	57.468		

Table B19 %Peak area of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve (continued) (second time)

Component	Retention Time (min)		
	Component A	Component B	Component C
isomerC9	57.880		
isomerC9	58.760		
isomerC9	61.360		
isomerC10	64.007		
isomerC11	69.453		

Table B20 %Peak area of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve (second time)

Component	%Peak Area		
	Component A	Component B	Component C
n-pentane		0.0020	
cyclohexane		0.1600	0.0830
isomerC7			
1,2-dimethylcyclohexane	0.1358		
1,2,4-trimethylcyclohexane	0.0409		
n-nonane	0.0249		
n-undecane	0.0195		
benzene	0.1229	0.0070	0.1280
toluene	17.5123	10.26	19.8840
isomerC7	0.0292		
polynaphthene	0.0059		
isomerC8	0.0164		
isomerC8	0.9447		
ethylbenzene	63.8440	68.9170	61.5660
iso-propylbenzene	15.7148	16.3830	15.4230
n-propylbenzene	0.8353	0.8540	0.8360
1,2,4-trimethylbenzene	0.1424	0.9870	0.6530
isomerC9	0.0283	0.1280	0.0123
isomerC9			
isomerC9	0.1063		
isomerC9	0.0842		
isomerC9	0.0576		

Table B20 %Peak area of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve (continued) (second time)

Component	%Peak Area		
	Component A	Component B	Component C
isomerC9	0.1514		
isomerC9	0.0707		
isomerC9	0.0355		
isomerC10	0.0606		
isomerC11	0.0164		

Table B21 Composition of products from hydrocracking as a function of reaction time (second time)

Component	Retention Time (min)	
	1.5 hours	2 hours
n-pentane	4.341	
cyclohexane	6.179	
n-hexane	7.199	
n-heptane	10.337	10.244
1,2-dimethylcyclohexane	12.559	12.393
n-nonane	16.581	
n-undecane	25.829	25.831
isomerC11	31.421	
benzene	31.506	31.509
toluene	31.713	31.696
polynaphthene	34.613	32.052
isomerC8	39.943	34.609
isomerC8		39.973
isomerC8	41.792	
ethylbenzene	42.155	41.792
iso-propylbenzene	42.513	42.159
n-propylbenzene	42.696	42.496
1,2,4-trimethylbenzene	43.242	42.690
isomerC9	44.369	43.236
isomerC9	56.765	
isomerC9	57.118	57.112

Table B21 Composition of products from hydrocracking as a function of reaction time (continued) (second time)

Component	Retention Time (min)	
	1.5 hours	2 hours
isomerC9	57.258	57.252
isomerC9	57.479	
isomerC9	57.890	57.882
isomerC9	58.360	58.351
isomerC9	58.771	58.754
isomerC10	61.360	61.360
isomerC10	63.998	63.998
isomerC11	69.453	69.453

Table B22 %Peak area of products from hydrocracking as a function of reaction time (second time)

Component	%Peak Area	
	1.5 hours	2 hours
n-pentane	0.0158	
cyclohexane	0.0725	
n-hexane	0.0357	
n-heptane	0.0135	0.2136
1,2-dimethylcyclohexane	0.0239	0.1059
n-nonane	0.0178	
n-undecane	0.0257	0.0193
isomerC11	0.3924	
benzene	0.1537	0.0746
toluene	20.2837	15.7238
polynaphthene	0.0053	0.0155
isomerC8	0.0207	0.0059
isomerC8		0.0168
isomerC8	1.0352	
ethylbenzene	64.4326	62.4953
iso-propylbenzene	10.8321	6.3900
n-propylbenzene	0.5211	1.5590
1,2,4-trimethylbenzene	0.1722	0.1607
isomerC9	0.0158	0.1059
isomerC9	0.0172	
isomerC9	0.0935	0.8606

Table B22 %Peak area of products from hydrocracking as a function of reaction time (continued) (second time)

Component	%Peak Area	
	1.5 hours	2 hours
isomerC9	0.2937	0.9203
isomerC9	0.0358	
isomerC9	0.4859	0.0814
isomerC9	0.0278	0.0492
isomerC9	0.0659	0.0176
isomerC10	0.0123	0.0426
isomerC10	0.1021	0.0695
isomerC11	0.0095	0.0165

Table B23 Composition of products from hydrocracking as a function of catalyst concentration (second time)

Component	Retention Time (min)		
	15%wt	20%wt	40%wt
n-pentane			4.341
cyclohexane	29.047		6.179
n-hexane			7.199
n-heptane			10.337
1,2-dimethylcyclohexane		12.503	12.559
n-nonane		16.613	16.581
n-undecane		25.821	25.829
isomerC11			31.421
benzene	28.014	31.544	31.506
toluene	41.378	31.738	31.713
polynaphthene		34.610	34.613
isomerC8		39.973	39.943
isomerC8		41.833	41.792
ethylbenzene	53.202	42.209	42.155
iso-propylbenzene	59.406	42.564	42.513
n-propylbenzene	61.701	42.752	42.696
1,2,4-trimethylbenzene	63.725	43.320	43.242
isomerC9	66.177		44.369
isomerC9			56.765
isomerC9		57.154	57.118

Table B23 %Peak area of products from hydrocracking as a function of catalyst concentration (continued) (second time)

Component	Retention Time (min)		
	15%wt	20%wt	40%wt
isomerC9			57.258
isomerC9		57.524	57.479
isomerC9		57.854	57.890
isomerC9			58.360
isomerC9		58.854	58.771
isomerC10		61.360	61.360
isomerC10		63.454	63.998
isomerC11			69.453

Table B24 %Peak area of products from hydrocracking as a function of catalyst concentration (second time)

Component	%Peak Area		
	15%wt	20%wt	40%wt
n-pentane			0.0158
cyclohexane	0.3290		0.0725
n-hexane			0.0357
n-heptane			0.0135
1,2-dimethylcyclohexane		0.3095	0.0239
n-nonane		0.0395	0.0178
n-undecane		0.0192	0.0257
isomerC11			0.3924
benzene	0.7910	0.0348	0.1537
toluene	23.4870	16.5725	20.2837
polynaphthene		0.0302	0.0053
isomerC8		0.0058	0.0207
isomerC8		0.5080	1.0352
ethylbenzene	56.2470	60.3176	64.4326
iso-propylbenzene	9.8420	21.1690	10.8321
n-propylbenzene	0.5410	0.6498	0.5211
1,2,4-trimethylbenzene	0.0140	0.0754	0.1722
isomerC9	0.1600		0.0158
isomerC9	0.0140		0.0172
isomerC9		0.0880	0.0935

Table B24 %Peak area of products from hydrocracking as a function of catalyst concentration (continued) (second time)

Component	%Peak Area		
	15%wt	20%wt	40%wt
isomerC9			0.2937
isomerC9		0.0308	0.0358
isomerC9		0.0430	0.4859
isomerC9			0.0278
isomerC9		0.3095	0.0659
isomerC10		0.0269	0.0123
isomerC10		0.0148	0.1021
isomerC11			0.0095

Table B25 Composition of products from hydrocracking as a function of hydrogen pressure (second time)

Component	Retention Time (min)	
	400 psig	500 psig
n-pentane		
cyclohexane	30.633	29.047
n-hexane		
n-heptane		
1,2-dimethylcyclohexane		
n-nonane		
n-undecane		
isomerC11		
benzene	28.040	28.014
toluene	41.167	41.378
polynaphthene		
isomerC8		
isomerC8		
isomerC8		
ethylbenzene	53.160	53.202
iso-propylbenzene	59.507	59.406
n-propylbenzene	61.752	61.701
1,2,4-trimethylbenzene	63.768	63.725
isomerC9	66.418	66.177
isomerC9	69.715	
isomerC9		

Table B26 %Peak area of products from hydrocracking as a function of hydrogen pressure (second time)

Component	%Peak Area	
	400 psig	500 psig
n-pentane		
cyclohexane	0.2150	0.3290
n-hexane		
n-heptane		
1,2-dimethylcyclohexane		
n-nonane		
n-undecane		
isomerC11		
benzene	0.0310	0.7910
toluene	8.3520	23.4870
polynaphthene		
isomerC8		
isomerC8		
isomerC8		
ethylbenzene	58.5280	56.2470
iso-propylbenzene	4.2530	9.8420
n-propylbenzene	0.0140	0.5410
iso-propylbenzene	0.0240	0.0140
isomerC9	0.4180	0.1600
isomerC9	0.0110	0.0140
isomerC9		

Table B27 Composition of products from cracking under nitrogen pressure as a function of reaction time (second time)

Component	Retention Time (min)	
	5.5 hours	6 hours
n-pentane		4.277
cyclohexane		6.026
n-hexane		7.010
n-heptane		10.112
1,2-dimethylcyclohexane		12.392
isomerC8		15.508
n-nonane		16.124
n-undecane	25.814	25.828
isomerC11		31.413
benzene		31.508
toluene	31.657	31.712
polynaphthene	34.608	34.609
isomerC8	39.973	39.973
isomerC8	41.712	41.791
ethylbenzene	42.060	42.154
iso-propylbenzene	42.421	42.504
n-propylbenzene		42.690
1,2,4-trimethylbenzene		43.246
isomerC9		56.765
isomerC9	56.727	57.117
isomerC9	57.068	57.258

