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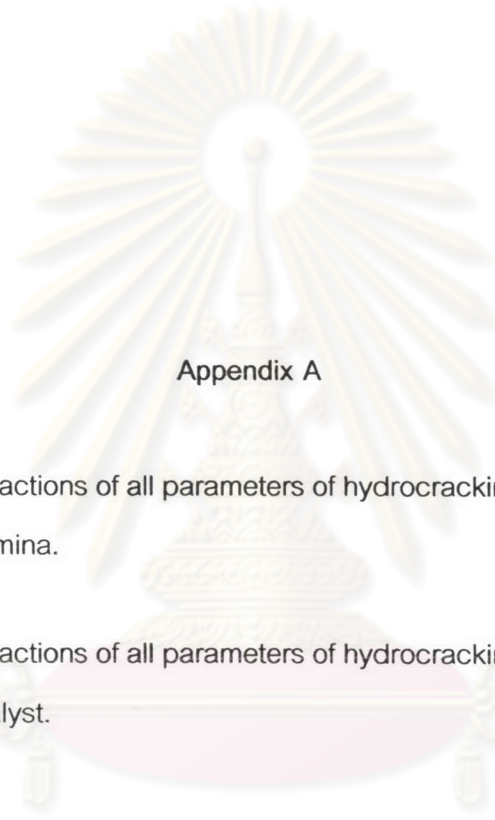
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APPENDICES

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



Appendix A

Table A.1 The condition reactions of all parameters of hydrocracking Used Lubricating Oil by Ni-Mo on alumina.

Table A.2 The condition reactions of all parameters of hydrocracking Used Lubricating Oil by HZSM-5 catalyst.

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Table A.1 The condition reactions of all parameters of hydrocracking used lubricating oil by Ni-Mo on alumina and percentage of light oil composition by DGC.

Batch No.	CONDITION				Yield of gas	Yield of liquid	Naphtha (65-200°C)	Kerosene (200-250°C)	Light gas oil (250-300 °C)	Heavy gas oil (300-350°C)	Long residue (>300°C)	Yield Of Solid
	Temperature (°C)	Initial P (psi)	Time (min)	% catalyst								
Used lube oil							0.00	0.00	1.86	20.97	77.17	.
1	350	100	90	1.0								
2	400	100	90	1.0	12.28	85.85	23.74	7.61	11.42	15.96	41.39	1.87
3	420	100	90	1.0	10.73	87.20	28.28	7.57	8.68	11.91	90.76	2.07
4	430	100	90	1.0	11.10	87.67	29.28	9.69	10.06	10.56	28.08	1.23
5	450	100	90	1.0	13.15	85.64	36.15	11.49	11.21	8.77	18.02	1.21
6	470	100	90	1.0	17.03	83.56	32.73	12.76	12.86	10.02	15.19	1.48
7	450	0	90	1.0	10.15	83.78	22.23	9.07	11.91	13.05	27.52	6.07
8	450	150	90	1.0	16.02	82.78	31.41	7.72	8.84	9.11	25.70	1.20
9	450	200	90	1.0	17.13	75.14	20.30	10.44	12.60	12.47	19.33	7.13
10	450	100	30	1.0	18.45	77.33	27.11	10.27	9.87	9.60	20.48	4.22
11	450	100	45	1.0	12.35	81.11	22.11	7.37	9.15	8.65	33.83	6.54
12	450	100	60	1.0	12.30	83.34	28.15	7.39	8.27	7.45	32.08	4.36
13	450	100	120	1.0	14.45	82.24	33.75	9.88	8.97	9.32	20.32	3.31
14	450	100	90	0.0	14.04	81.21	27.70	12.36	12.98	10.14	18.04	4.74
15	450	100	90	3.0	14.18	82.99	33.45	8.51	9.98	8.77	21.94	2.83
16	450	100	90	5.0	5.56	81.16	30.09	12.67	12.79	9.83	15.78	13.28

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Table A.2 The condition reactions of all parameters of hydrocracking Used Lubricating Oil by HZSM-5 catalyst and percentage of light oil composition by DGC.

Batch No.	CONDITION				Yield of gas	Yield of liquid	Naphtha (65-200°C)	Kerosene (200-250°C)	Light gas oil (250-300 °C)	Heavy gas oil (300-350°C)	Long residue (>300°C)	Yield of Solid
	Temperature (°C)	Initial P (psi)	Time (min)	% catalyst								
Used lube oil	-	-	-	-	-	-	0.00	0.00	1.86	20.97	77.17	-
1	350	100	60	0.5								
2	400	100	60	0.5	6.99	89.62	6.39	4.14	6.90	18.23	53.96	3.39
3	420	100	60	0.5	10.23	83.99	21.15	8.77	10.95	12.85	30.27	5.78
4	435	100	60	0.5	14.69	83.19	32.89	9.66	9.88	8.63	22.13	2.12
5	450	100	60	0.5	12.33	85.46	34.87	11.03	11.49	8.73	19.34	2.21
6	470	100	60	0.5	17.03	81.16	26.30	6.54	7.17	7.91	33.24	1.81
7	450	0	60	0.5	11.42	81.75	20.64	7.12	9.64	11.44	32.91	6.83
8	450	150	60	0.5	13.83	84.53	31.49	7.66	9.66	9.66	26.06	1.64
9	450	200	60	0.5	14.40	82.90	25.76	11.22	12.73	11.01	22.18	2.70
10	450	100	30	0.5	12.20	82.02	25.86	10.13	11.79	10.90	23.34	5.78
11	450	100	90	0.5	12.55	80.79	22.95	8.09	10.42	10.34	28.99	6.66
12	450	100	60	0	15.84	79.96	33.75	7.33	8.08	7.99	22.80	1.37
13	450	100	60	0.1	12.62	85.08	33.54	10.37	10.61	8.87	21.68	2.30
14	450	100	60	0.3	15.97	81.38	34.32	7.91	9.27	8.04	21.84	2.65
15	450	100	60	0.6	20.50	62.69	22.83	5.91	6.87	6.62	20.47	16.81

Appendix B

Figure B.1 Composition of used lubricating oil.

Figure B.2 Composition at condition 400^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.3 Composition at condition 420^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.4 Composition at condition 430^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.5 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.6 Composition at condition 470^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.7 Composition at condition 400^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Figure B.8 Composition at condition 420^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Figure B.9 Composition at condition 435^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Figure B.10 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Figure B.11 Composition at condition 470^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Figure B.12 Composition at condition 450^oC of reaction temperature, 0 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Figure B.13 Composition at condition 450^oC of reaction temperature, 150 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

- Figure B.14** Composition at condition 450^oC of reaction temperature, 200 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.
- Figure B.15** Composition at condition 450^oC of reaction temperature, 0 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.
- Figure B.16** Composition at condition 450^oC of reaction temperature, 150 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.
- Figure B.17** Composition at condition 450^oC of reaction temperature, 200 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.
- Figure B.18** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 30 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.
- Figure B.19** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 45 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.
- Figure B.20** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.
- Figure B.21** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 120 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.
- Figure B.22** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 30 minutes of reaction time and 0.5% of HZSM-5 catalyst.
- Figure B.23** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 0.5% of HZSM-5 catalyst.
- Figure B.24** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 0.0% of Ni-Mo/Al₂O₃.
- Figure B.25** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 3.0% of Ni-Mo/Al₂O₃.
- Figure B.26** Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 5.0% of Ni-Mo/Al₂O₃.

Figure B.27 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0% of HZSM-5 catalyst.

Figure B.28 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.1% of HZSM-5 catalyst.

Figure B.29 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.3% of HZSM-5 catalyst.

Figure B.30 Composition at condition 450^oC of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.6% of HZSM-5 catalyst.



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Unit	Boiling Range Distribution										
	°F	529.2	630.8	656.1	676.5	697.7	718.0	742.6	779.0	828.4	930.8
°C	276.2	332.7	346.7	358.1	369.8	381.1	394.8	415.0	442.4	499.3	540.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

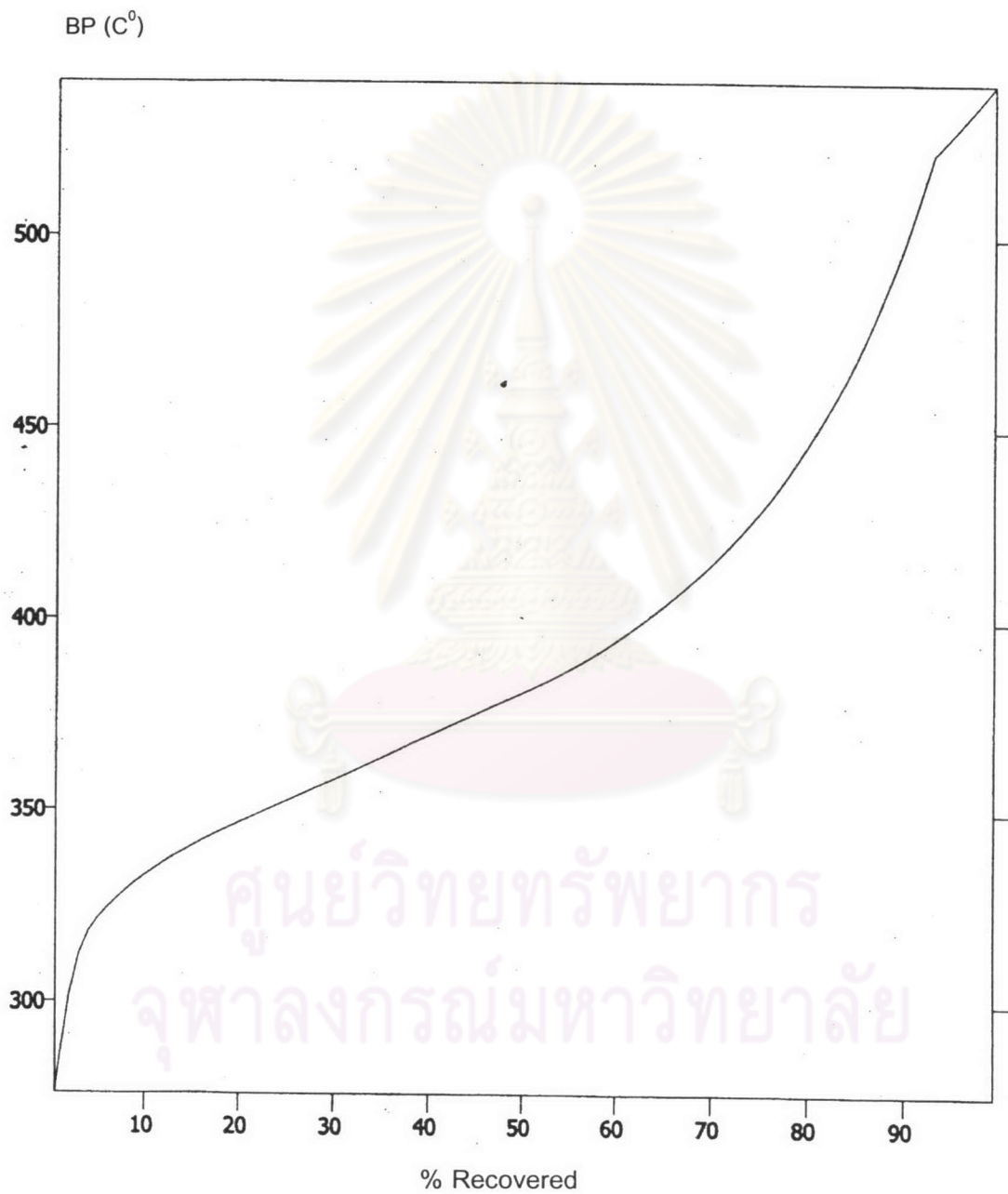


Figure B.1 Composition of used lubricating oil.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	133.0	276.3	356.6	430.1	495.8	547.7	618.3	659.8	703.6	773.3	996.6
$^{\circ}\text{C}$	56.1	135.7	180.3	221.2	257.7	286.5	325.7	348.8	373.1	411.9	535.9
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

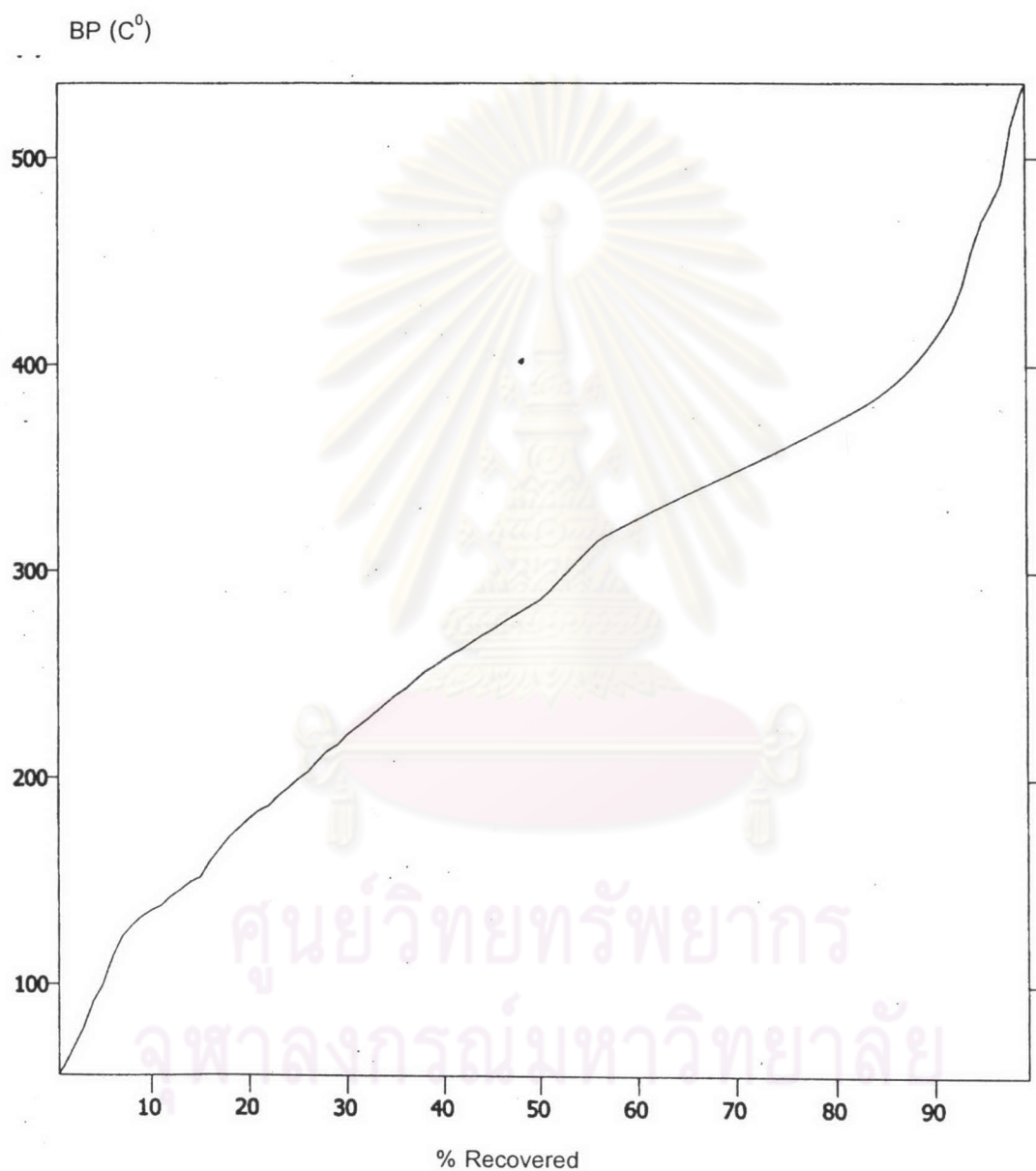


Figure B.2 Composition at condition 400°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
°F	127.6	203.0	298.3	367.7	471.1	563.7	633.6	692.0	752.4	859.1	1011.2
°C	53.1	95.0	147.9	186.5	243.9	295.4	334.2	366.7	400.2	459.5	544.0
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

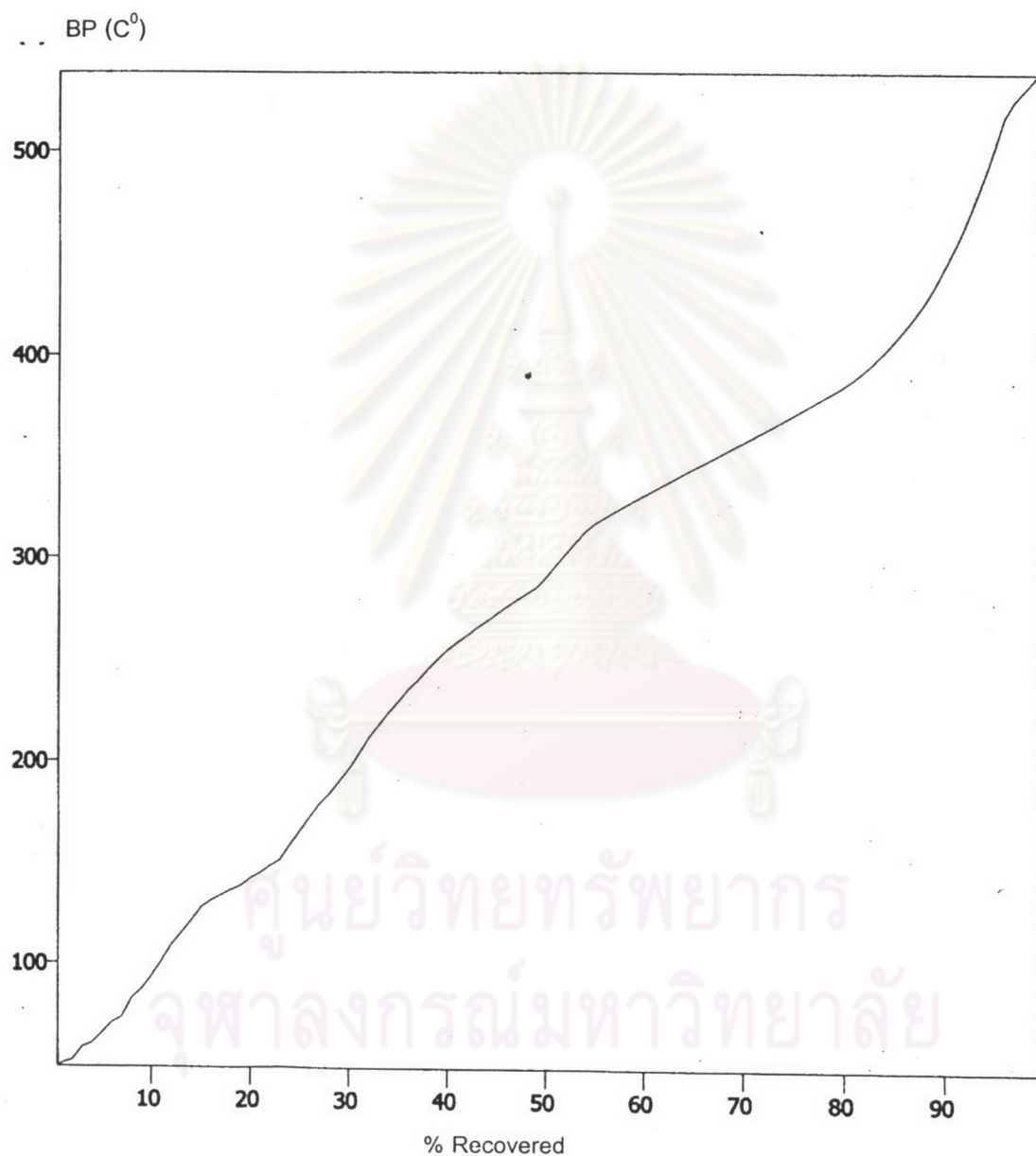


Figure B.3 Composition at condition 420°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
°F	127.7	207.4	306.1	367.4	445.3	526.9	601.9	676.2	745.2	858.7	1011.3
°C	53.2	97.5	152.3	186.4	229.6	274.9	316.6	357.9	396.2	459.3	544.0
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

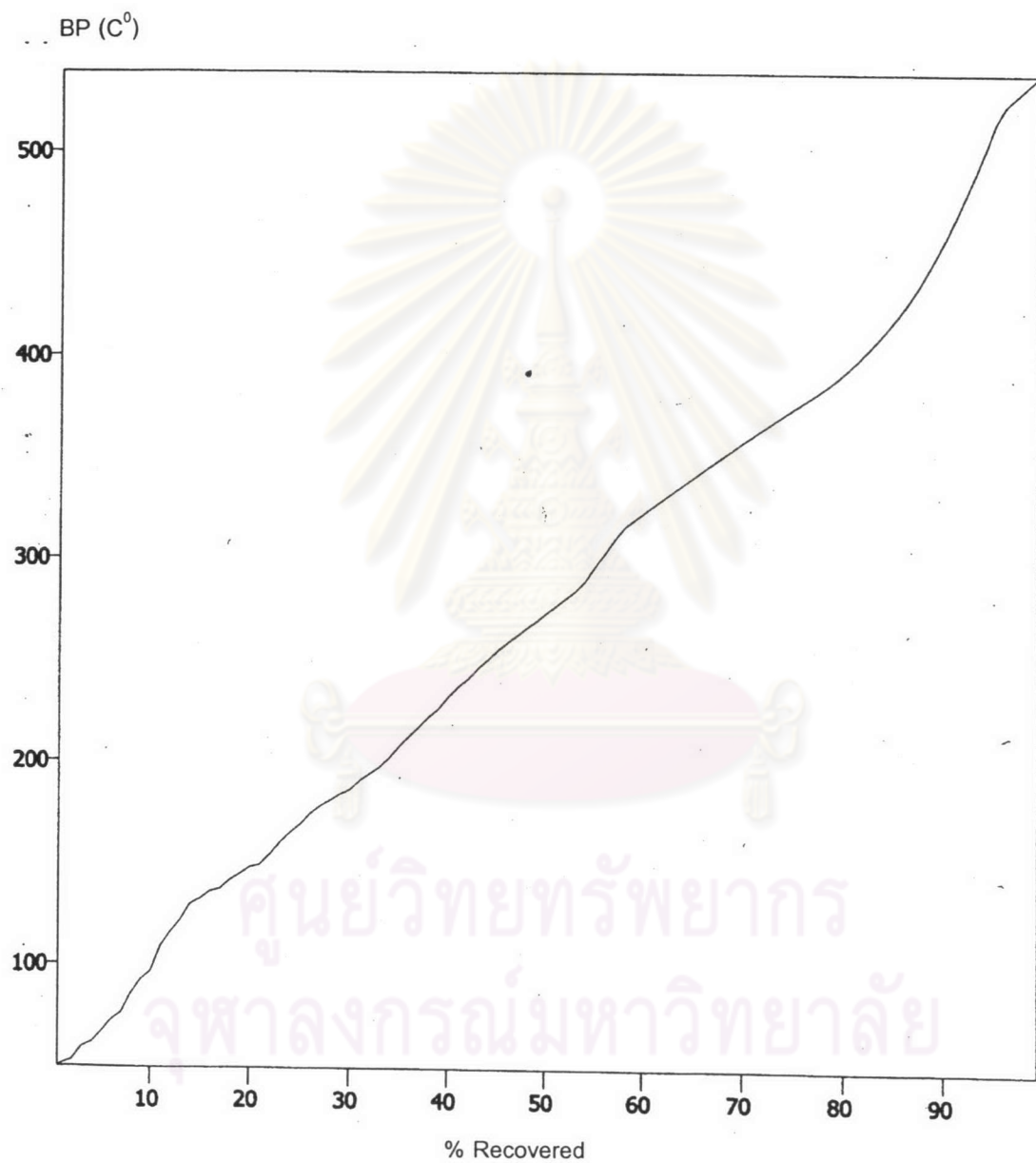


Figure B.4 Composition at condition 430°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
°F	120.9	201.9	275.4	323.3	379.7	443.2	507.5	587.8	670.5	769.7	999.6
°C	49.4	94.4	135.2	161.9	193.1	228.4	264.1	308.8	354.7	409.8	537.6
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

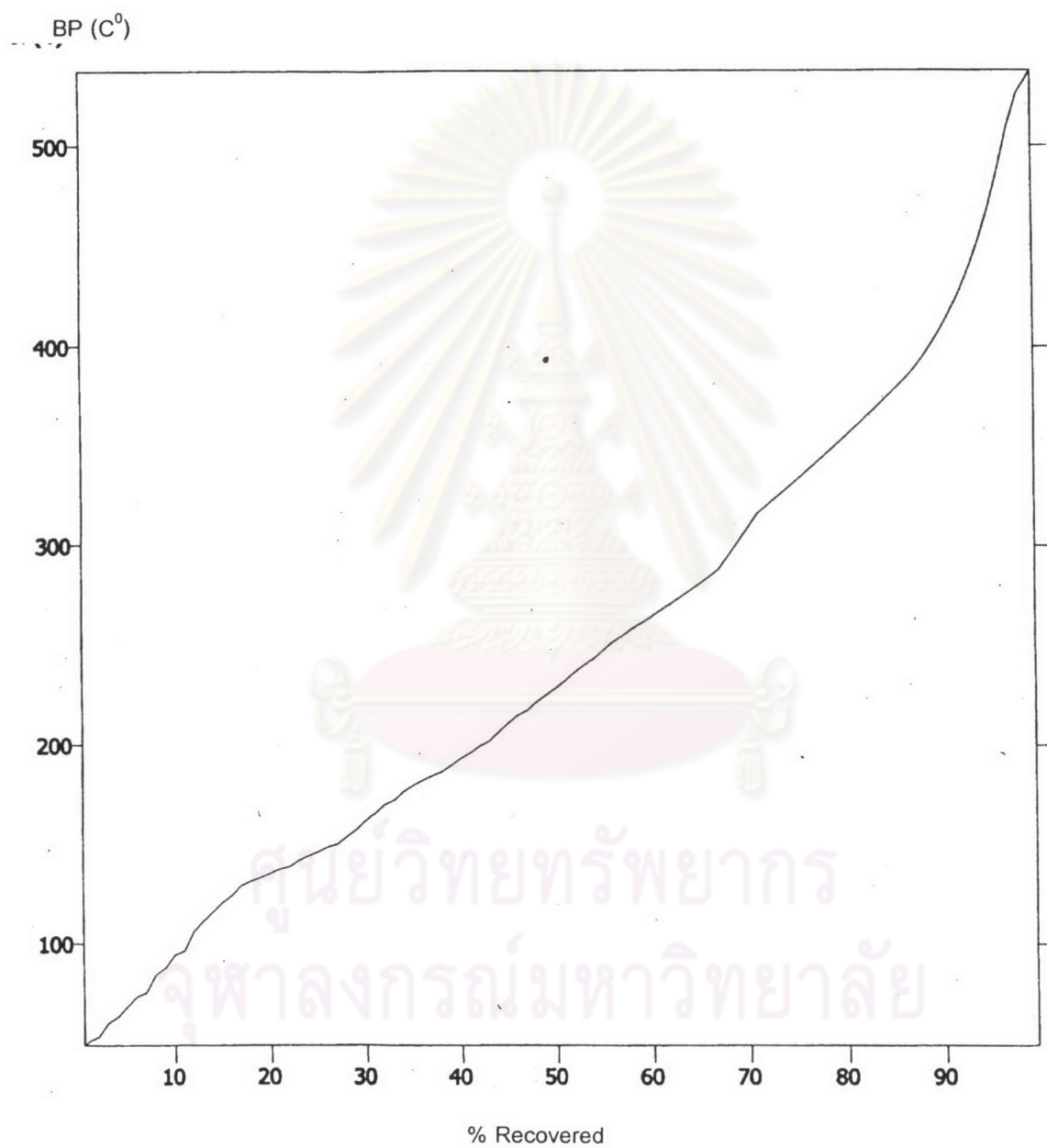


Figure B.5 Composition at condition 450 °C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	127.0	241.0	291.9	348.4	395.4	456.2	510.0	573.7	649.2	728.8	995.4
$^{\circ}\text{C}$	52.8	116.1	144.4	175.8	201.9	235.6	265.6	300.9	342.9	387.1	535.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

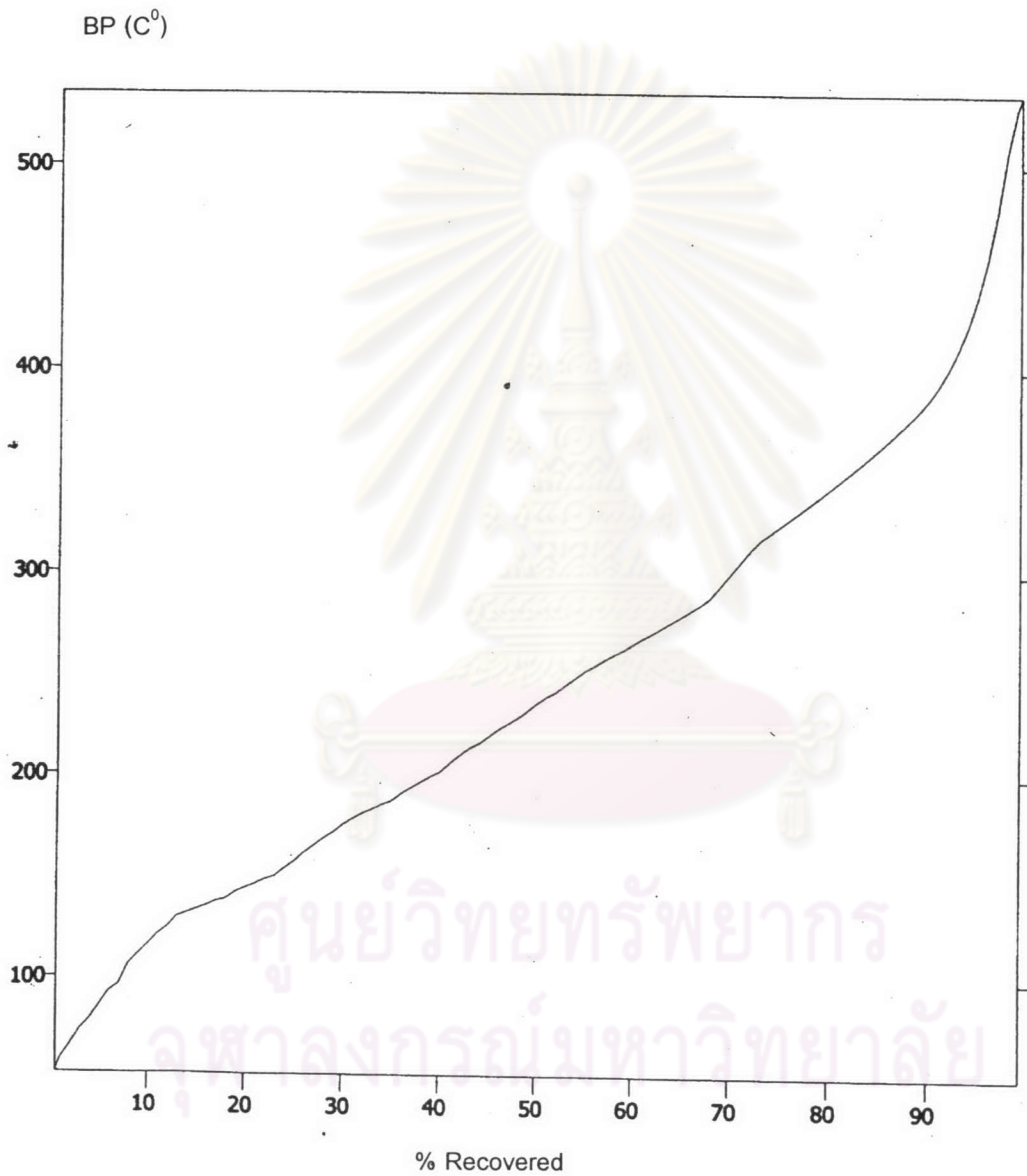


Figure B.6 Composition at condition 470°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	156.7	445.1	546.9	618.0	647.3	671.6	696.8	723.4	765.3	851.3	1001.7
$^{\circ}\text{C}$	69.3	229.5	286.0	325.5	341.8	355.3	369.3	384.1	407.4	455.1	538.7
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