Table B27 Composition of products from cracking under nitrogen pressure as a function of reaction time (continued) (second time)

Component	Retention Time (min)	
	1.5 hours	2 hours
isomerC9	57.424	57.480
isomerC9		57.894
isomerC9		58.367
isomerC9		58.780
isomerC10	61.359	61.360
isomerC11	69.453	69.453

Table B28 %Peak area of products from cracking under nitrogen pressure as a function of reaction time (second time)

Component	%Peak Area	
	1.5 hours	2 hours
n-pentane		0.0095
cyclohexane		0.1097
n-hexane		0.0219
n-heptane		0.0293
1,2-dimethylcyclohexane		0.0537
isomerC8		0.0593
n-nonane		0.0321
n-undecane	6.5413	0.0171
isomerC11		0.2832
benzene		0.2839
toluene	5.1612	21.9872
polynaphthene	2.0006	0.0029
isomerC8	5.8183	0.0213
isomerC8	10.4778	1.6275
ethylbenzene	18.3613	63.1594
iso-propylbenzene	3.9310	10.7821
n-propylbenzene		0.5326
1,2,4-trimethylbenzene		0.1429
isomerC9		0.0187
isomerC9	7.3350	0.1029
isomerC9	19.759	0.1395

Table B28 %Peak area of products from hydrocracking as a function of reaction time (continued) (second time)

Component	%Peak Area	
	1.5 hours	2 hours
isomerC9	4.9837	0.0537
isomerC9		0.4169
isomerC9		0.0135
isomerC9		0.0587
isomerC10	10.0559	0.0258
isomerC11	5.5746	0.0137

Table B29 Composition of products from cracking under nitrogen pressure as a function of catalyst concentration (second time)

Component	Retention Time (min)		
	5%	10%	20%
1,2-dimethylcyclohexane	12.249	12.359	12.371
n-nonane		16.279	
n-undecane	25.815	25.816	25.817
benzene		31.508	31.498
toluene		31.705	31.690
isomerC7		32.058	
isomerC7	34.377		
polynaphthene	34.609	34.608	34.609
isomerC8	39.974	39.973	39.973
isomerC8		41.782	41.772
ethylbenzene	42.089	42.144	42.133
iso-propylbenzene		42.492	42.477
n-propylbenzene		42.671	42.658
1,2,4-trimethylbenzene		43.224	43.204
isomerC9	44.371	44.368	44.369
isomerC9		56.754	
isomerC9		57.103	57.091
isomerC9		57.243	57.231
isomerC9		57.463	57.448
isomerC9		57.872	57.862
isomerC9		58.751	58.728
isomerC10	61.360	61.359	61.359
isomerC11	69.454	69.453	69.453

Table B30 %Peak area of products from cracking under nitrogen pressure as a function of nitrogen pressure (second time)

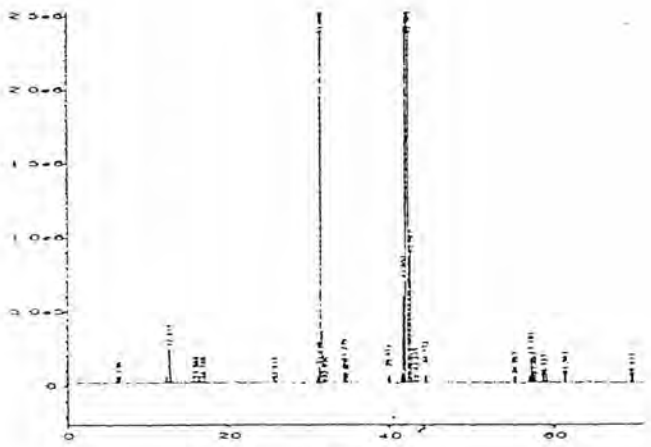
Component	%Peak Area		
	5%	10%	20%
1,2-dimethylcyclohexane	20.0121	0.0425	0.0324
n-nonane		0.0128	
n-undecane	9.9586	0.0189	0.0187
benzene		0.0954	0.0693
toluene		16.1025	18.1526
isomerC7		0.0152	
isomerC7	14.1911		
polynaphthene	3.0435	0.0047	0.0024
isomerC8	8.0644	0.0095	0.0359
isomerC8		1.3469	0.9857
ethylbenzene	11.8181	66.0192	61.2949
iso-propylbenzene		14.8912	17.6783
n-propylbenzene		0.6762	1.0985
1,2,4-trimethylbenzene		0.1429	0.1974
isomerC9	13.3994	0.0485	0.0299
isomerC9		0.0099	
isomerC9		0.0794	0.0761
isomerC9		0.0997	0.0415
isomerC9		0.0159	0.0615
isomerC9		0.2553	0.1175
isomerC9		0.0245	0.0723
isomerC10	12.3444	0.0178	0.0258
isomerC11	7.1686	0.0569	0.0093

Table B31 Composition of products from cracking under nitrogen pressure as a function of nitrogen pressure (second time)

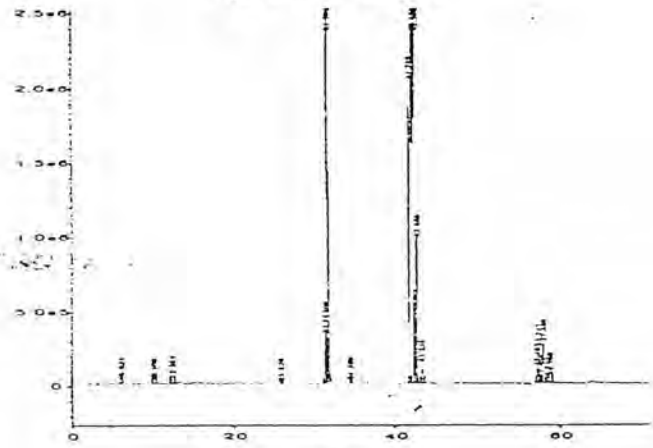
Component	Retention Time (min)	
	100 psig	150 psig
1,2-dimethylcyclohexane	12.451	12.359
n-nonane	16.349	16.279
n-undecane	25.821	25.816
benzene	31.545	31.508
toluene	31.751	31.705
isomerC7	32.117	32.058
polynaphthene	34.610	34.608
isomerC8	39.973	39.973
isomerC8	41.828	41.782
ethylbenzene	42.128	42.144
iso-propylbenzene	42.505	42.492
n-propylbenzene		42.671
1,2,4-trimethylbenzene	43.324	43.224
isomerC9	44.365	44.368
isomerC9	56.798	56.754
isomerC9	57.159	57.103
isomerC9	57.301	57.243
isomerC9	57.430	57.463
isomerC9	57.951	57.872
isomerC9	58.432	58.751
isomerC10	61.360	61.359
isomerC11	69.453	69.453

Table B32 %Peak area of products from cracking under nitrogen pressure as a function of nitrogen pressure (second time)

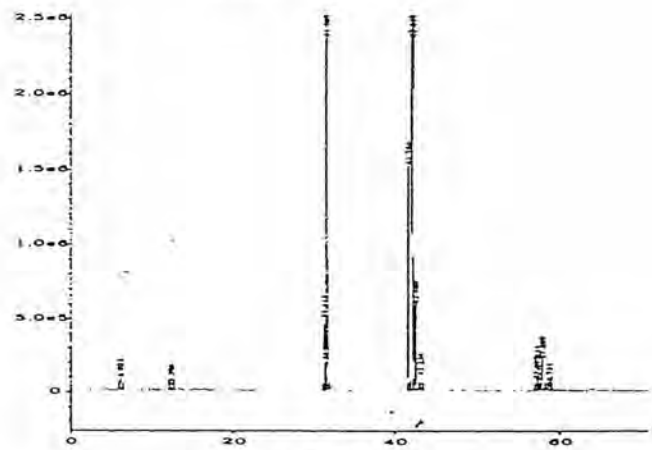
Component	%Peak Area	
	100 psig	150 psig
1,2-dimethylcyclohexane	0.0432	0.0425
n-nonane	0.0359	0.0128
n-undecane	0.0207	0.0189
benzene	0.1583	0.0954
toluene	20.4531	16.1025
isomerC7	0.0359	0.0152
isomerC7	0.0043	
polynaphthene	0.0258	0.0047
isomerC8	1.0579	0.0095
isomerC8	62.4243	1.3469
ethylbenzene	14.9851	66.0192
iso-propylbenzene		14.8912
n-propylbenzene	0.1726	0.6762
1,2,4-trimethylbenzene	0.0193	0.1429
isomerC9	0.0134	0.0485
isomerC9	0.0715	0.0099
isomerC9	0.0934	0.0794
isomerC9	0.0359	0.0997
isomerC9	0.1536	0.0159
isomerC9	0.0385	0.2553
isomerC9	0.0253	0.0245
isomerC10	0.0378	0.0178
isomerC11	0.0327	0.0569



Type 2 Catalyst



Type 4 Catalyst



Type 5 Catalyst

Figure B1 GC chromatograms of products from hydrocracking as a function of catalyst type