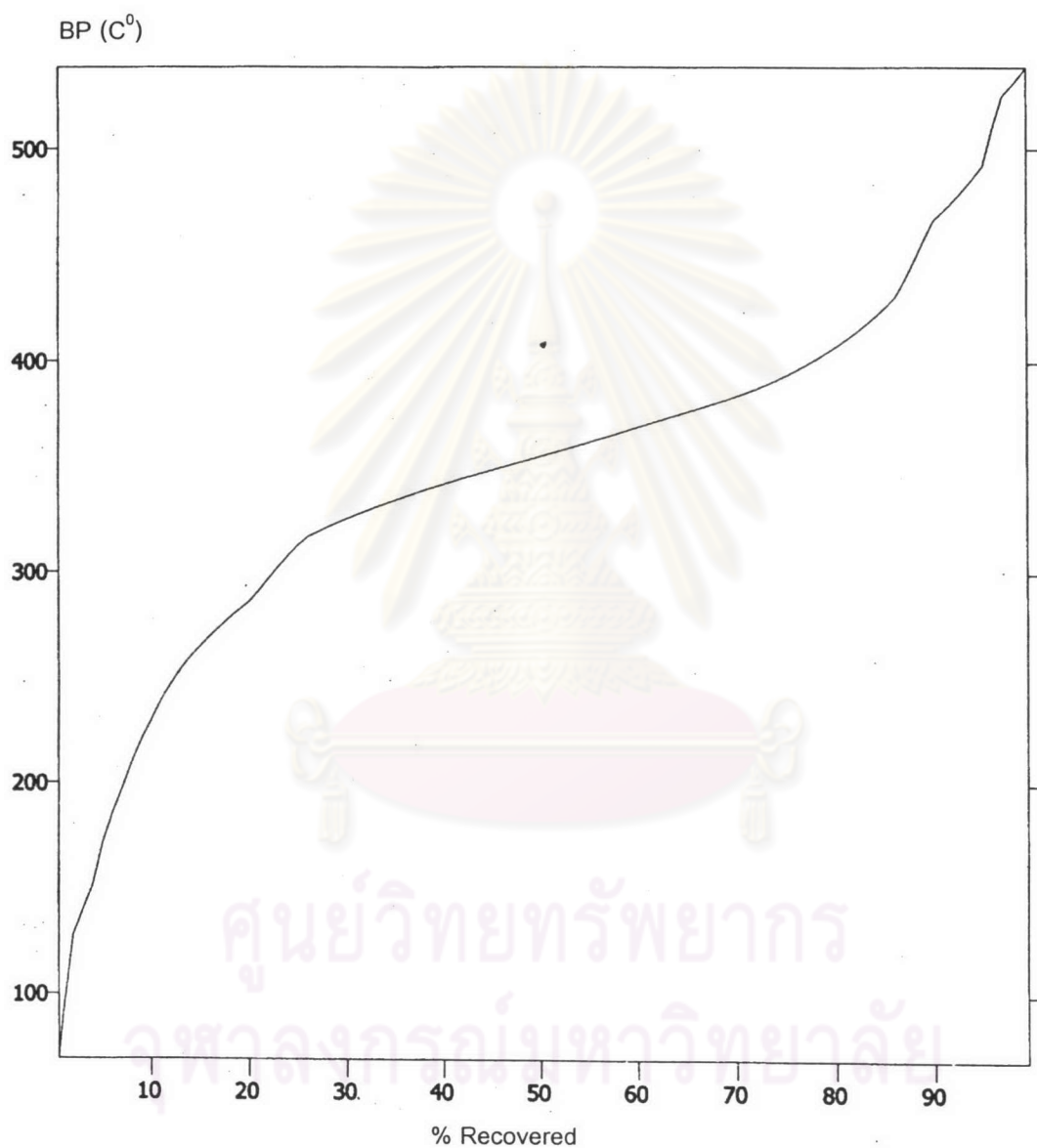


Figure B.7 Composition at condition 400°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	122.3	267.7	353.8	435.9	510.3	586.0	643.8	691.0	745.3	855.3	1002.7
$^{\circ}\text{C}$	50.2	131.0	178.8	224.4	265.7	307.8	339.9	366.1	396.3	457.4	539.3
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

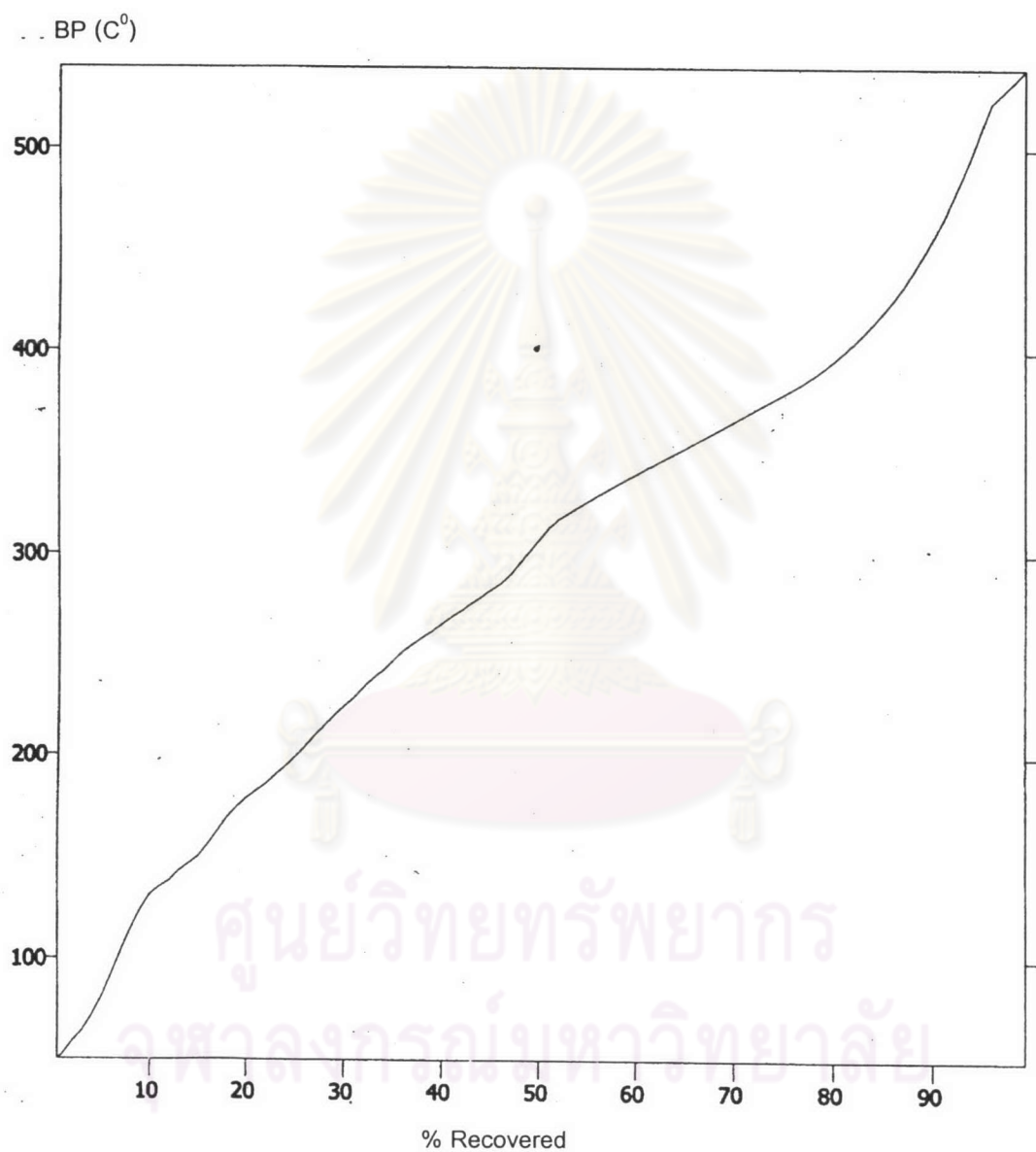


Figure B.8 Composition at condition 420°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	121.0	198.6	278.1	337.6	395.1	472.5	540.7	636.1	712.7	836.1	1002.7
$^{\circ}\text{C}$	49.4	92.6	136.7	169.8	201.7	244.7	282.6	335.6	378.2	446.7	539.3
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

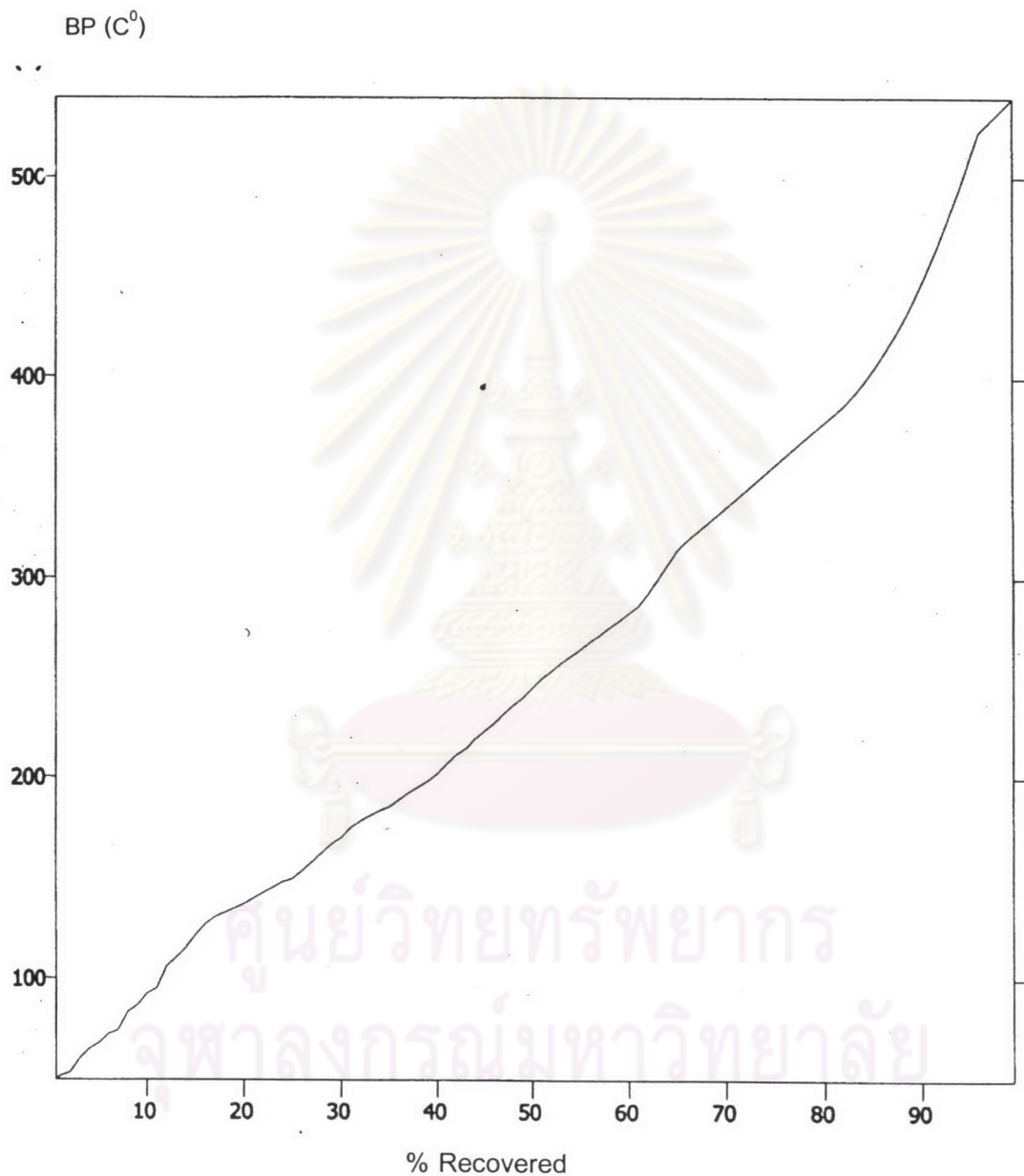


Figure B.9 Composition at condition 435°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	121.8	241.5	280.8	333.8	389.1	456.9	518.1	604.4	684.4	792.2	1000.9
$^{\circ}\text{C}$	49.9	101.4	138.2	167.7	198.4	236.1	270.1	318.0	362.4	422.3	538.3
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

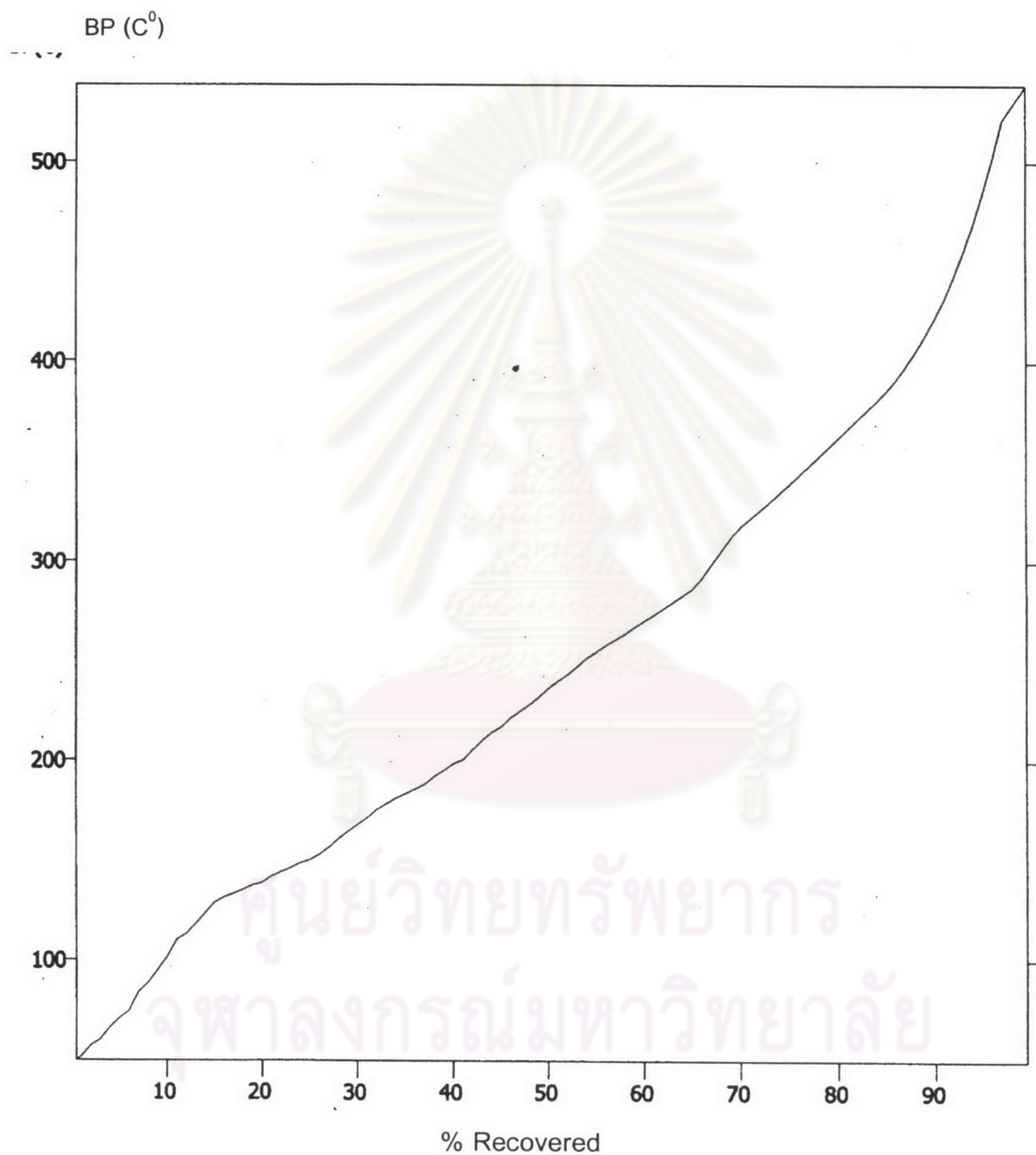


Figure B.10 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	121.2	196.1	293.5	373.0	476.9	582.9	668.6	729.4	809.6	929.3	1004.6
$^{\circ}\text{C}$	49.6	91.2	145.3	189.4	247.2	306.0	353.7	387.5	432.0	498.5	540.3
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

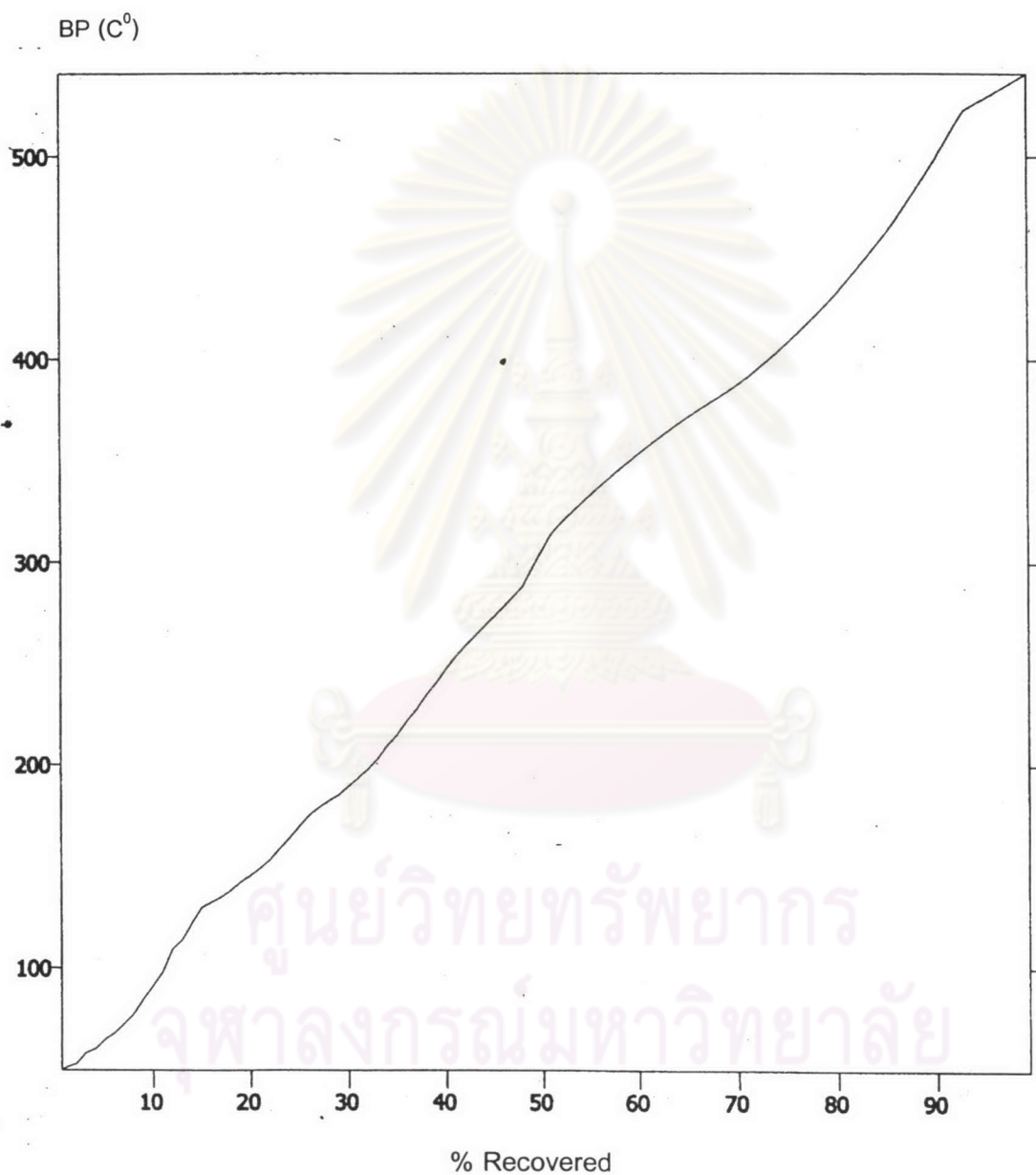


Figure B.11 Composition at condition 470°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
°F	121.8	260.3	338.8	424.5	498.9	556.5	628.2	675.8	732.2	845.1	1002.6
°C	49.9	126.8	170.4	218.1	259.4	291.4	331.2	357.7	389.0	451.7	539.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

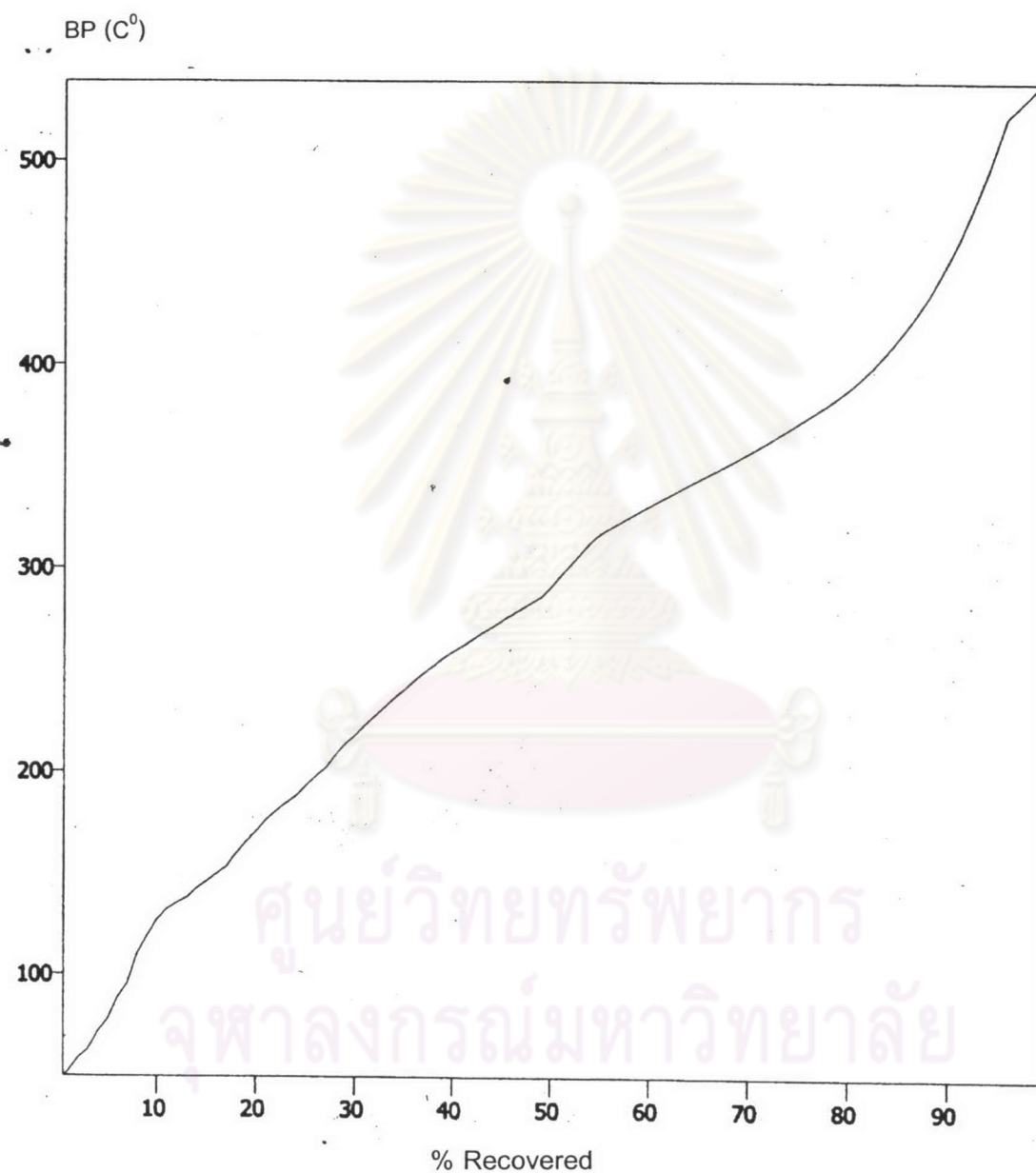


Figure B.12 Composition at condition 450°C of reaction temperature, 0 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	126.9	169.8	268.9	336.1	441.8	506.4	588.1	670.0	743.8	861.4	1011.8
$^{\circ}\text{C}$	52.7	76.6	131.6	168.9	211.0	263.6	309.0	354.5	395.4	460.8	544.3
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

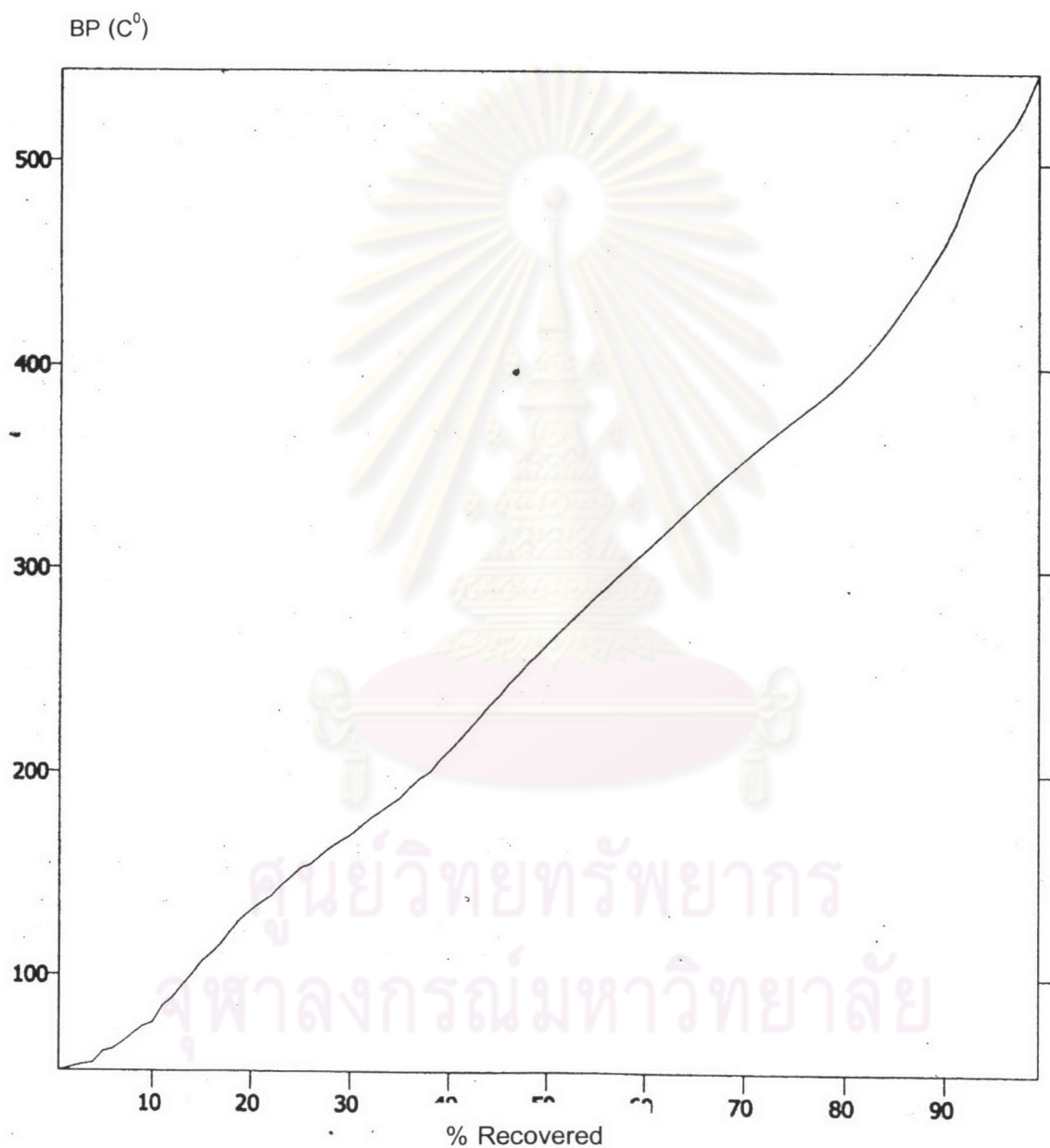


Figure B.13 Composition at condition 450°C of reaction temperature, 150 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
°F	136.8	275.5	349.2	415.1	476.8	526.0	592.0	642.2	690.5	761.7	997.1
°C	58.2	135.3	176.2	212.9	247.1	274.4	311.1	339.0	365.9	405.4	536.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

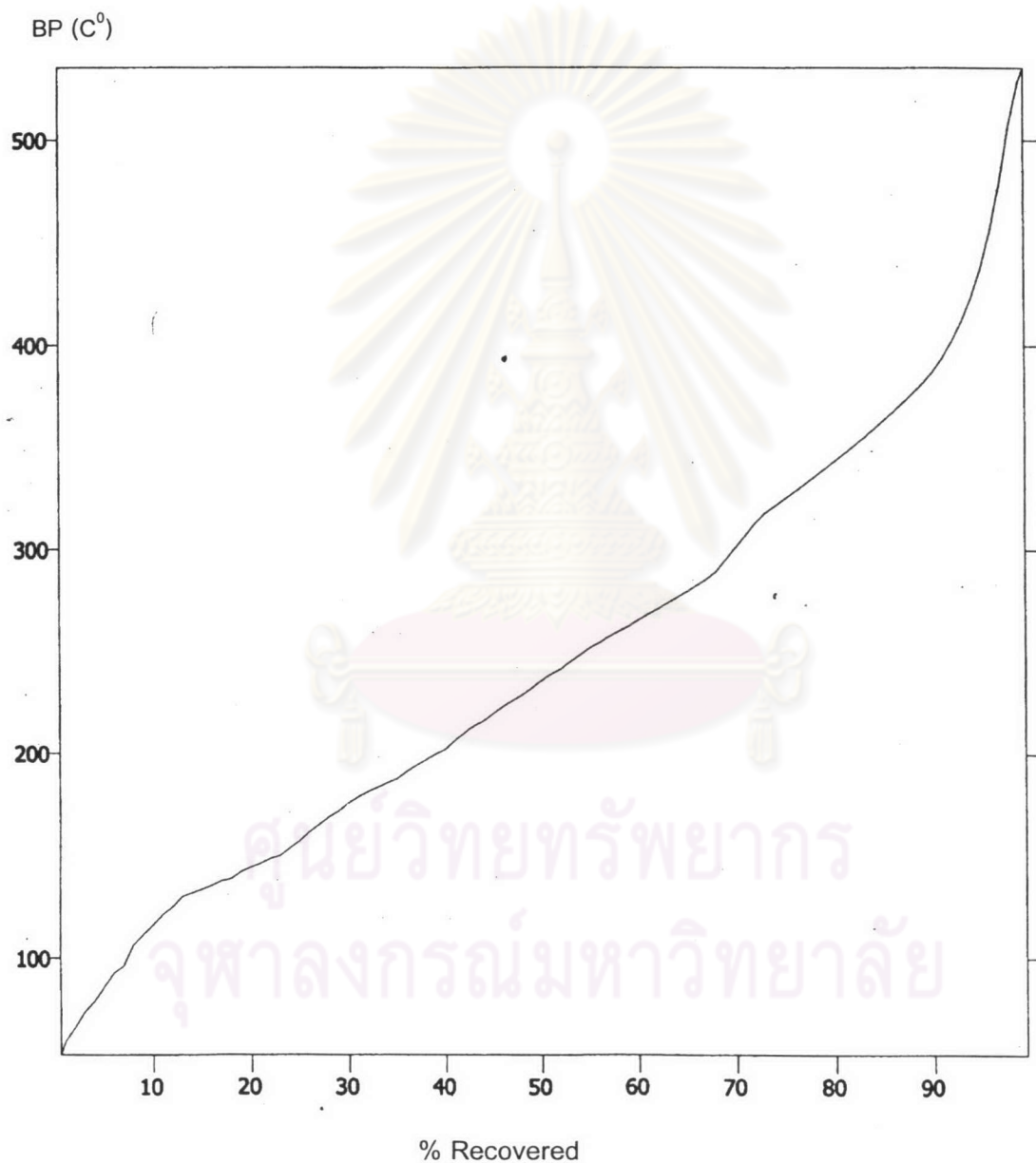


Figure B.14 Composition at condition 450°C of reaction temperature, 200 psi of initial hydrogen pressure, 90 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	121.1	231.2	337.9	442.3	531.6	618.6	672.1	721.0	790.7	909.6	1004.2
$^{\circ}\text{C}$	49.5	110.7	170.0	228.0	277.6	325.9	355.6	382.8	421.5	487.6	540.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