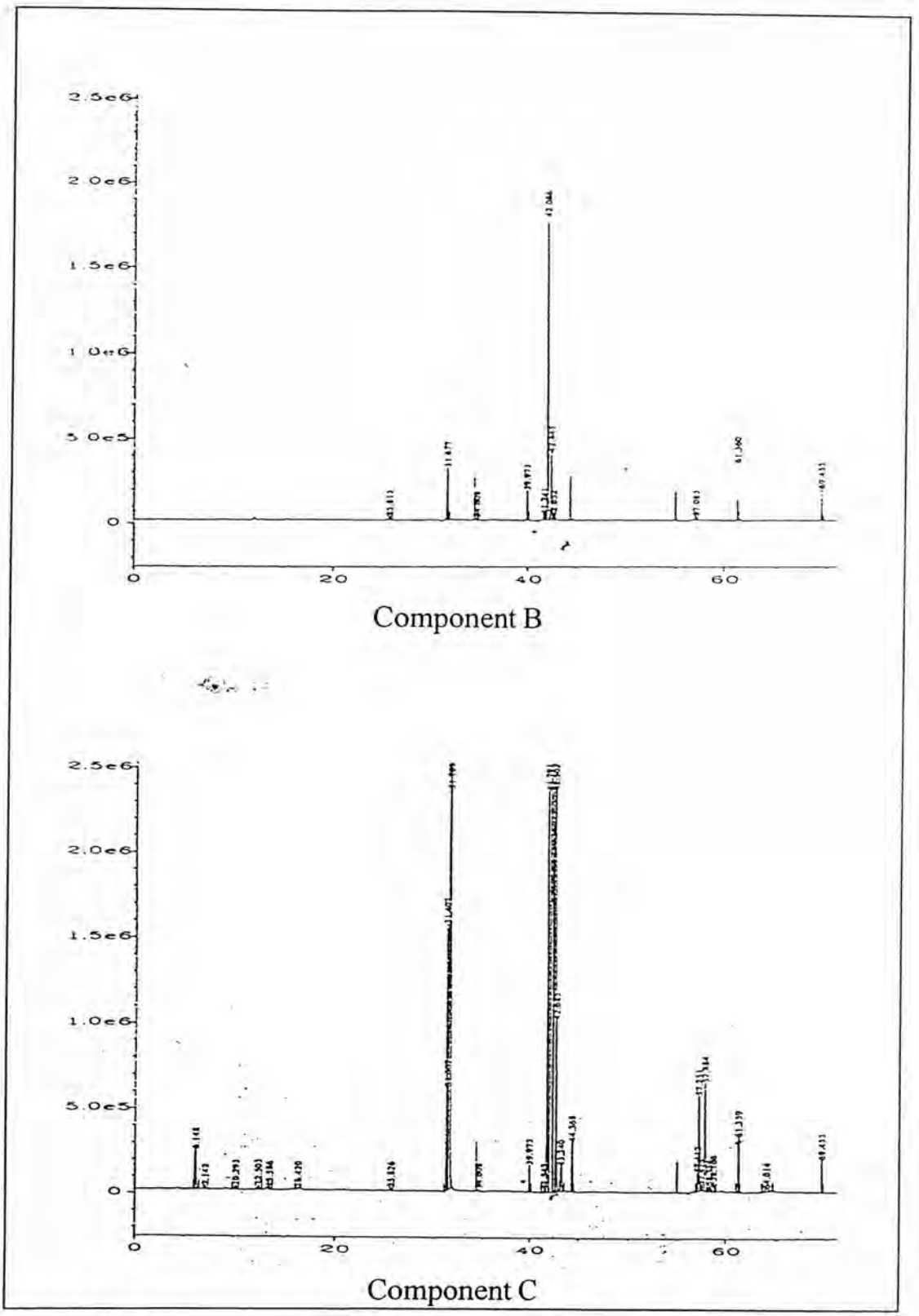


Figure B2 GC chromatograms of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve

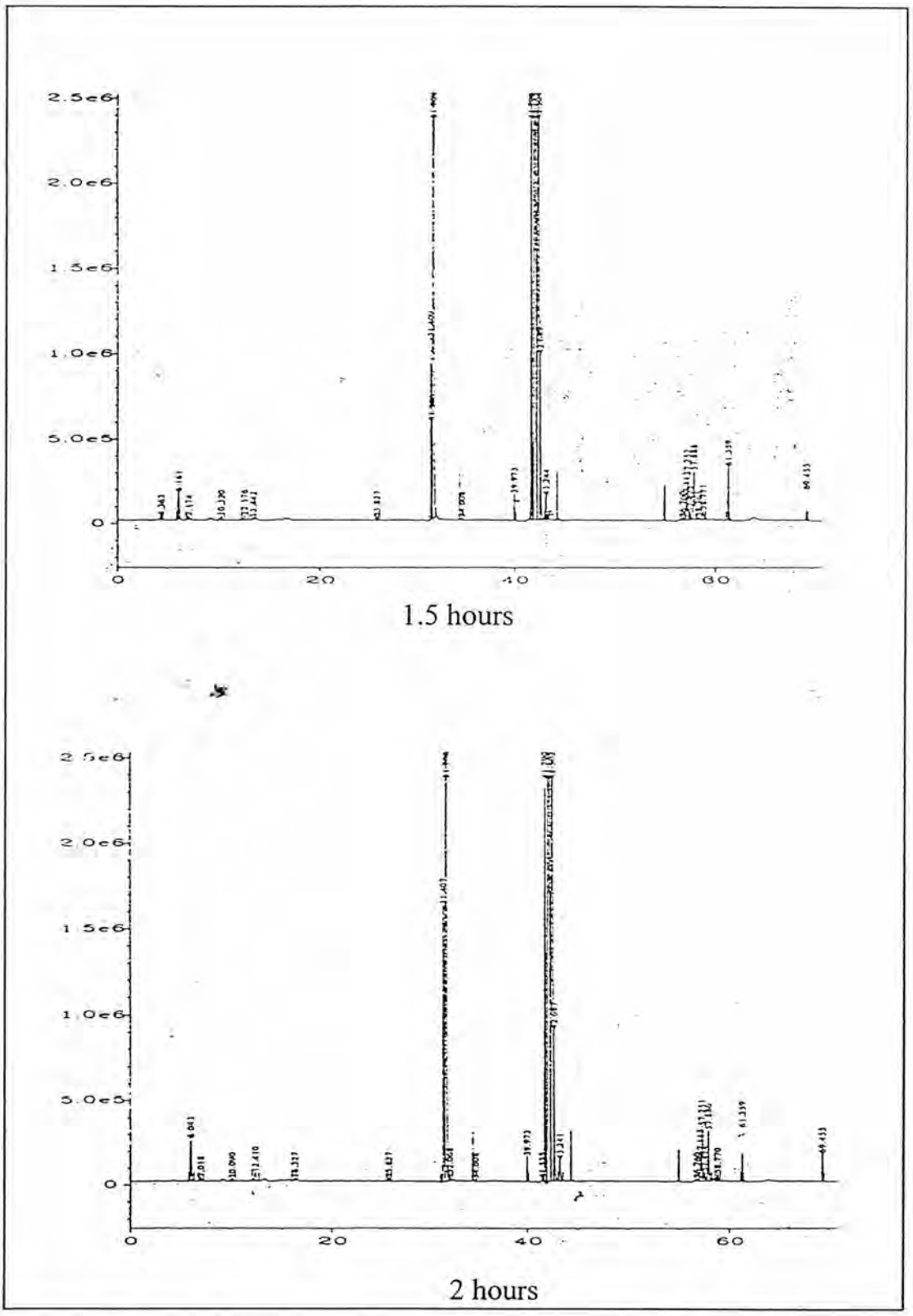


Figure B3 GC chromatograms of products from hydrocracking as a function of reaction time