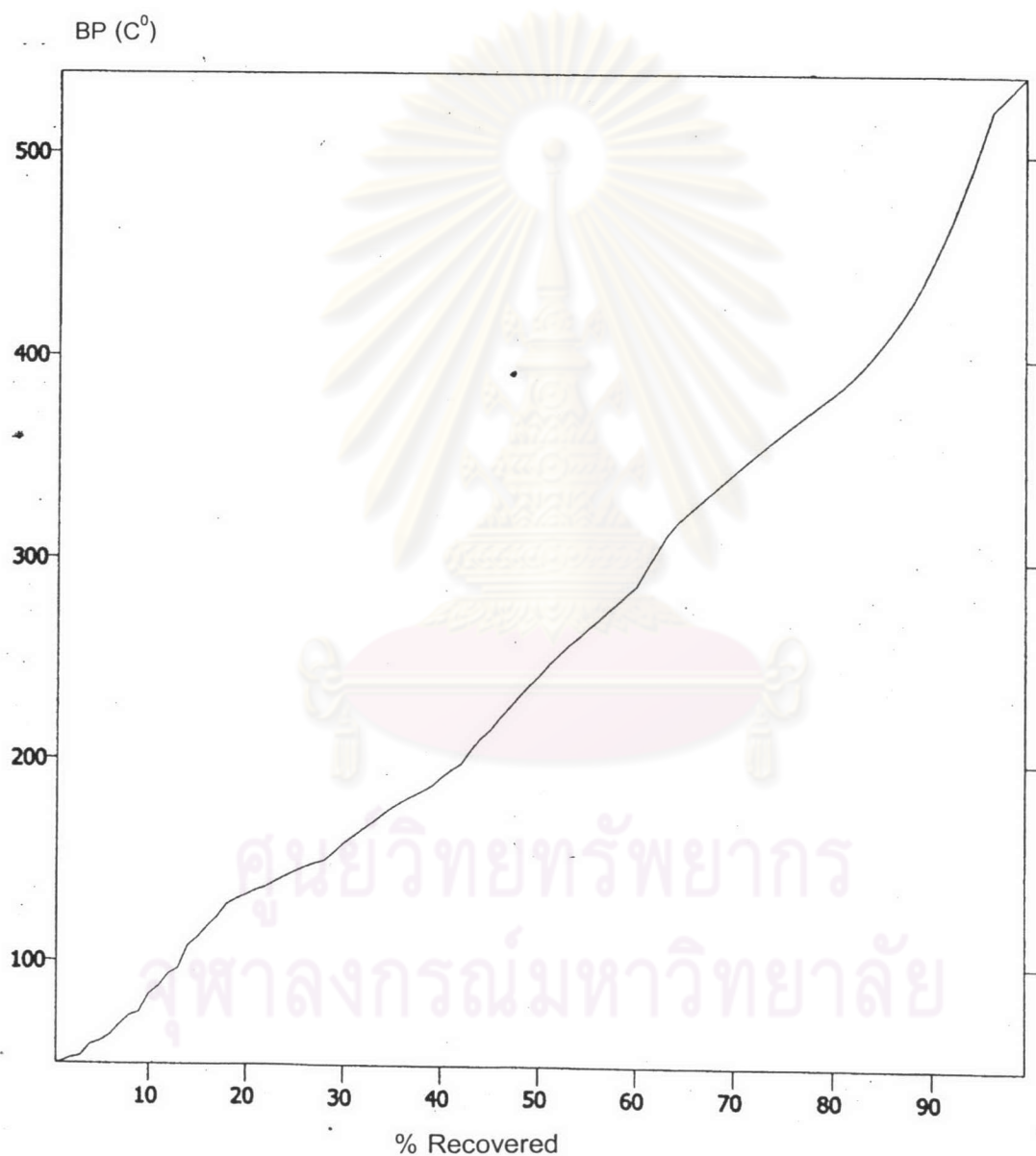


Figure B.15 Composition at condition 450°C of reaction temperature, 0 psi of initial hydrogen pressure, 30 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	120.5	185.8	281.3	350.2	419.4	509.0	600.3	667.4	731.0	850.7	1002.9
$^{\circ}\text{C}$	49.2	85.4	138.5	176.8	215.2	265.0	315.7	353.0	388.3	454.9	539.4
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

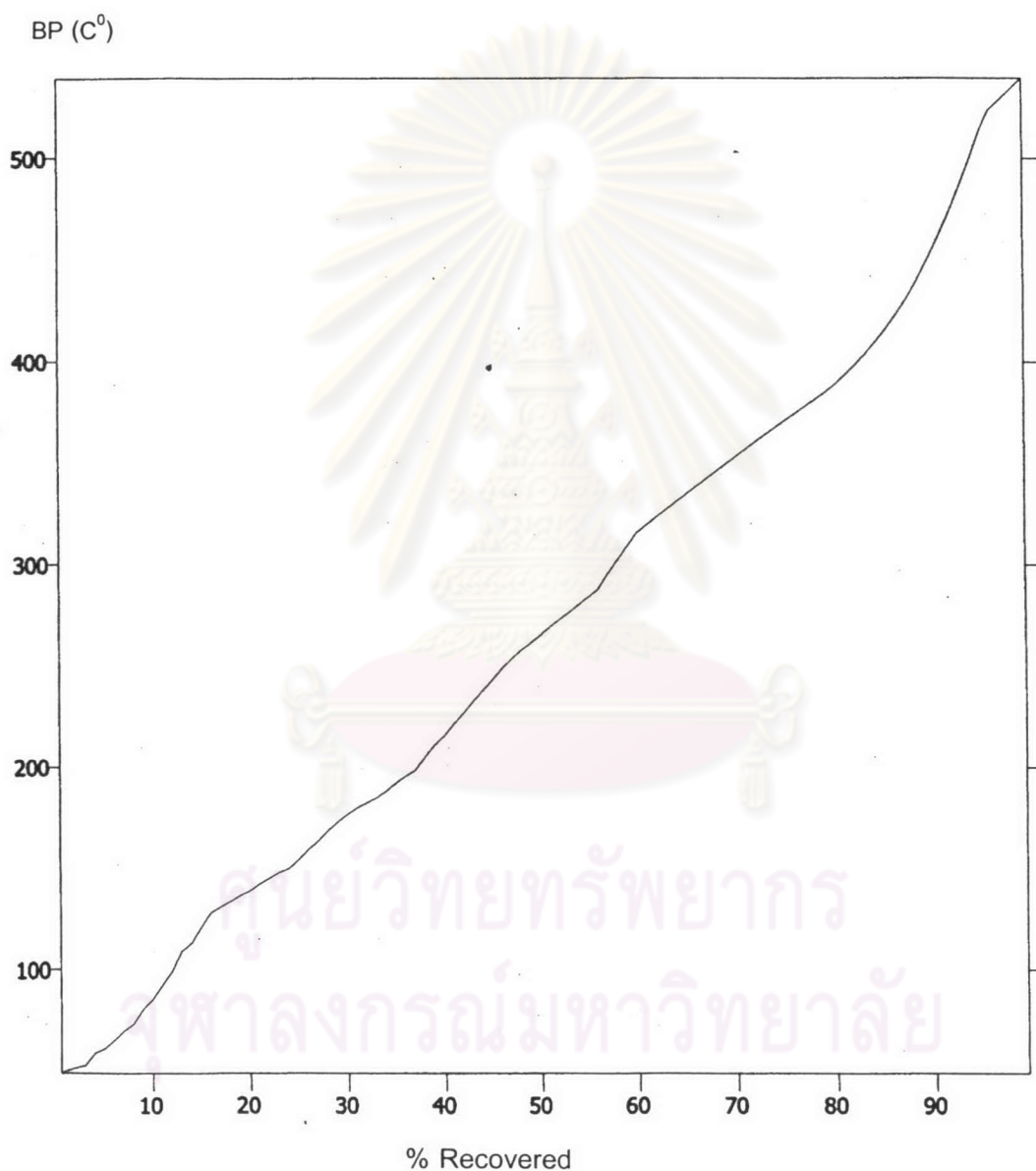


Figure B.16 Composition at condition 450°C of reaction temperature, 150 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	158.8	271.5	320.8	386.9	453.4	510.0	572.3	642.6	705.1	800.2	1000.7
$^{\circ}\text{C}$	70.4	133.0	160.4	197.2	234.1	265.5	300.2	339.2	373.9	426.8	538.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

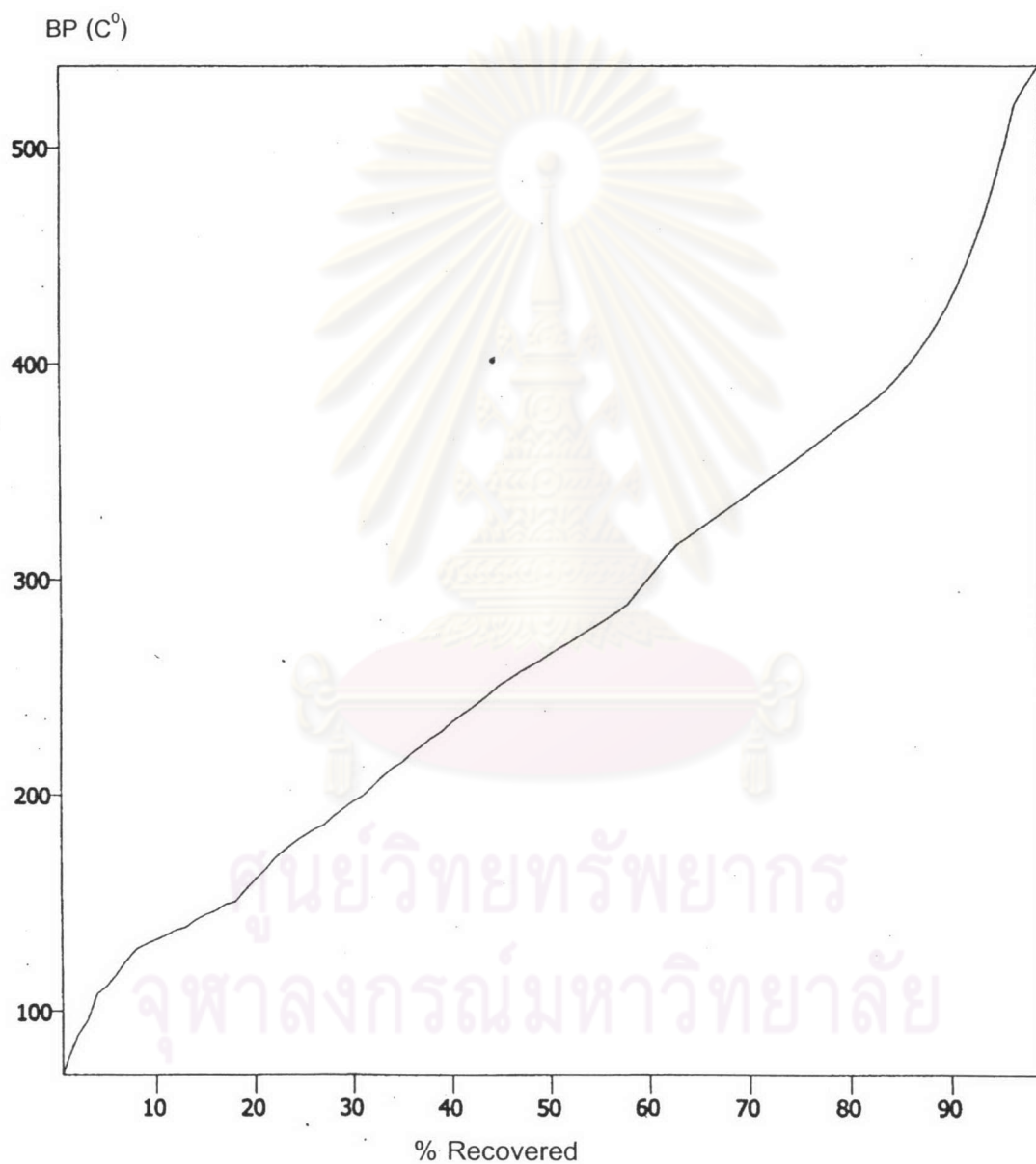


Figure B.17 Composition at condition 450°C of reaction temperature, 200 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	124.5	240.1	295.5	361.4	430.8	498.2	559.5	639.8	703.9	798.6	1000.6
$^{\circ}\text{C}$	51.4	115.6	146.4	183.0	221.5	259.0	293.0	337.7	373.3	425.9	538.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

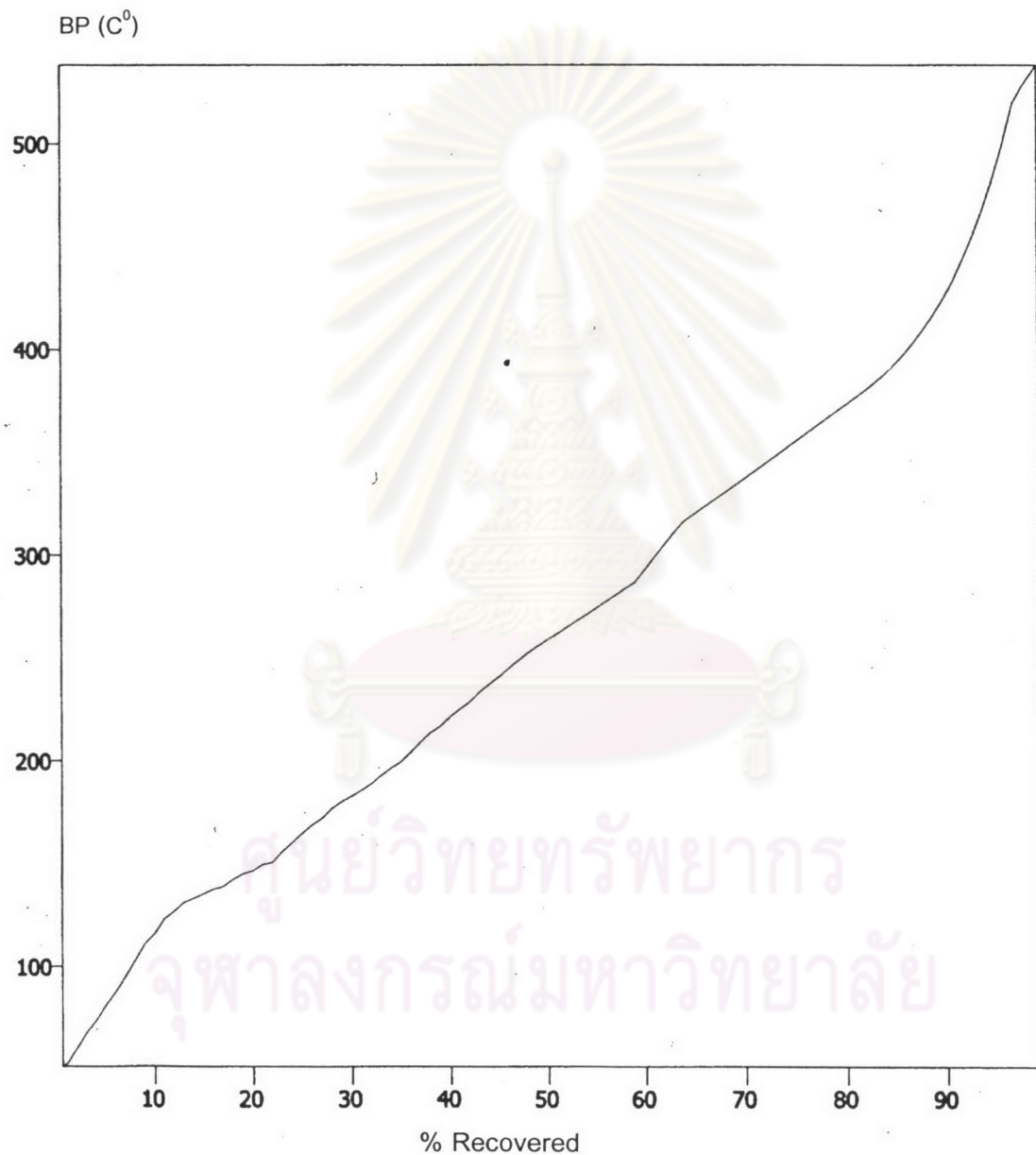


Figure B.18 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 30 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	121.1	231.0	320.7	421.8	511.4	602.7	673.6	730.6	798.0	910.5	1003.9
$^{\circ}\text{C}$	49.5	110.5	160.4	216.6	266.3	317.1	356.5	388.1	425.6	488.0	540.0
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