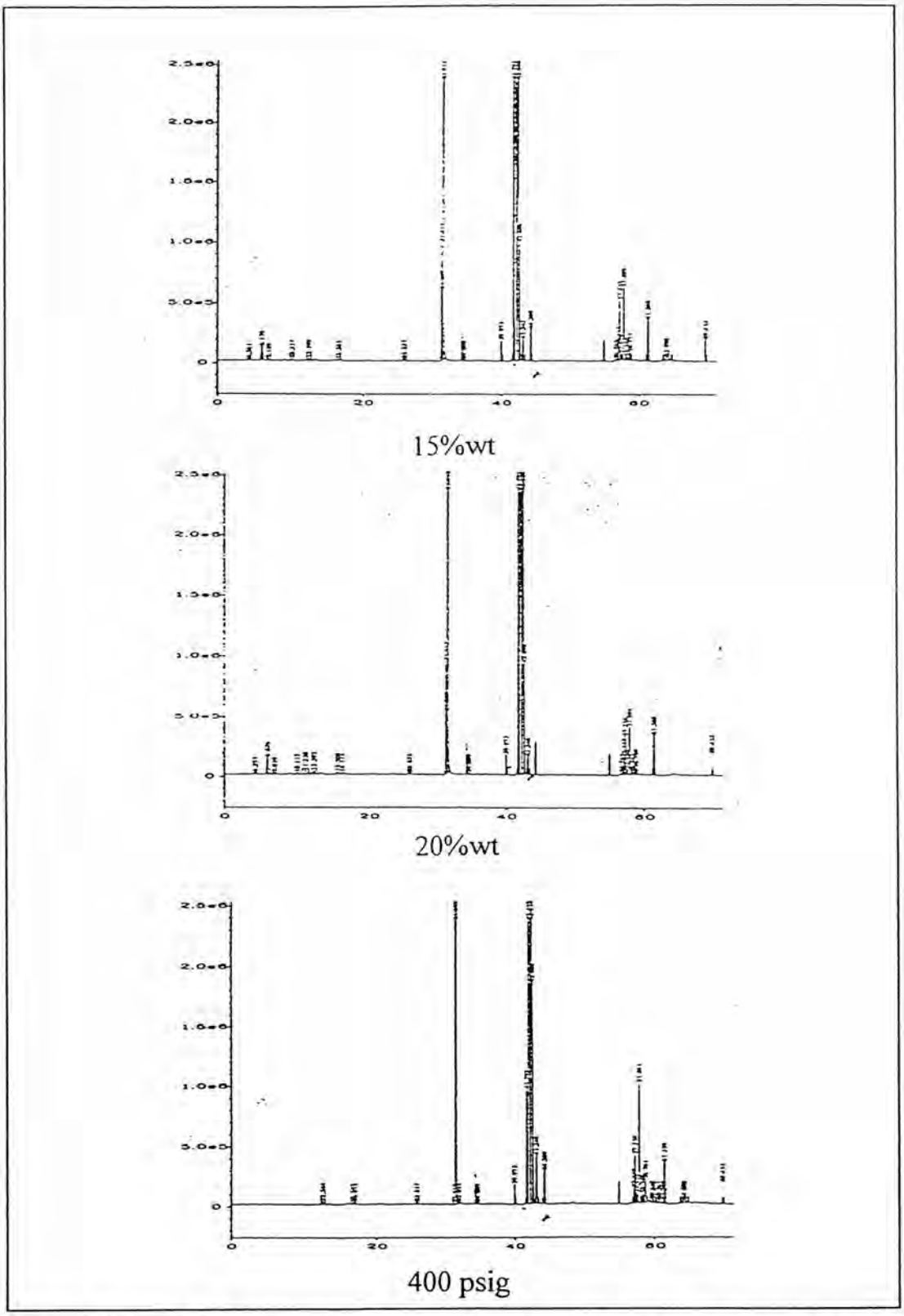


Figure B4 GC chromatograms of products from hydrocracking as a function of catalyst concentration and pressure

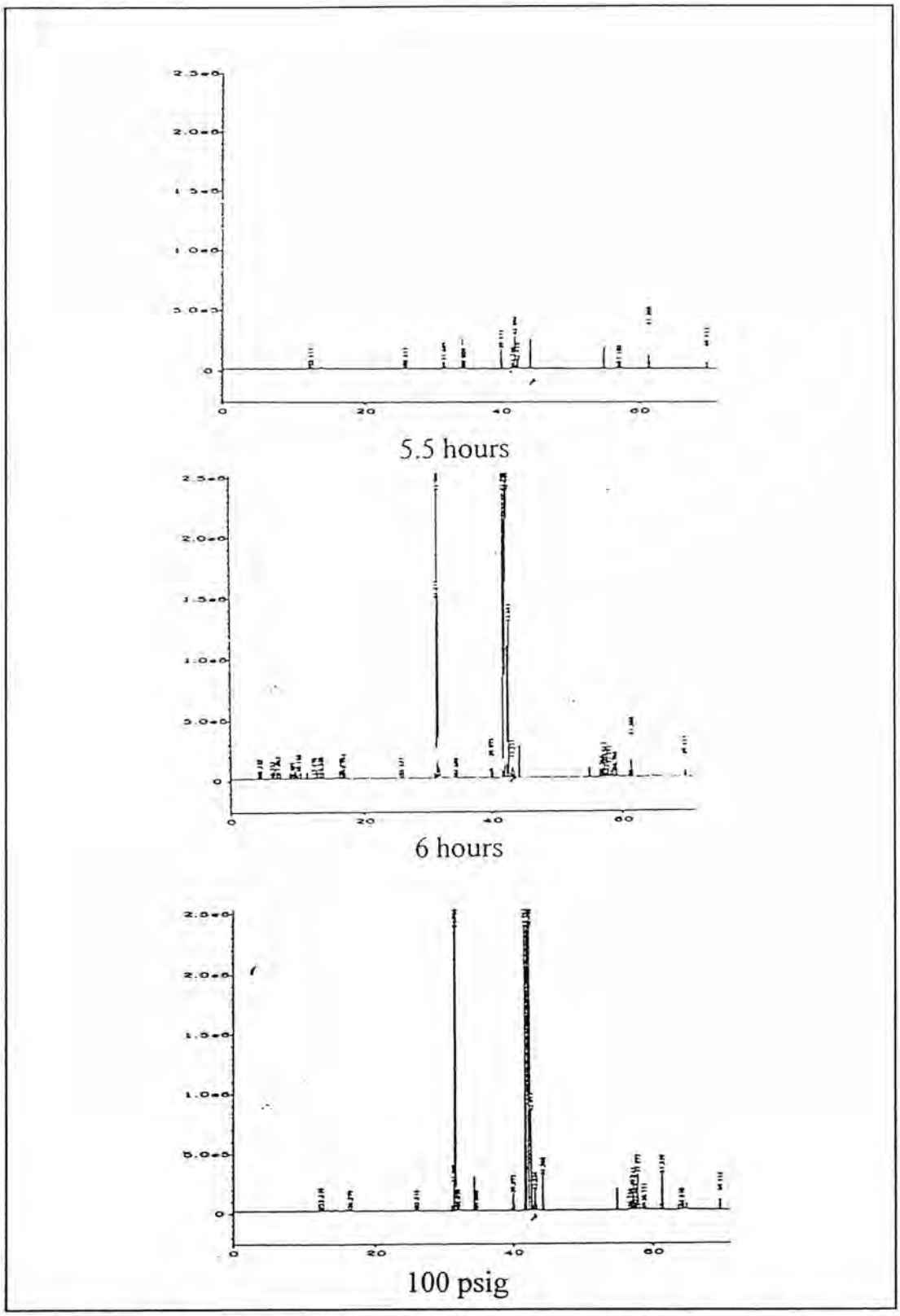


Figure B5 GC chromatograms of products from cracking under nitrogen pressure as a function of reaction time and nitrogen pressure

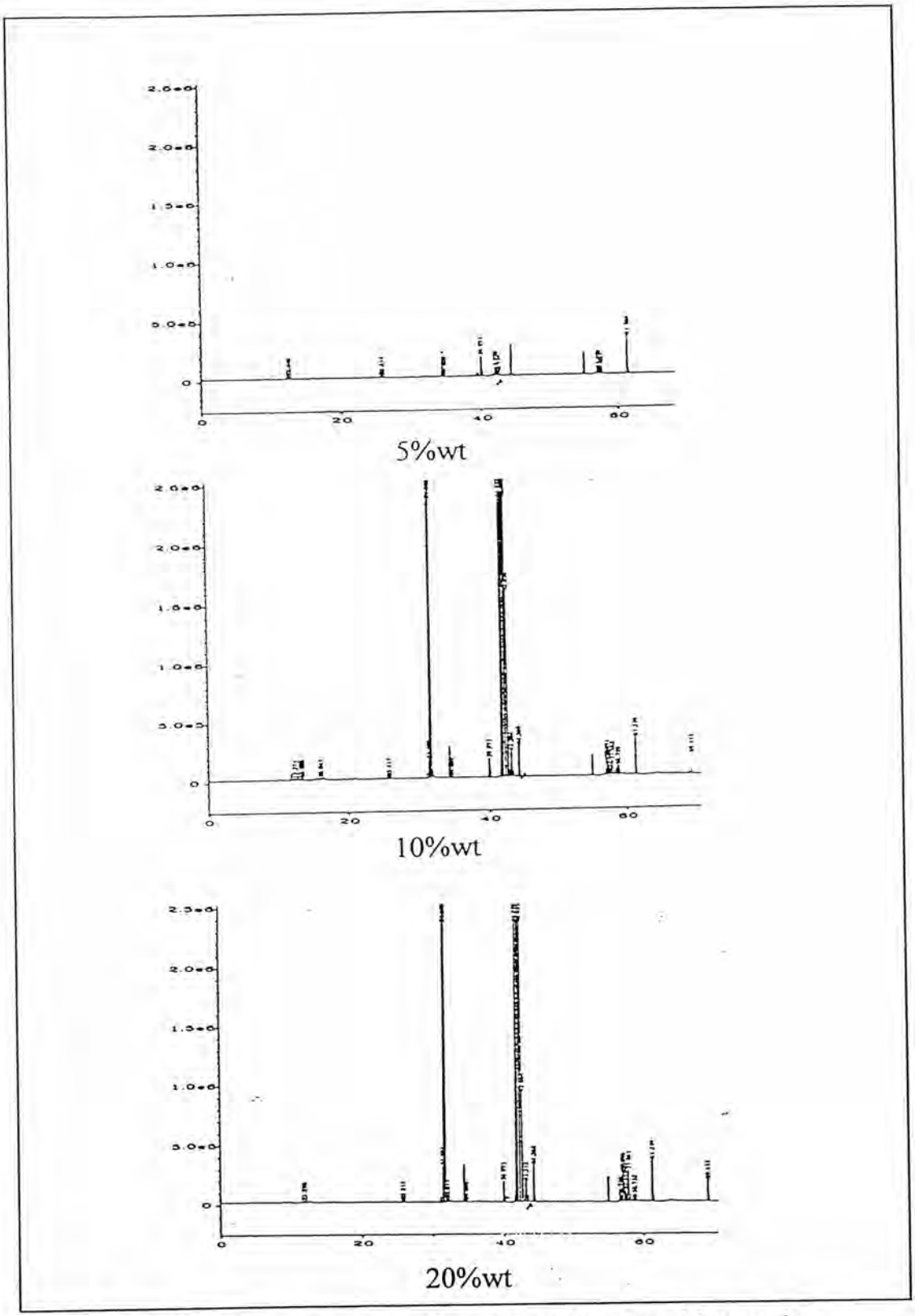


Figure B6 GC chromatograms of products from cracking under nitrogen pressure as a function of catalyst concentration

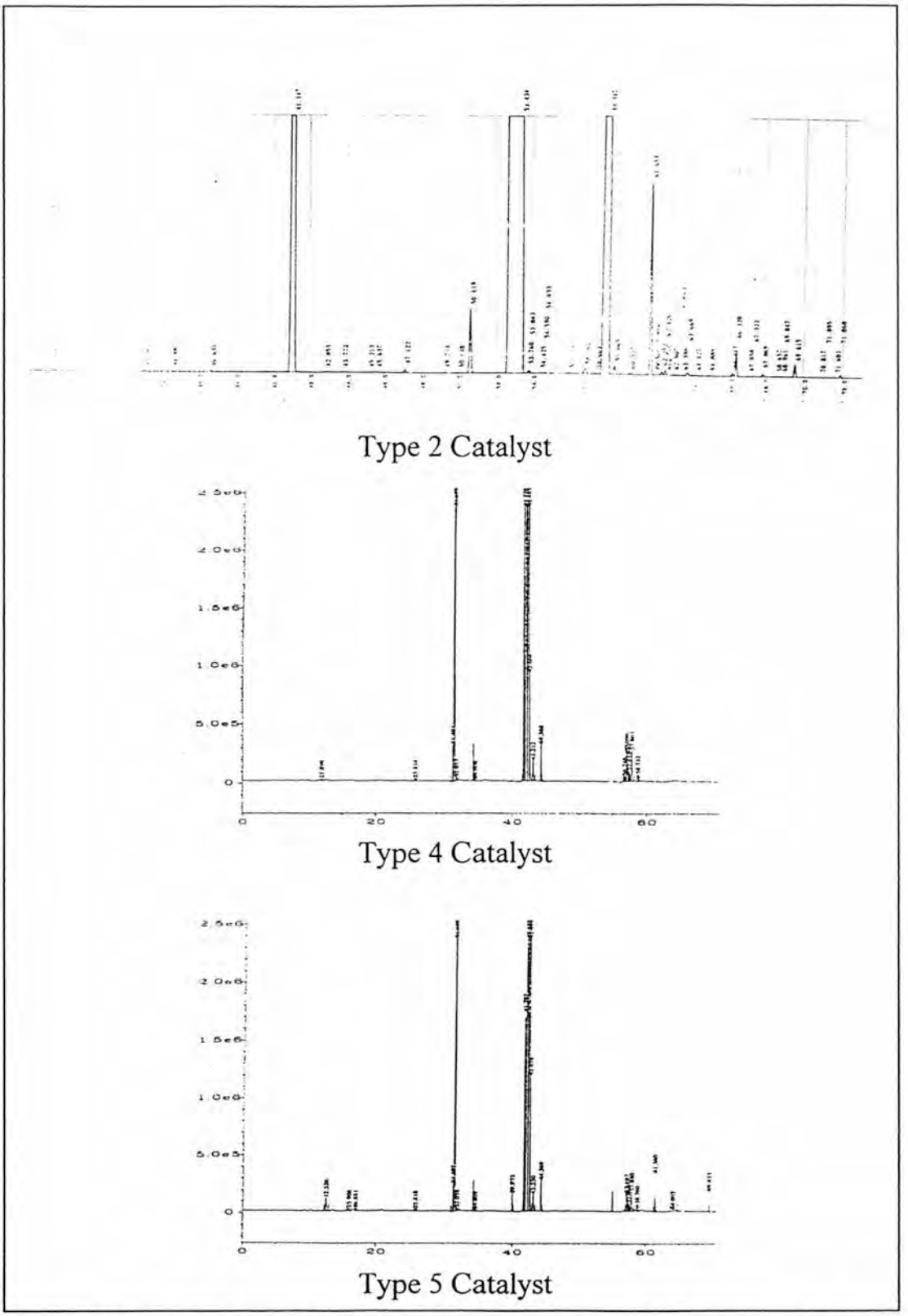
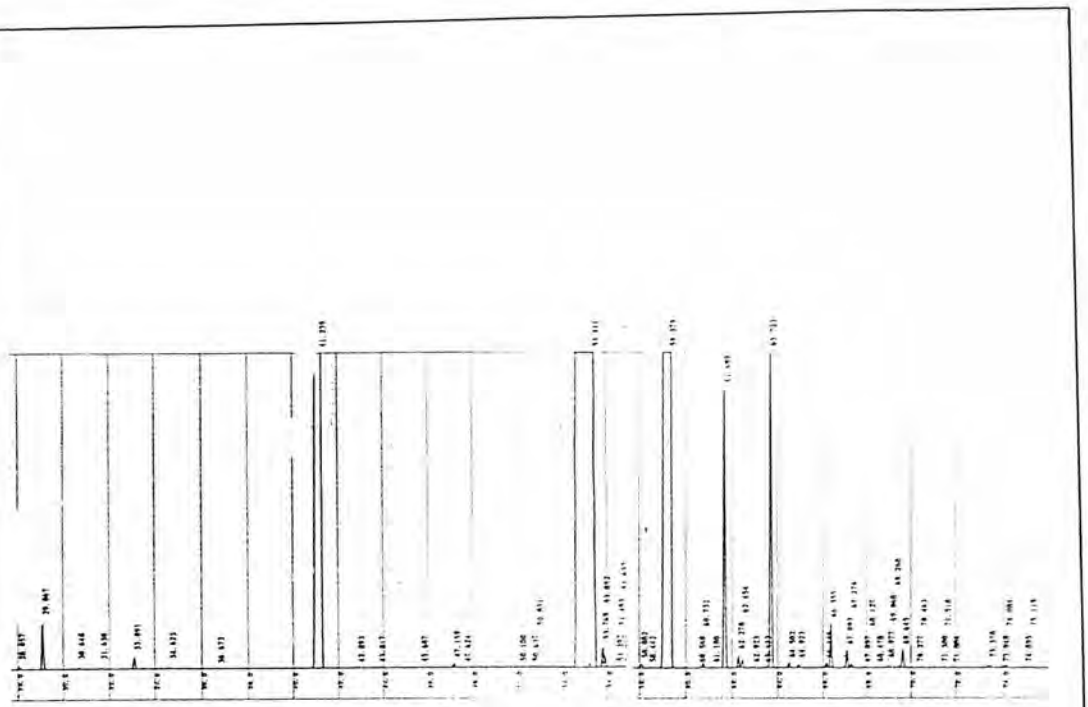
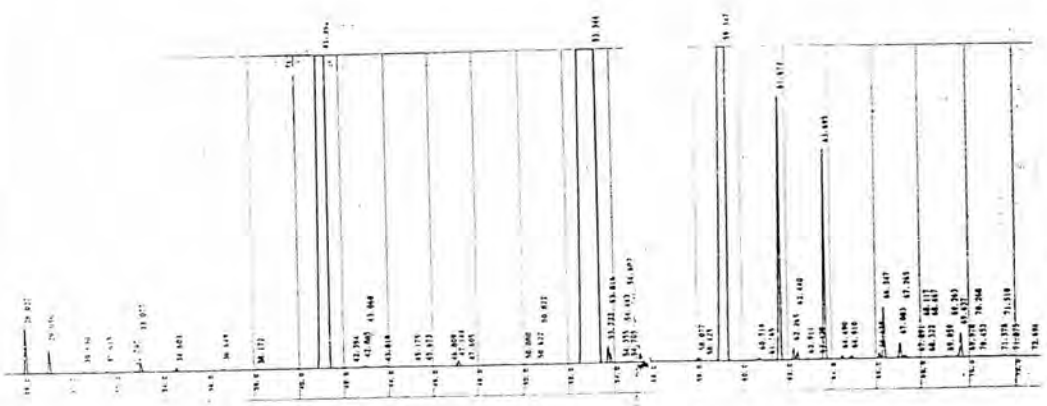