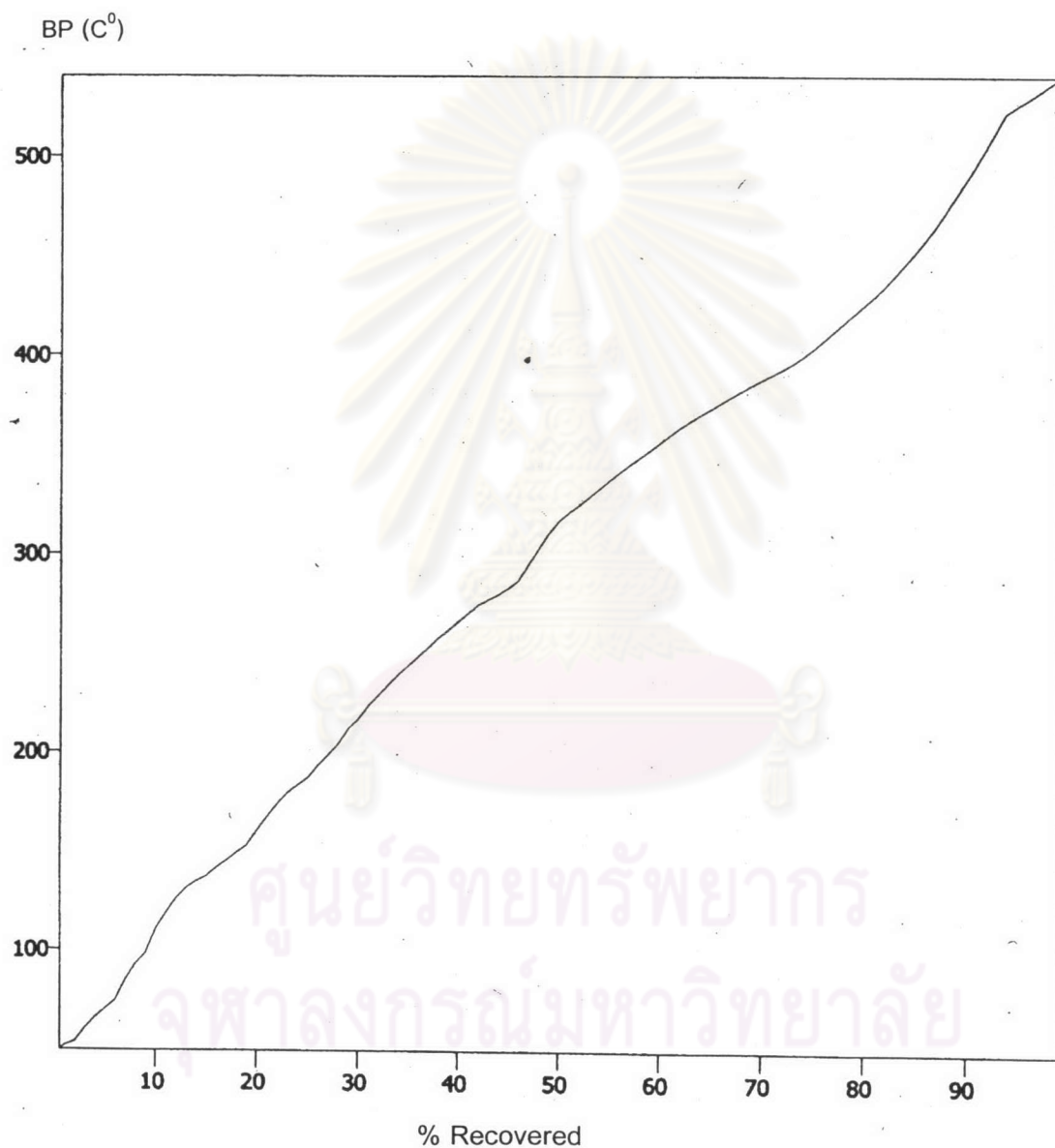


Figure B.19 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 45 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	120.4	201.6	293.5	365.1	457.1	540.5	649.7	721.1	797.5	913.8	1004.2
$^{\circ}\text{C}$	49.1	94.2	145.3	185.1	236.2	282.5	343.1	382.9	425.3	489.9	540.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

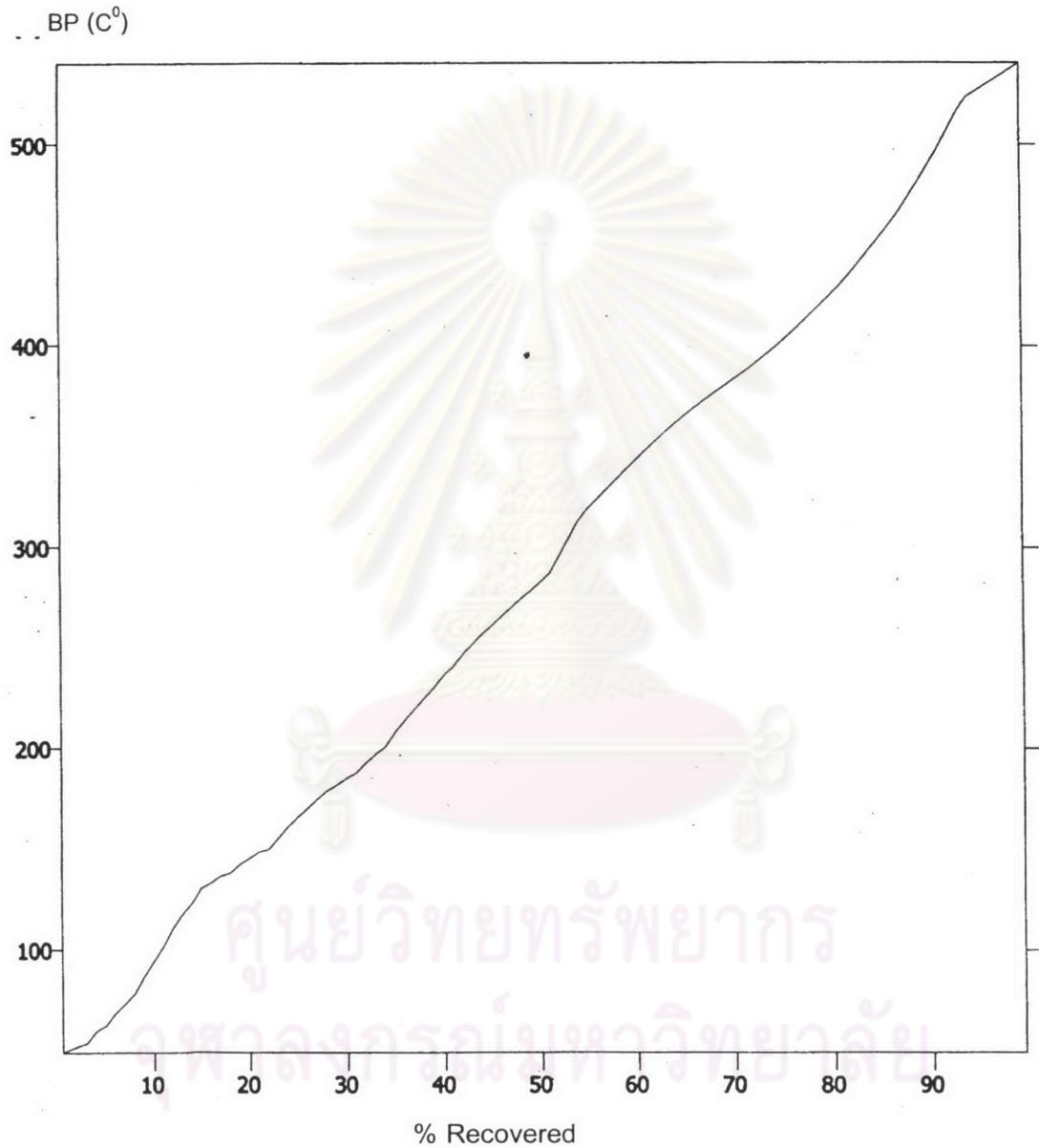


Figure B.20 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 1.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
°F	125.0	233.1	284.1	338.2	391.7	458.1	516.3	594.9	668.3	757.8	998.4
°C	51.6	111.7	140.0	170.1	199.8	236.7	269.1	312.7	353.5	403.2	536.9
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

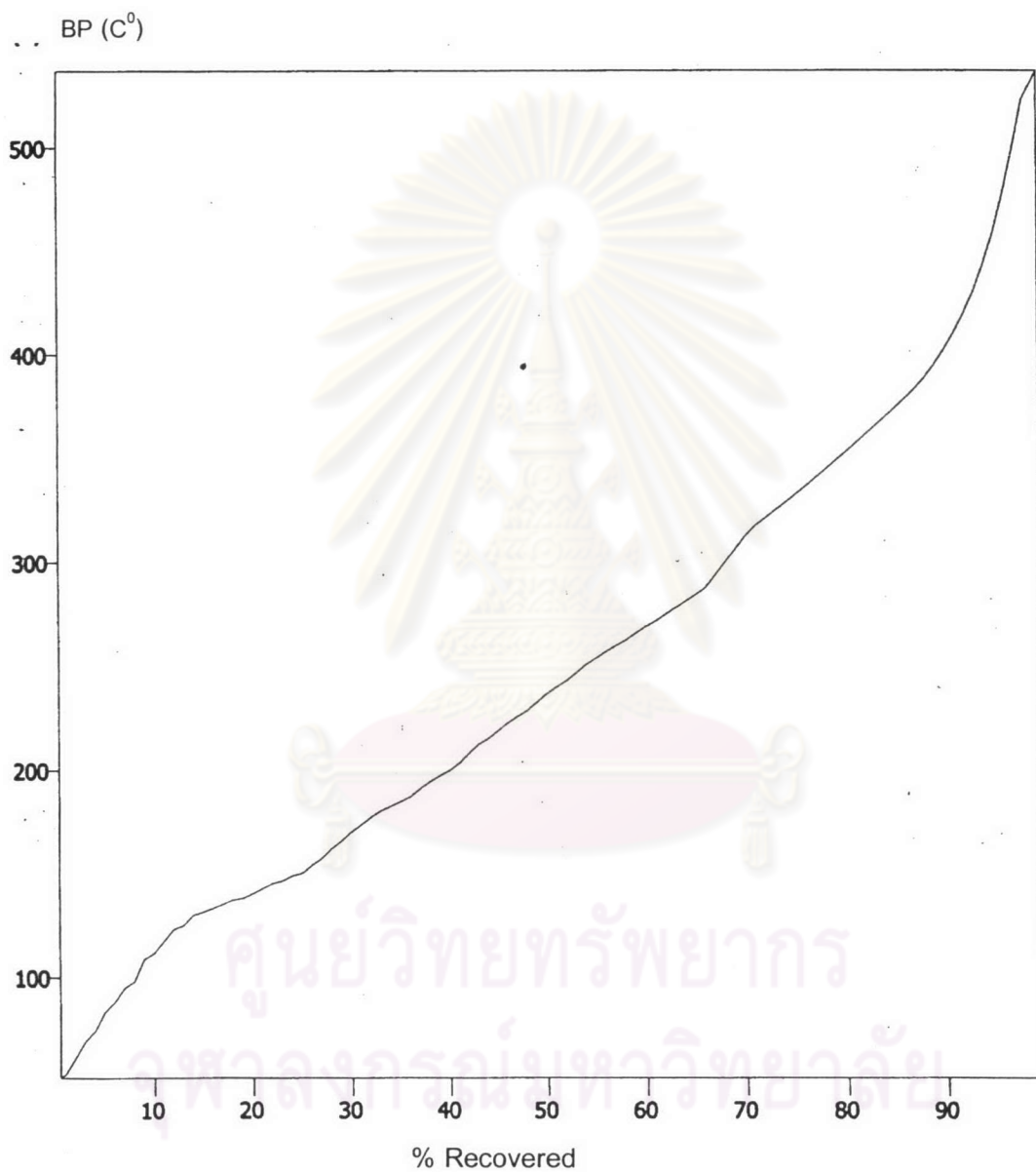


Figure B.21 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 120 minutes of reaction time and 1.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	125.7	259.9	312.0	381.9	455.4	516.5	590.1	652.8	714.4	818.2	1001.6
$^{\circ}\text{C}$	52.1	126.6	155.6	194.4	235.2	269.2	310.0	344.9	379.1	436.8	538.7
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

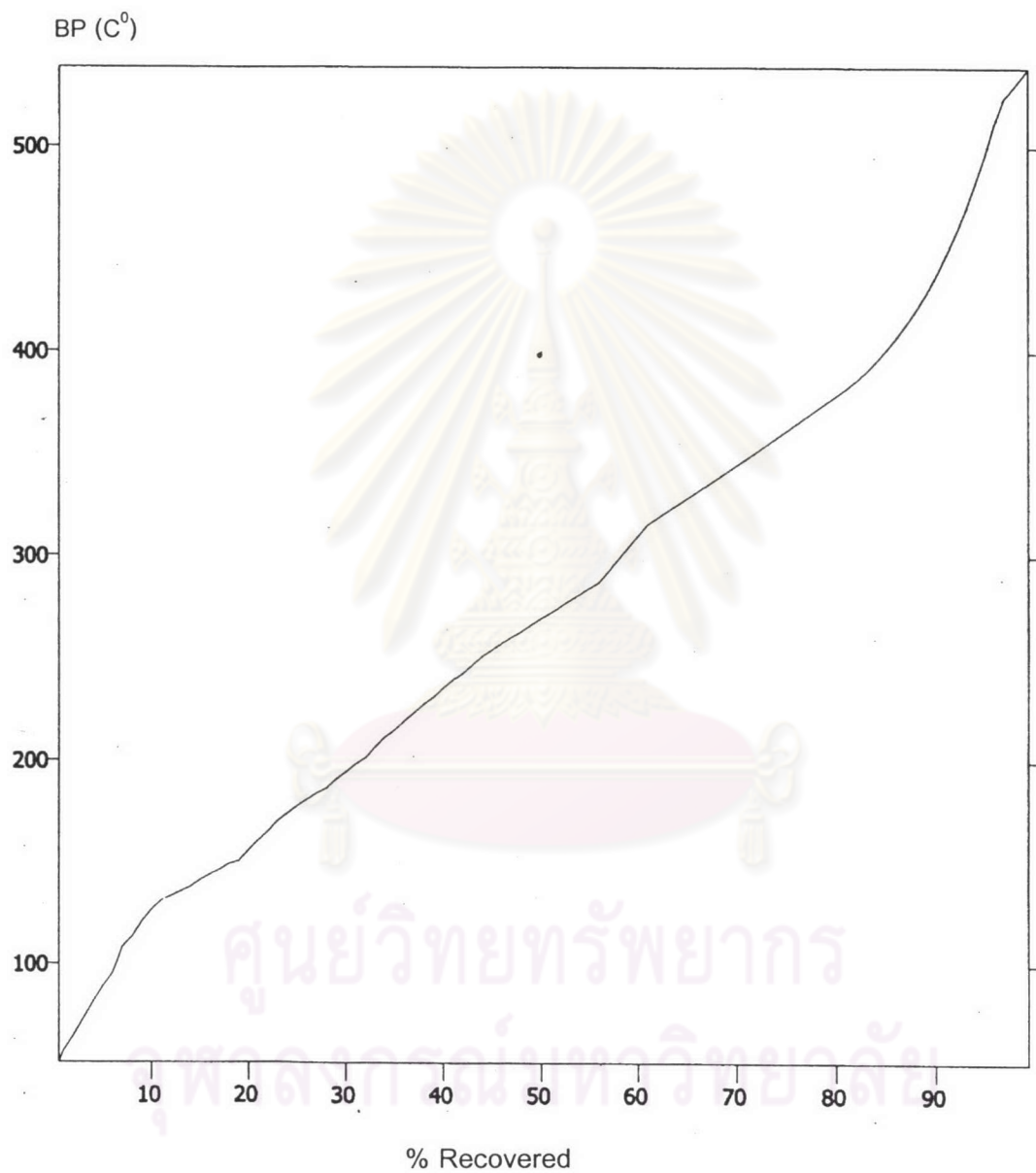


Figure B.22 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 30 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	122.5	250.3	330.1	407.9	493.9	557.2	636.7	698.5	769.8	896.1	1003.9
$^{\circ}\text{C}$	50.3	121.3	165.6	208.8	256.6	291.8	336.0	370.3	409.9	480.0	540.0
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