Figure B7 GC chromatograms of products from hydrocracking as a function of catalyst type (second time)



Component B



Component C

Figure B8 GC chromatograms of products from hydrocracking as a function of %component of Fe/Sn/F on molecular sieve (second time)

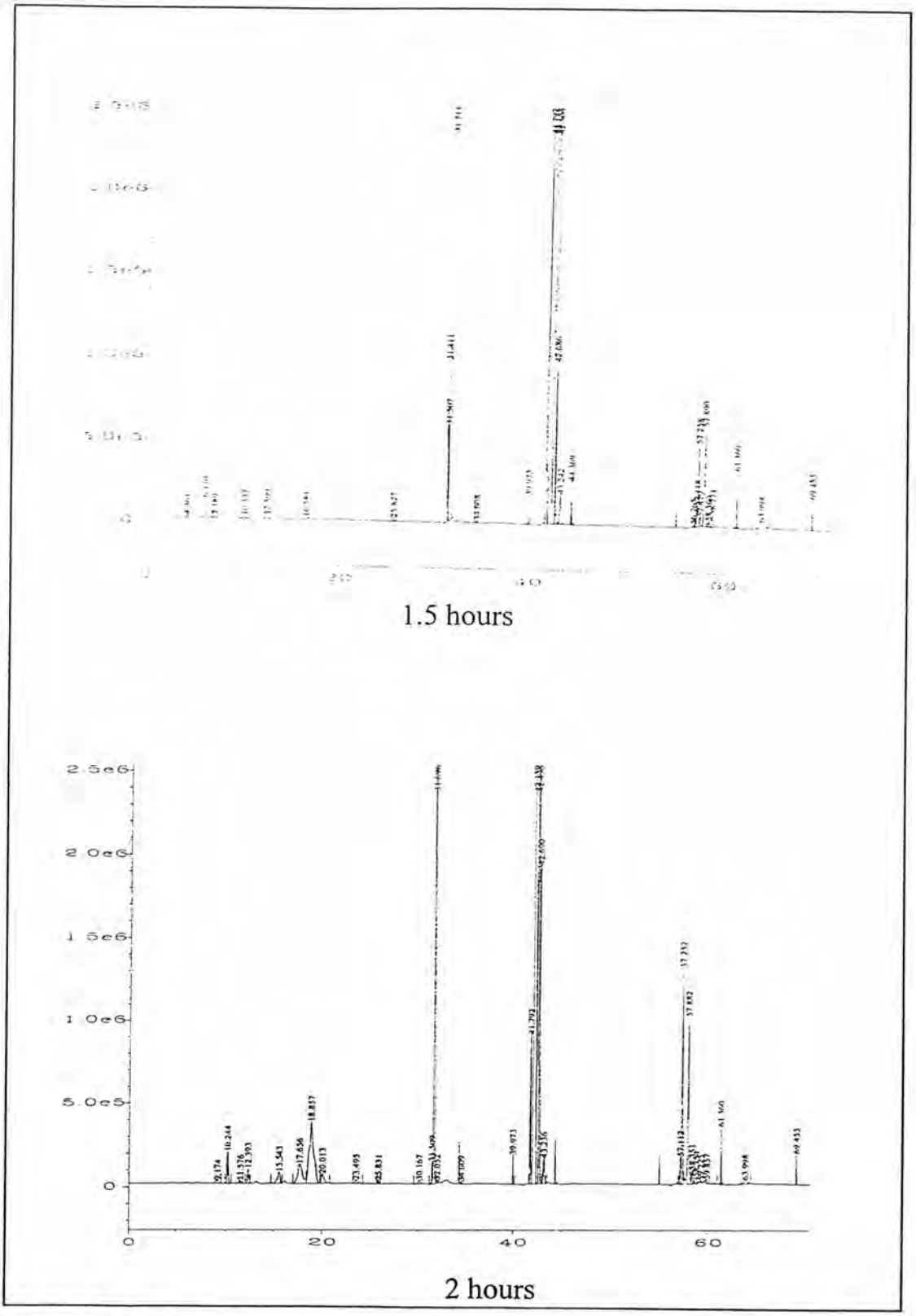


Figure B9 GC chromatograms of products from hydrocracking as a function of reaction time (second time)

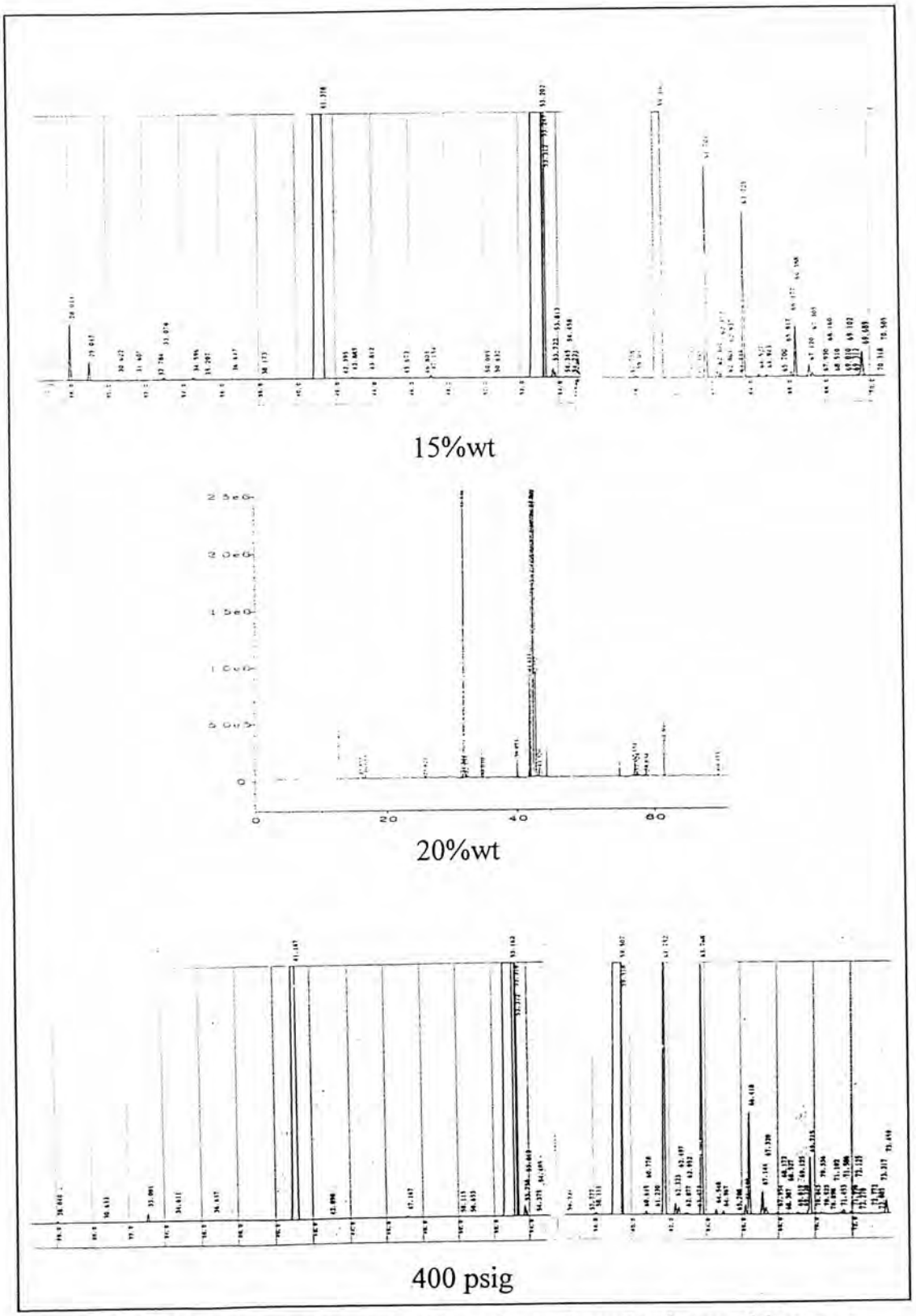


Figure B10 GC chromatograms of products from hydrocracking as a function of catalyst concentration and pressure (second time)

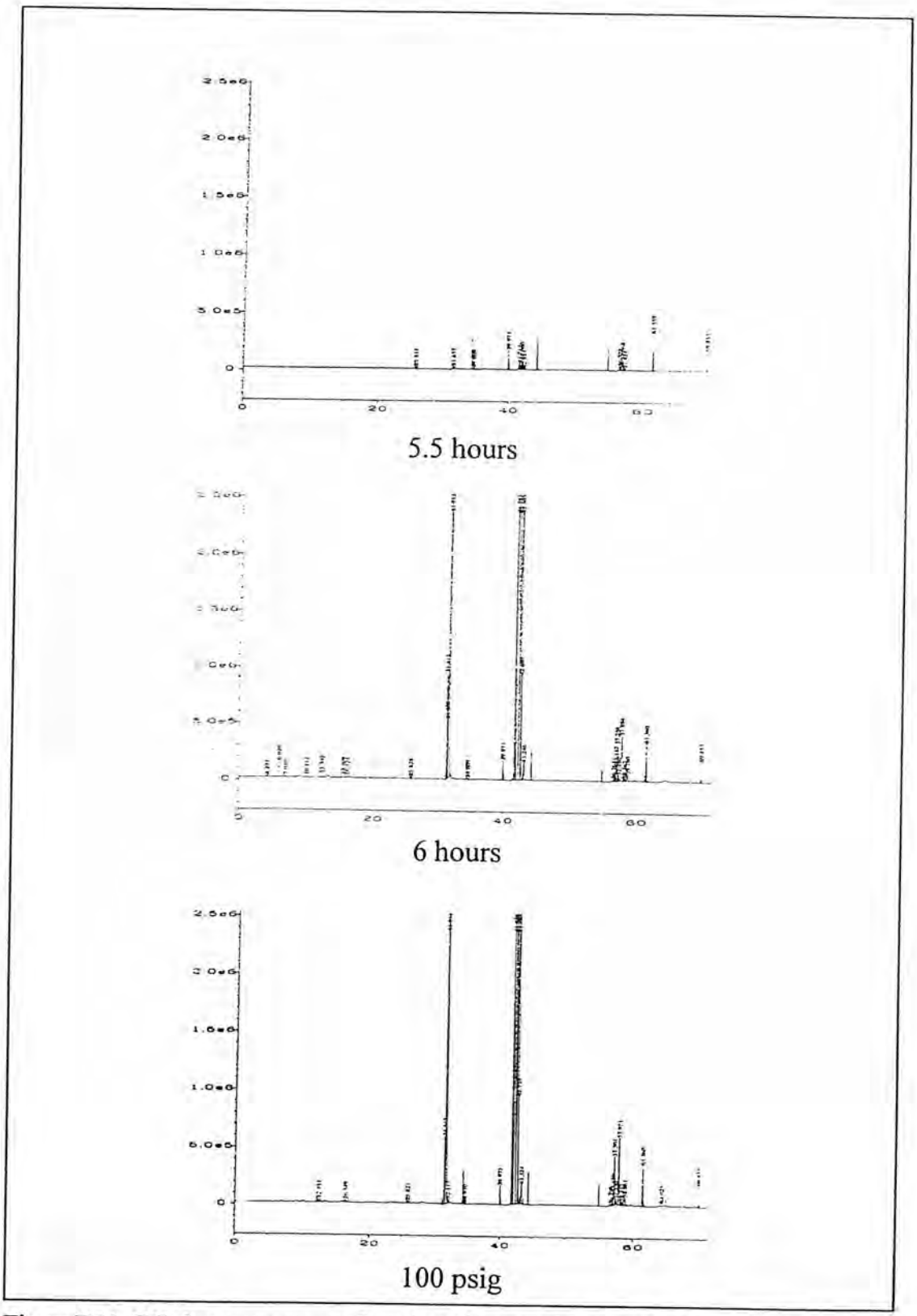


Figure B11 GC chromatograms of products from cracking under nitrogen pressure as a function of reaction time and nitrogen pressure (second time)

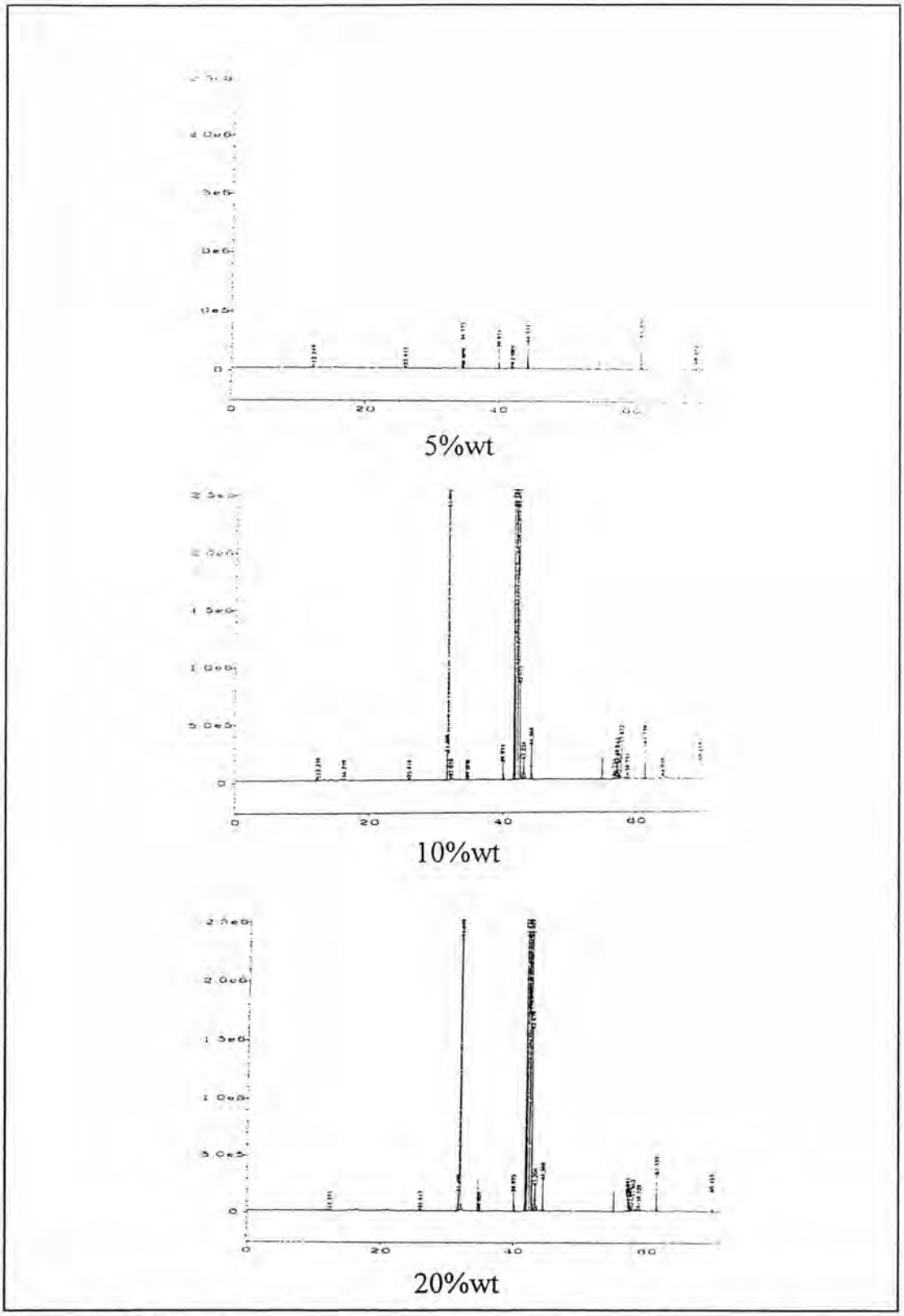


Figure B12 GC chromatograms of products from cracking under nitrogen pressure as a function of catalyst concentration (second time)