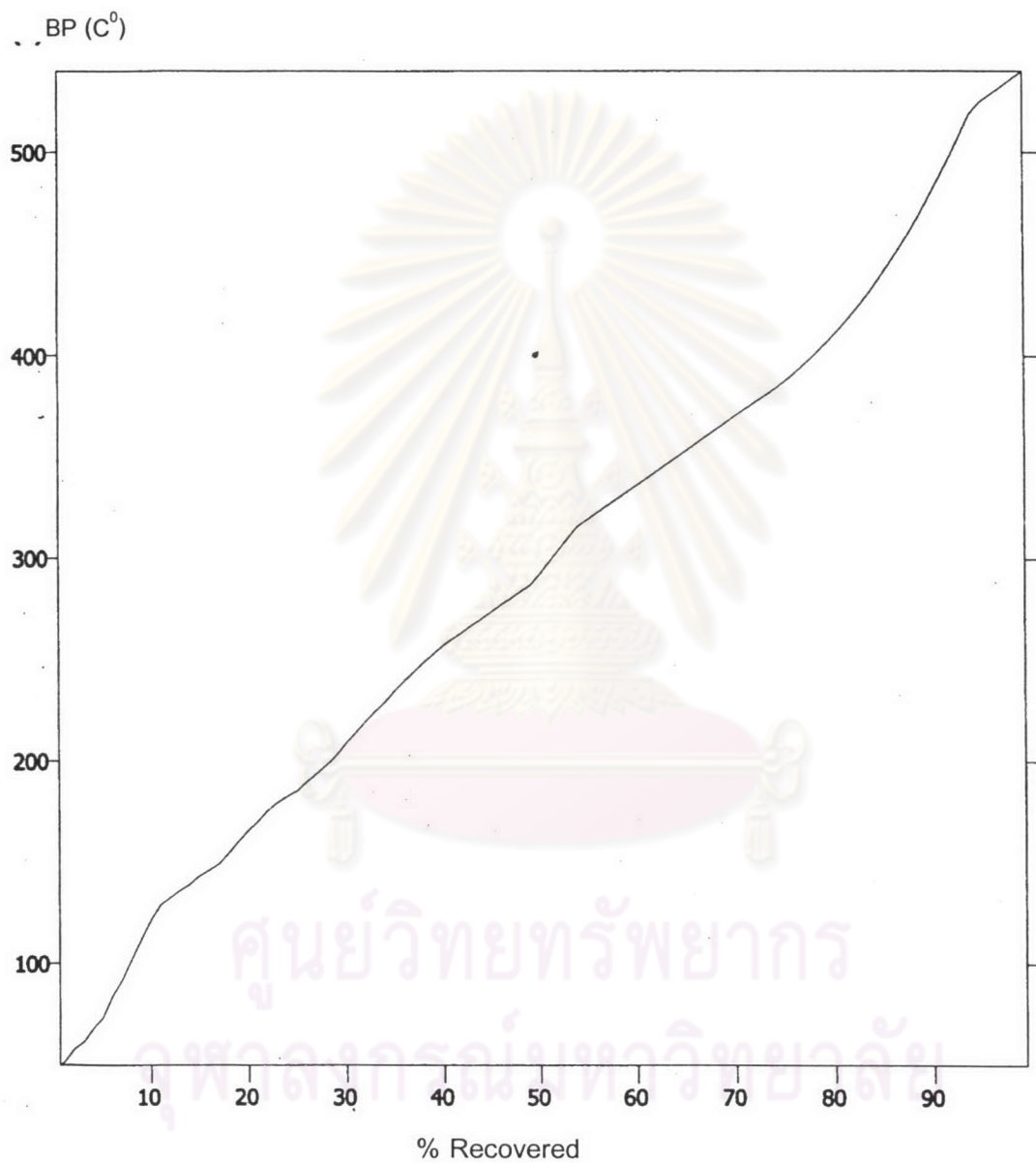


Figure B.23 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 0.5% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
	$^{\circ}\text{F}$	127.5	268.0	312.5	369.4	429.0	486.0	533.8	611.8	677.6	766.5
$^{\circ}\text{C}$	53.1	131.1	155.8	187.5	220.5	252.2	278.8	322.1	358.7	408.1	537.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

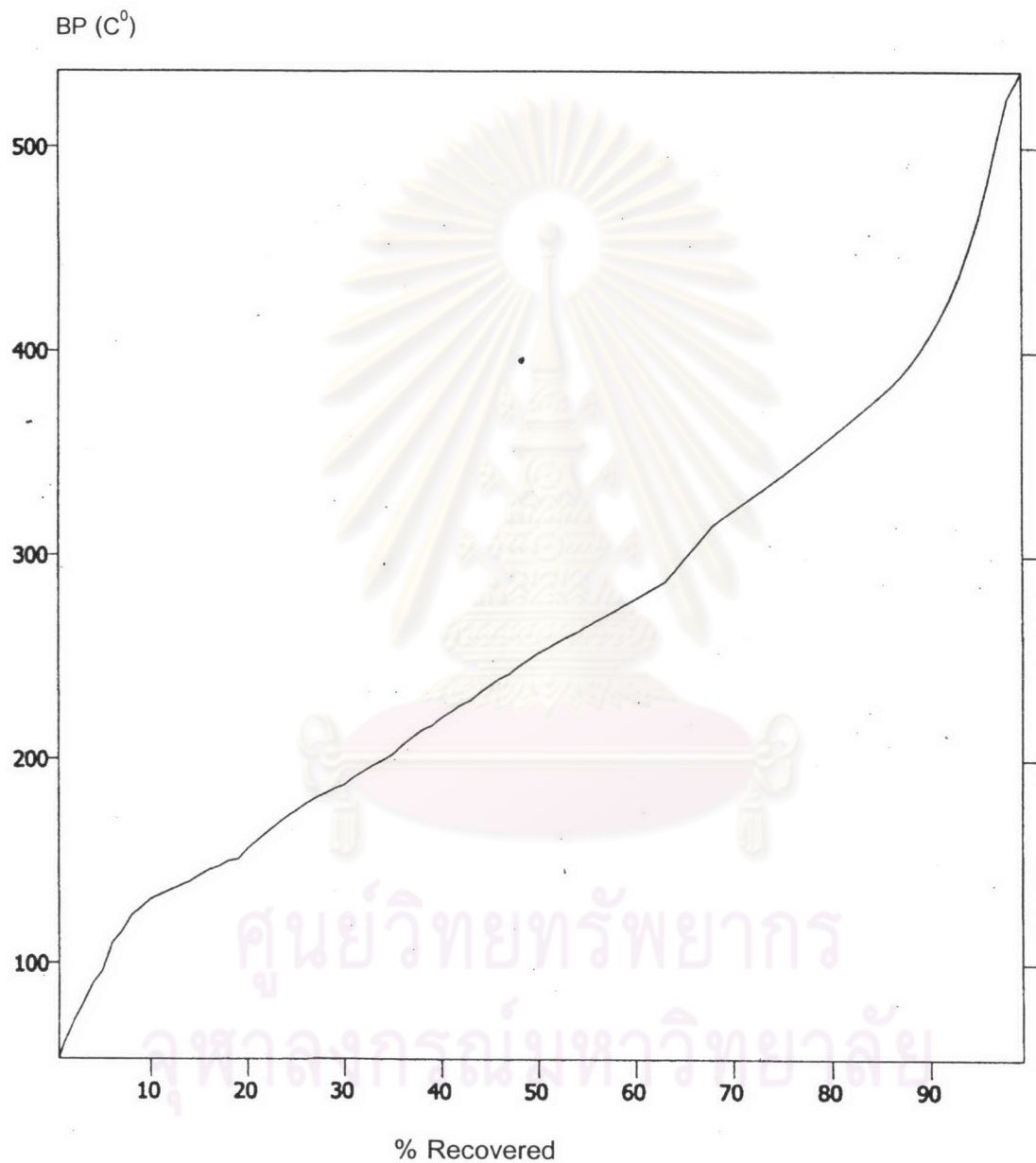


Figure B.24 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 0.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
°F	126.9	168.1	251.2	320.5	389.5	477.2	553.0	631.8	713.2	830.1	1009.6
°C	52.7	75.6	121.8	160.3	198.6	247.3	289.4	333.2	378.5	443.4	543.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

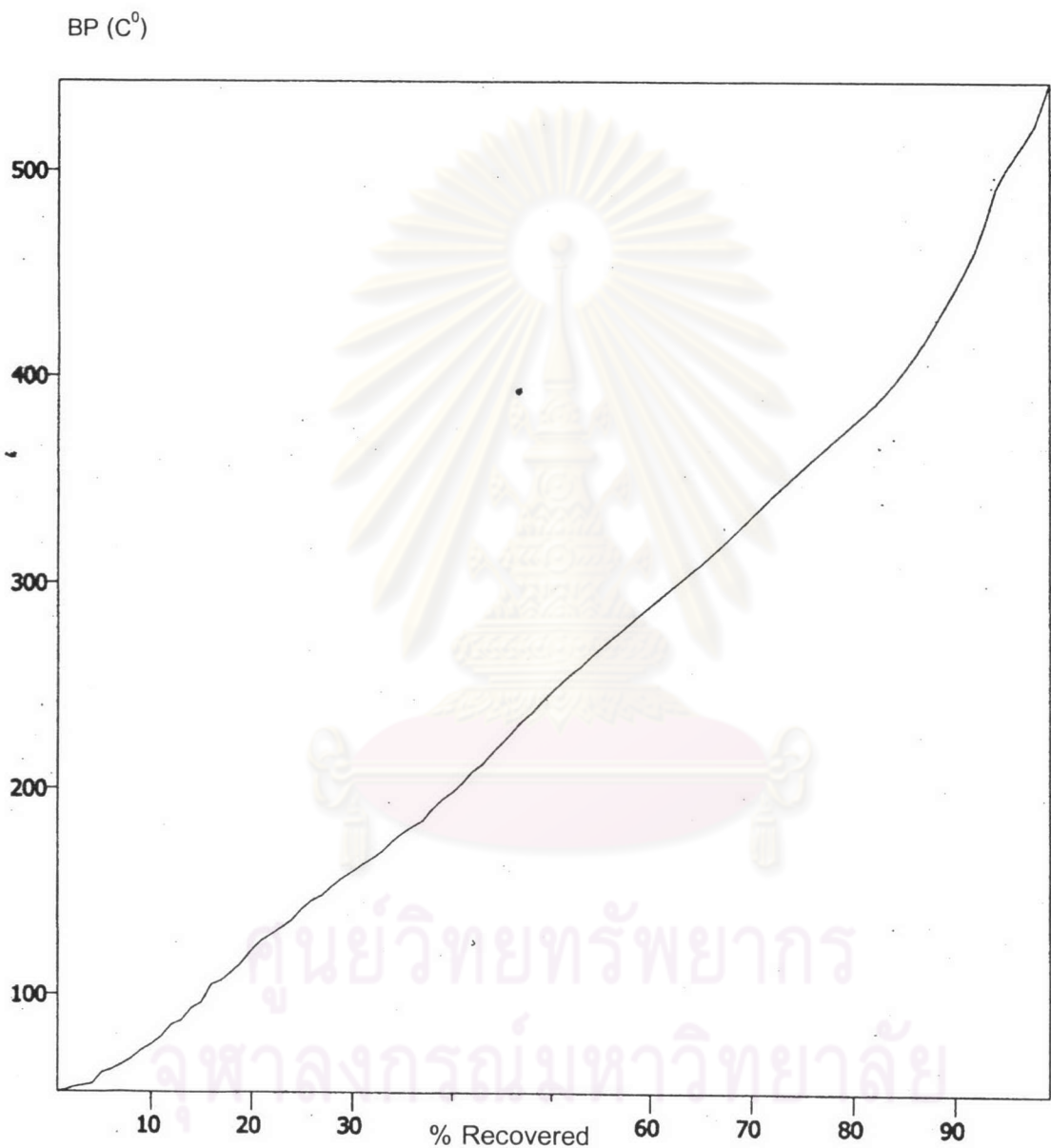


Figure B.25 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 3.0% of Ni-Mo/Al₂O₃.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	124.2	248.9	298.2	358.5	410.6	465.9	518.0	587.9	658.0	741.5	997.0
$^{\circ}\text{C}$	51.2	120.5	147.9	181.4	210.3	241.0	270.0	308.9	347.8	394.2	536.1
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

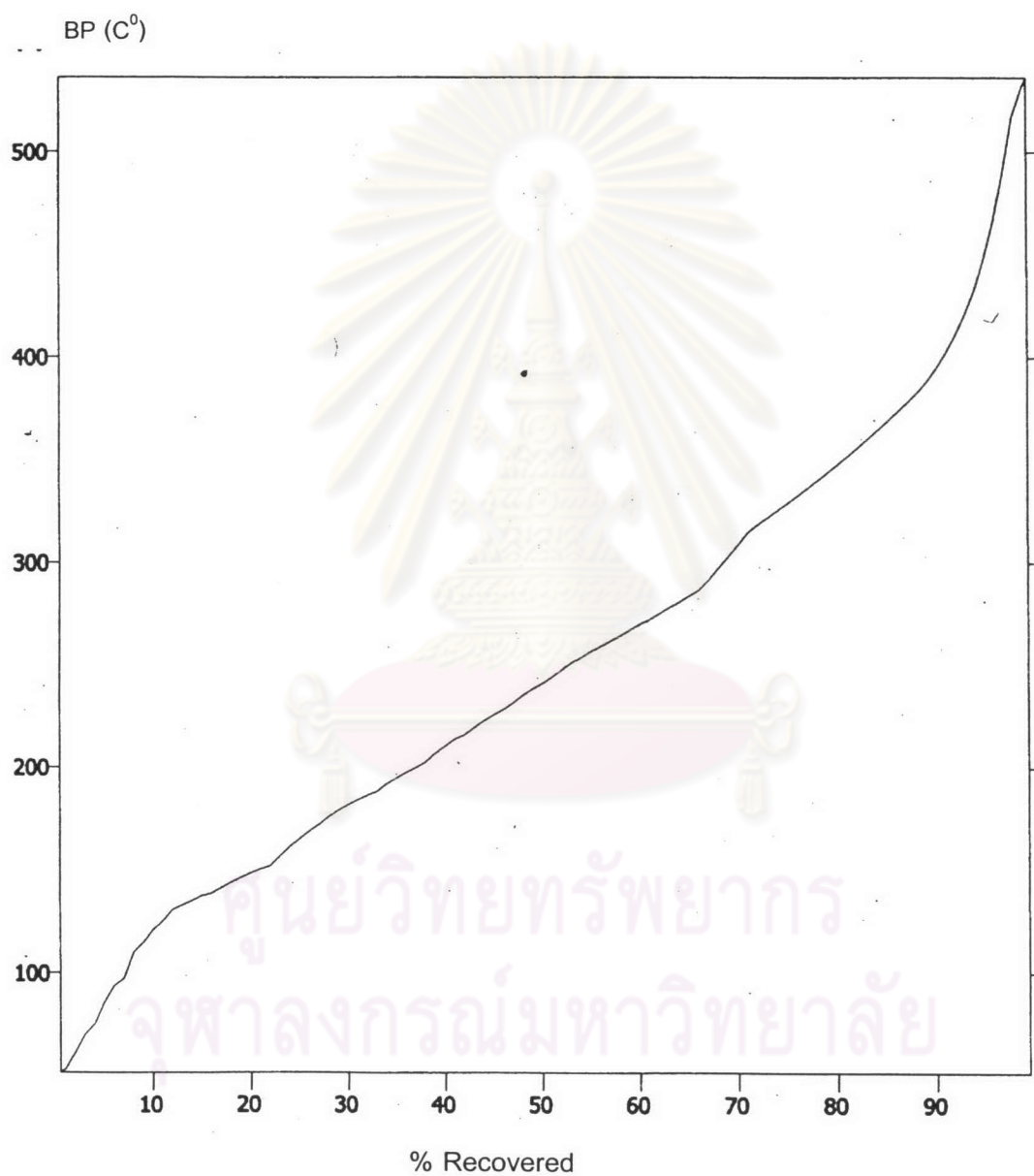


Figure B.26 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 90 minutes of reaction time and 5.0% of Ni-Mo/ Al_2O_3 .