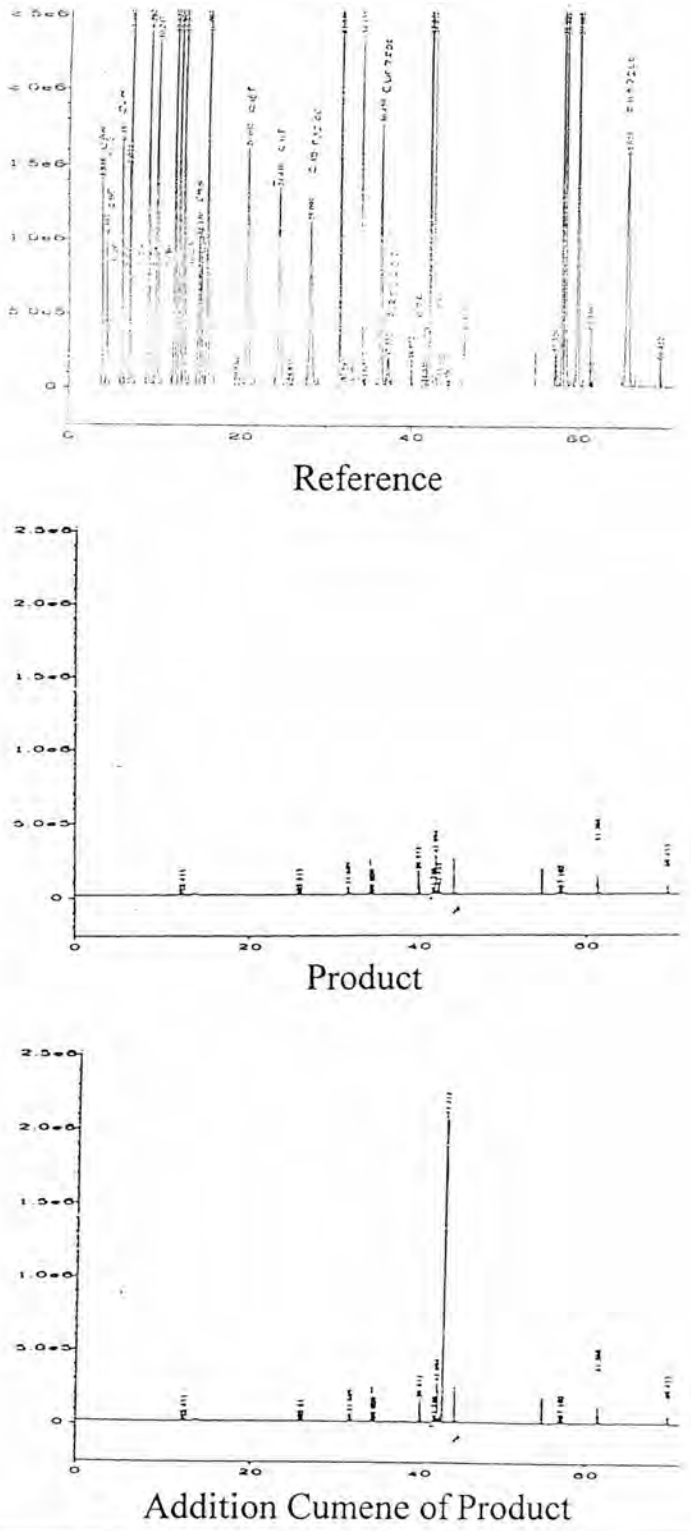


Figure B13 GC chromatograms of reference, product and addition cumene of product

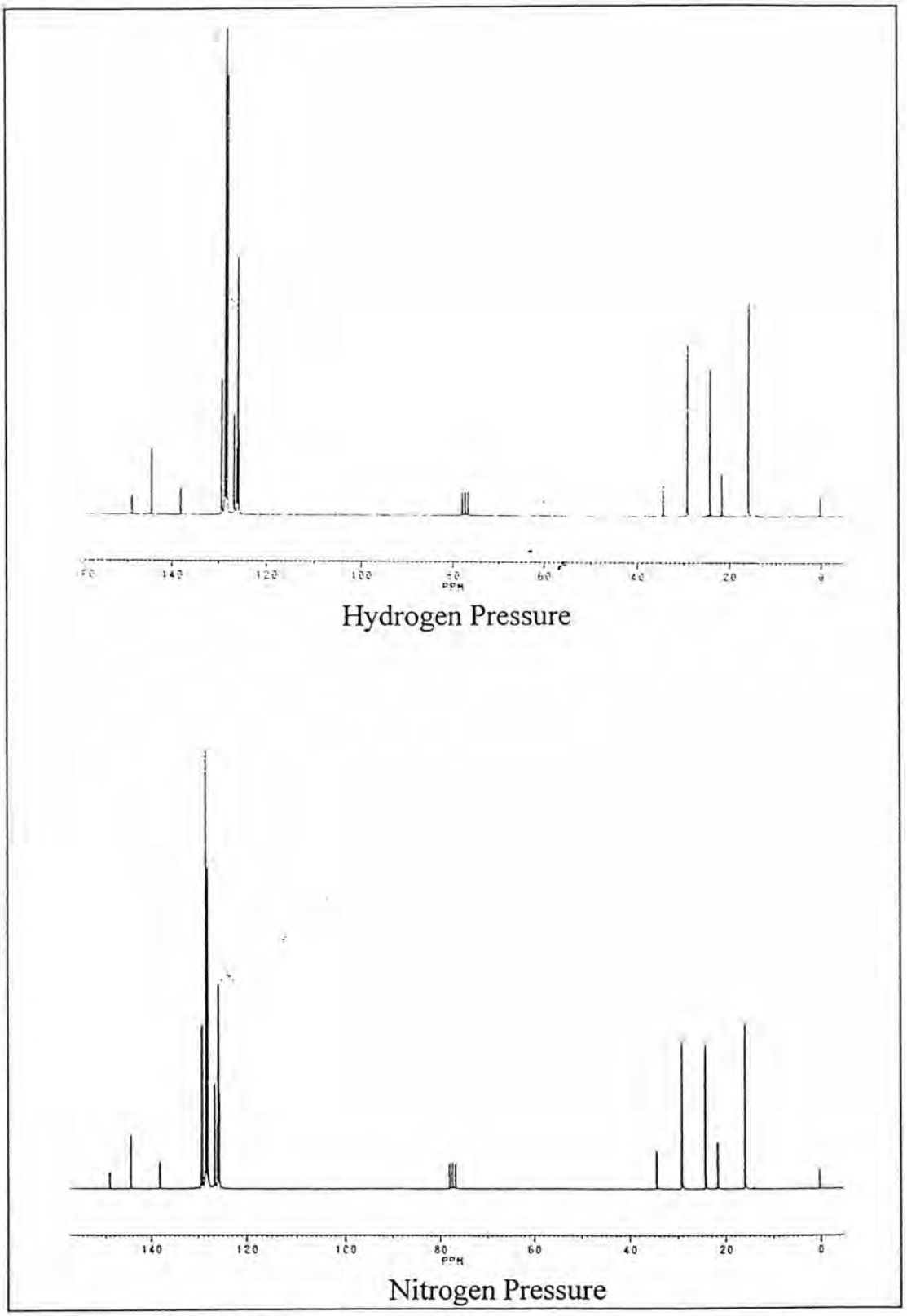


Figure B14 ^{13}C NMR ($CDCl_3$) spectra of products from cracking of used polystyrene under optimum condition

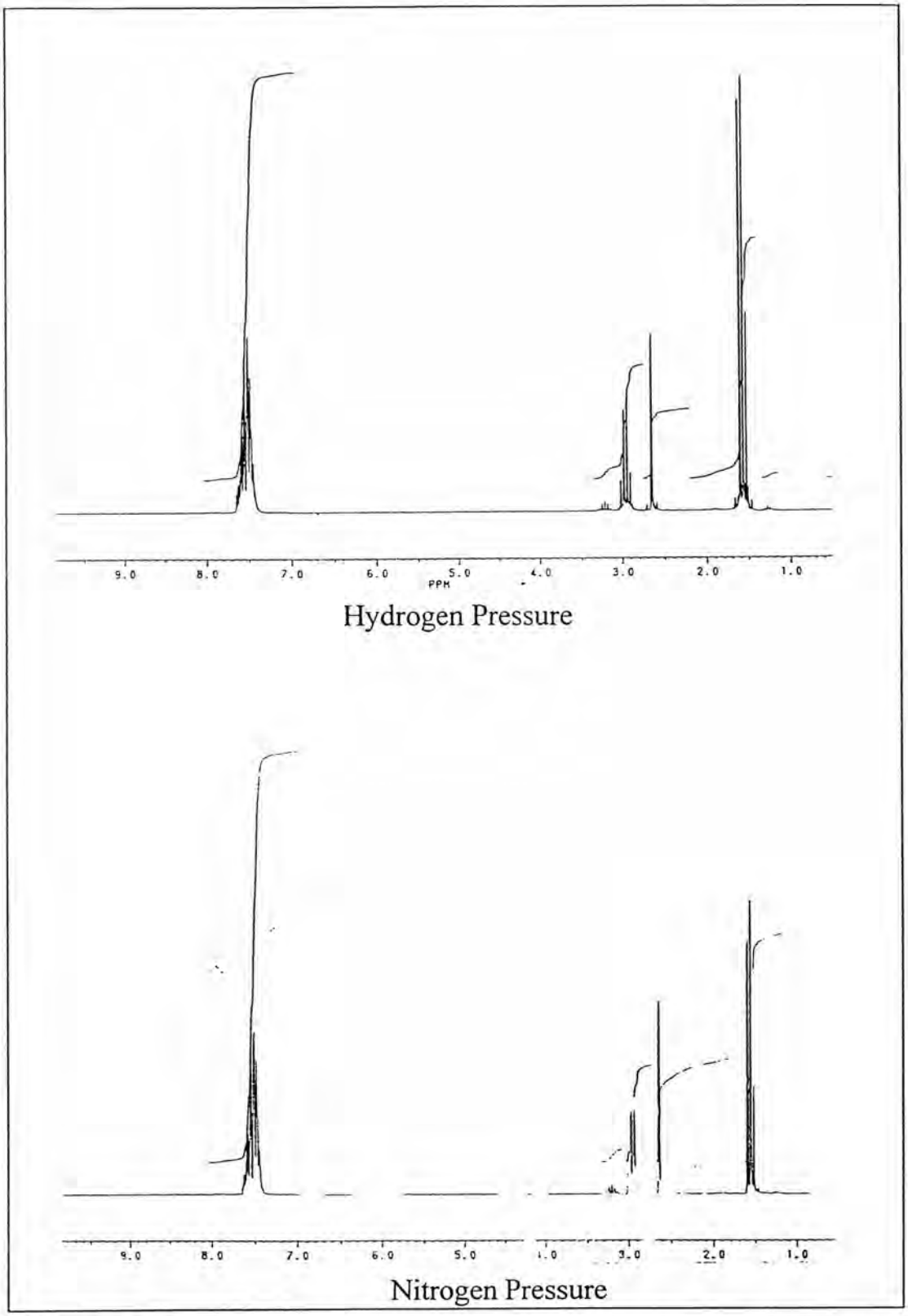


Figure B15 ^{1}H NMR ($CDCl_3$) spectra of products from cracking of used polystyrene under optimum condition

VITA

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