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	120.0	182.3	271.5	317.9	377.3	468.4	549.5	651.2	721.3	839.3	1002.6
$^{\circ}\text{C}$	48.9	83.5	133.1	158.8	191.8	242.5	287.5	344.0	382.9	448.5	539.2
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

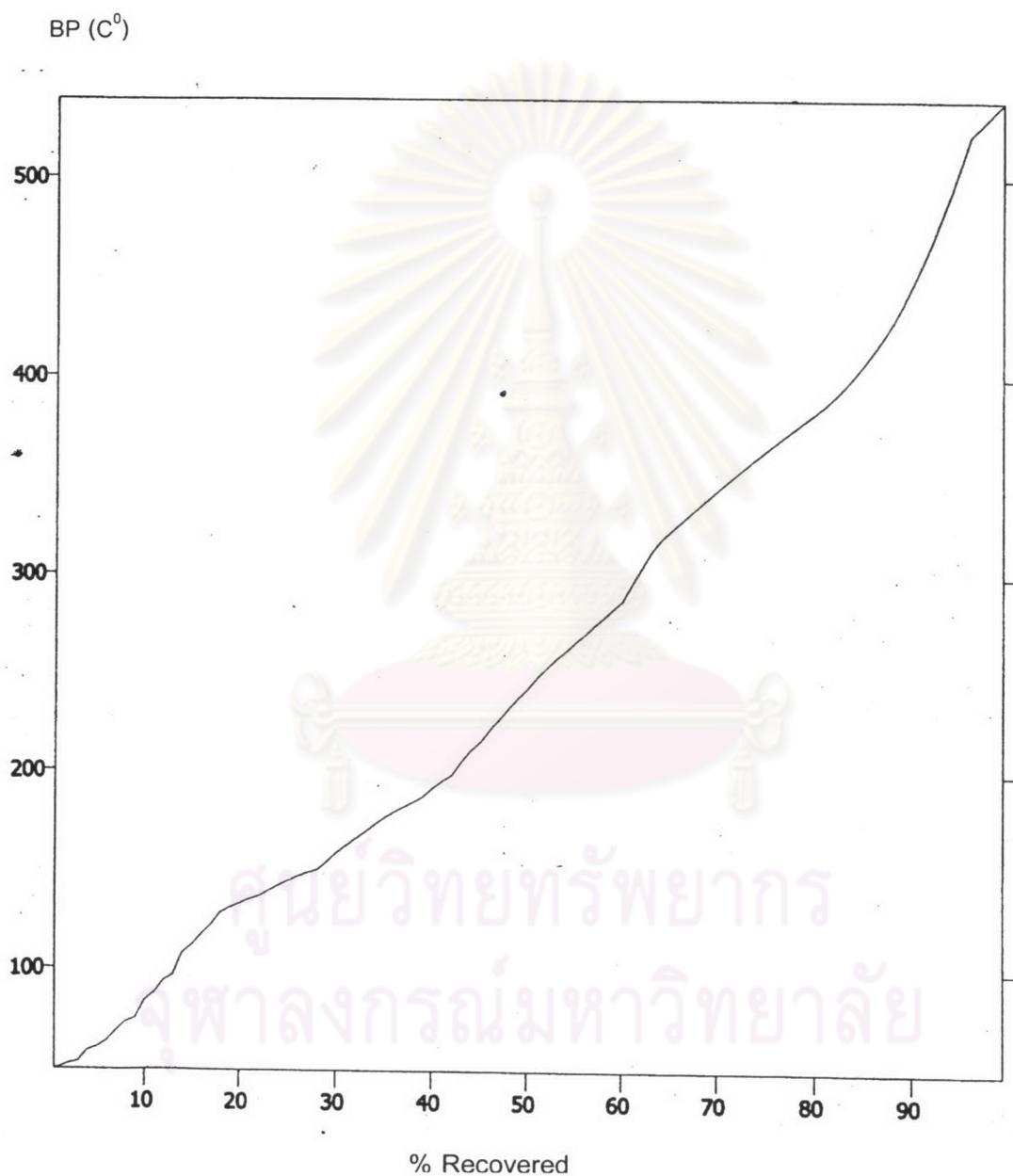


Figure B.27 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	122.7	204.1	280.5	339.6	395.3	468.7	534.0	627.5	704.7	816.7	1001.8
$^{\circ}\text{C}$	50.4	95.6	138.1	170.9	201.8	242.6	278.9	330.8	373.7	4736.0	538.8
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

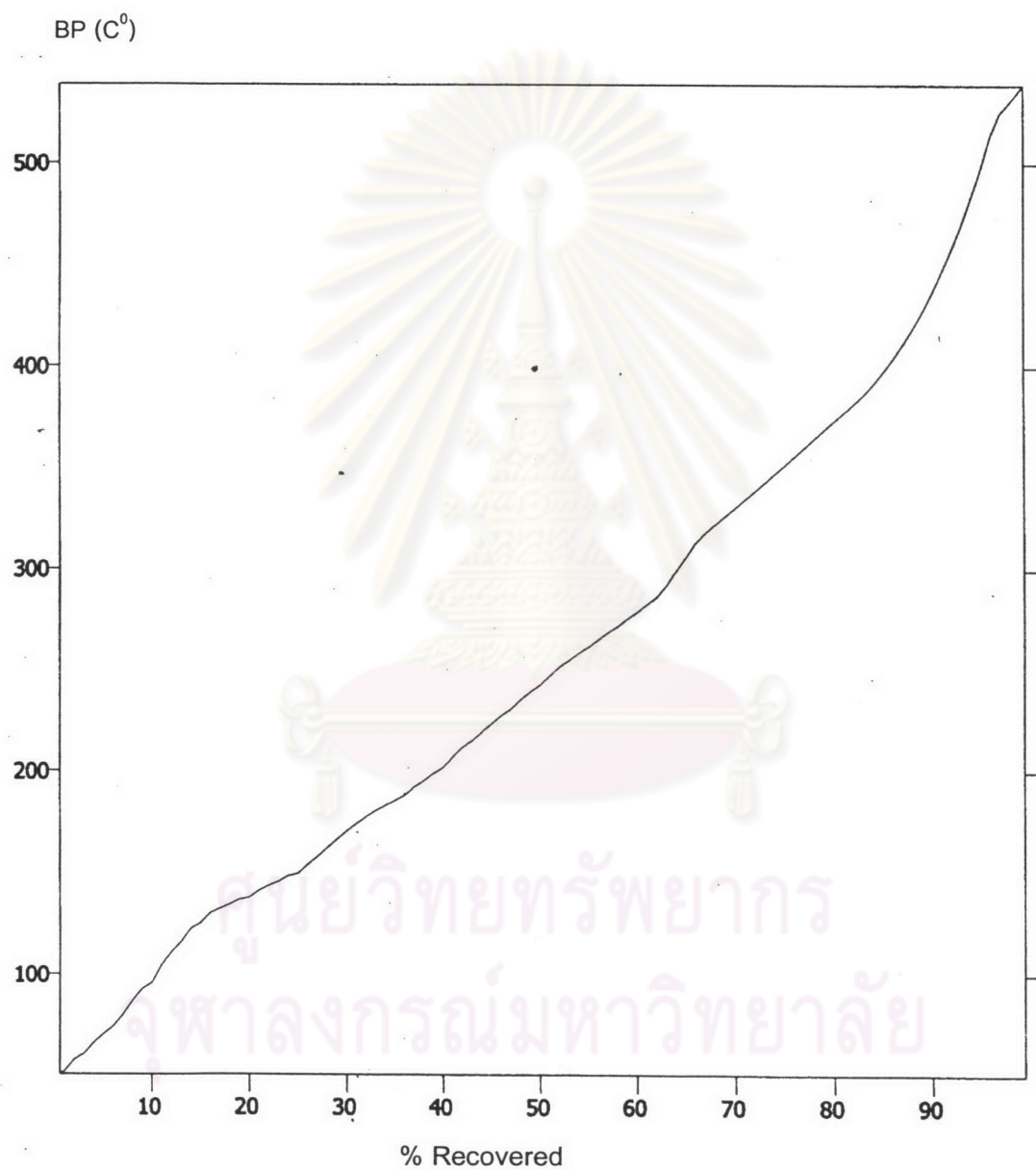


Figure B.28 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.1% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
$^{\circ}\text{F}$	120.4	182.8	272.0	321.4	380.1	463.6	538.7	636.1	714.3	838.3	1002.9
$^{\circ}\text{C}$	49.1	83.8	133.3	160.8	193.4	239.8	281.5	335.6	379.0	448.0	539.4
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

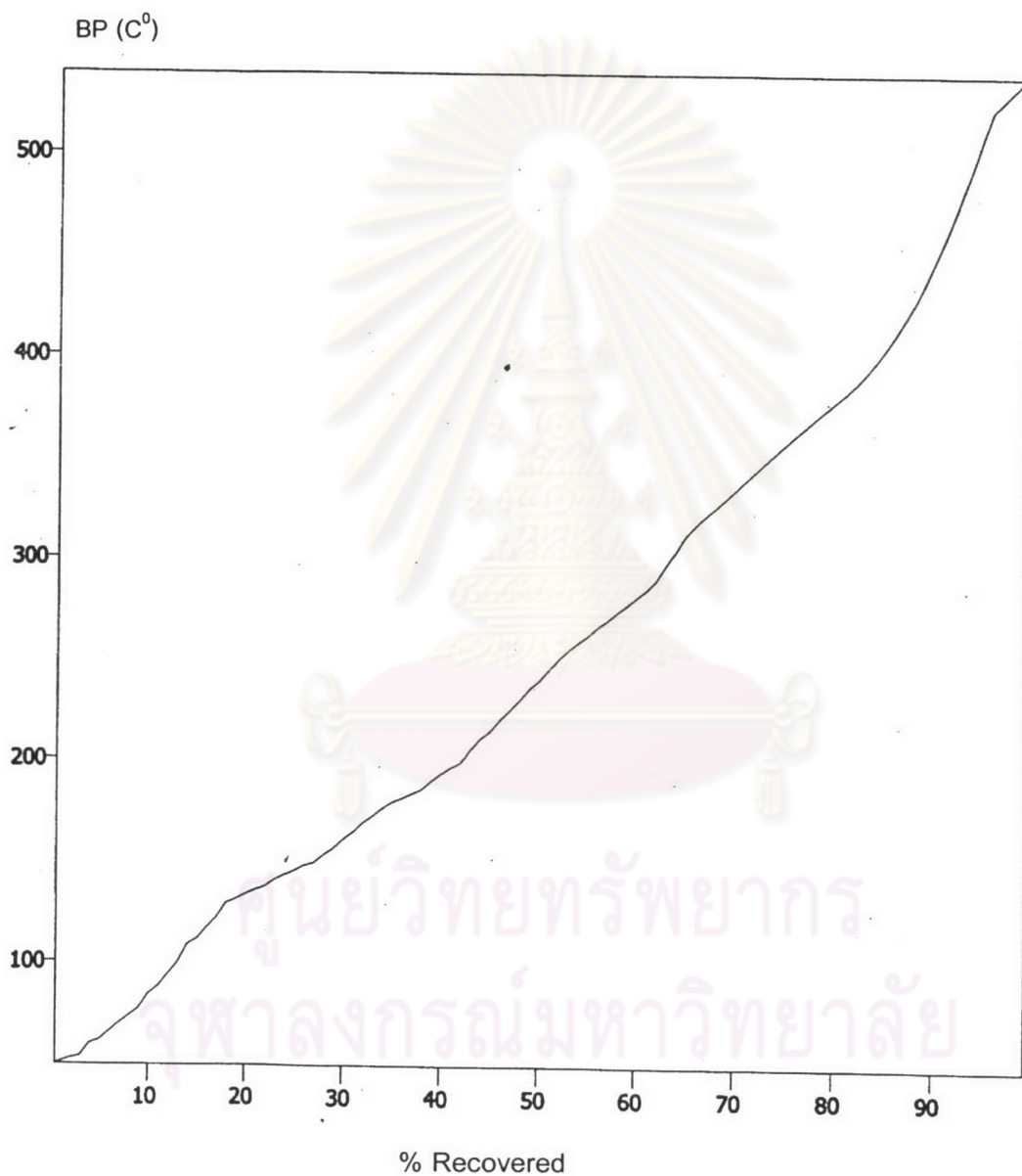


Figure B.29 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.3% of HZSM-5 catalyst.

Unit	Boiling Range Distribution										
	$^{\circ}\text{F}$	120.6	188.5	280.7	350.1	427.3	513.3	608.1	680.9	752.7	879.2
$^{\circ}\text{C}$	49.2	86.9	138.2	176.7	219.6	267.4	320.1	360.5	400.4	470.7	539.8
% Recovered	IBP	10	20	30	40	50	60	70	80	90	FBP

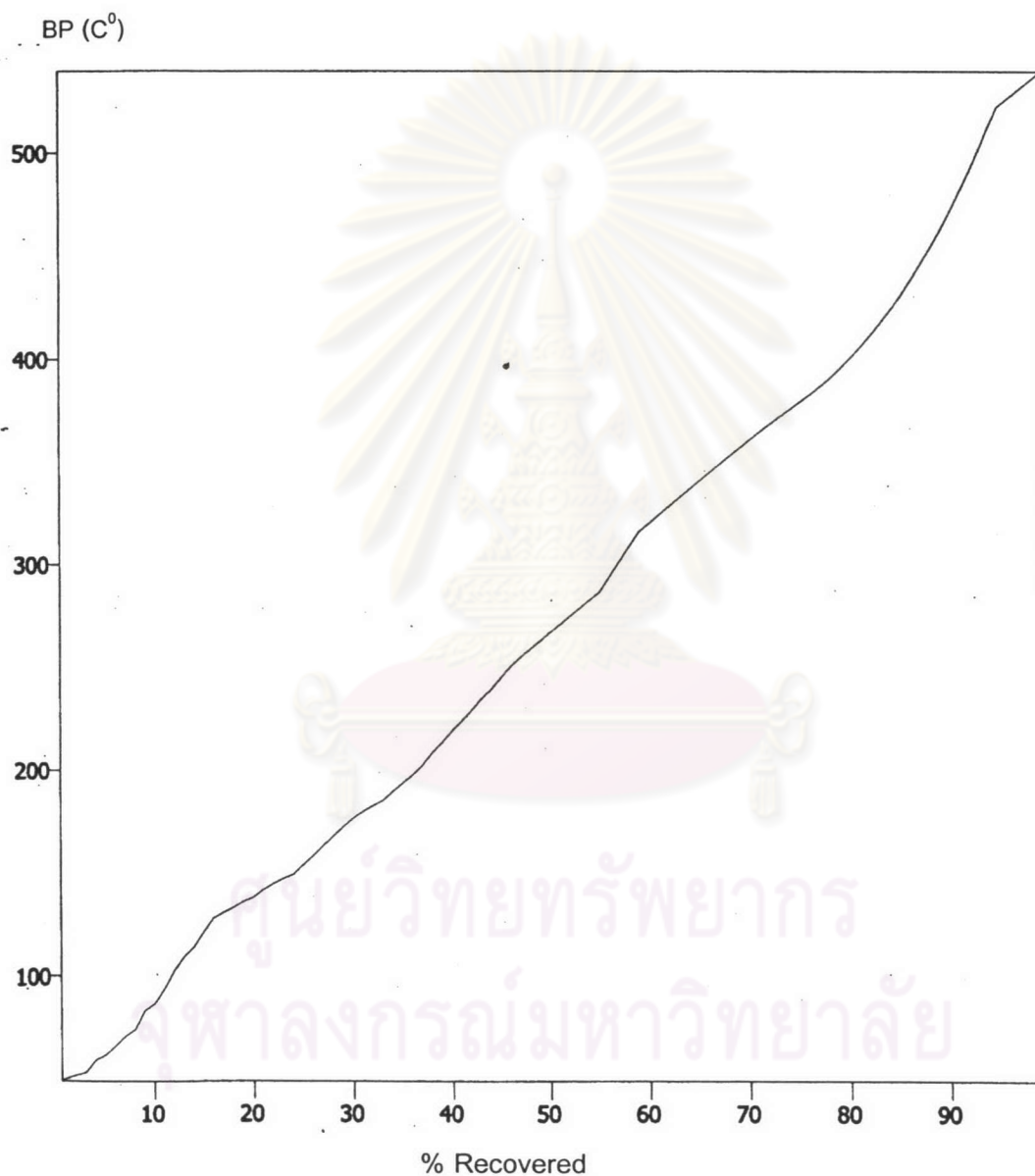


Figure B.30 Composition at condition 450°C of reaction temperature, 100 psi of initial hydrogen pressure, 60 minutes of reaction time and 0.6% of HZSM-5 catalyst.



Appendix C

UNITS AND CONVERSION FACTORS

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

UNITS AND CONVERSION FACTORS

Temperature

$$1\text{ }^{\circ}\text{C} = 1.8\text{ }^{\circ}\text{F}$$

$$^{\circ}\text{C to }^{\circ}\text{F: } 9/5 * (^{\circ}\text{C}) + 32 = ^{\circ}\text{F}$$

$$^{\circ}\text{F to }^{\circ}\text{C: } (^{\circ}\text{F} - 32) * 5/9 = ^{\circ}\text{C}$$

Volume

$$1\text{ cubic inch} = 16.39\text{ cm}^3 = 0.01639\text{ litres}$$

$$1\text{ Imperial gallon} = 4546\text{ cm}^3 = 1.201\text{ U.S. gallons}$$

$$1\text{ U.S. gallon} = 3785\text{ cm}^3 = 3.785\text{ litres}$$

$$1\text{ cubic foot} = 28.32\text{ litres} = 0.02832\text{ m}^3$$

$$1\text{ cubic metre} = 35.315\text{ ft}^3$$

Mass

$$1\text{ gram} = 15.432\text{ grains} = 0.0022\text{ lb}$$

$$1\text{ pound} = 453.6\text{ g} = 7000\text{ grains}$$

$$1\text{ ton} = 1016\text{ kg} = 1.12\text{ U.S. tons}$$

$$1\text{ U.S. ton} = 907\text{ kg} = 0.907\text{ tonnes} = 0.893\text{ tons}$$

$$1\text{ tonne} = 1000\text{ kg} = 2204.6\text{ lb}$$

Pressure

$$1\text{ atmosphere} = 760\text{ mm Hg at } 0^{\circ}\text{C}$$

$$= 29.93\text{ in. Hg}$$

$$= 33.9\text{ ft H}_2\text{O} = 1.033\text{ kg/cm}^2$$

$$= 14.695\text{ lb/in}^2\text{ (psi)}$$

$$= 2116\text{ lb/ft}^2$$

VITA

Flight Lieutenant Atsadayut Kaewsaiyoy was born on January 10, 1974 in Chachoengsao. He graduated with the Bachelor degree of Science of Chemistry at Burapha University in 1997. He had worked in the Quality Control Department, Six Armament Plant Division, Directorate of Armament, Air Support Command, RTAF. He continued his Master 's Study at Program of Petrochemical and Polymer Science, Faculty of Science, Chulalongkorn University in 2002 and completed the program in 2004.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย