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APPENDICES

APPENDIX A Temperature Profiles

Table A1 Pyrolysis conditions: Non-catalytic Pyrolysis

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	33.4	31.1	32	367.9	499.2	62	361.2	506.7	92	361.2	496.6
4	53.6	52.8	34	370.2	496.9	64	356.4	502.8	94	359.9	507.8
6	78.4	81.5	36	367.4	499.9	66	352.4	491.8	96	354.5	502.6
8	120.4	125.2	38	366.4	496.5	68	353.4	502.7	98	350.1	500.9
10	145.7	158.0	40	364.2	498.3	70	346.2	500.1	100	353.5	502.7
12	186.0	205.0	42	365.5	495.2	72	355.2	502.3	102	350.5	494.0
14	266.2	302.6	44	357.2	502.7	74	351.4	496.2	104	351.2	502.2
16	277.5	325.5	46	359.1	502.3	76	355.8	508.7	106	353.1	498.8
18	296.5	412.3	48	353.9	506.1	78	352.4	504.2	108	352.4	505.7
20	324.4	429.8	50	352.7	500.1	80	352.0	505.7	110	350.2	495.8
22	331.9	470.8	52	355.6	502.9	82	352.9	497.9	112	349.2	494.8
24	349.1	500.2	54	358.8	497.0	84	351.4	501.5	114	356.1	499.8
26	360.1	501.5	56	359.1	500.9	86	350.3	508.0	116	351.3	499.0
28	363.2	486.0	58	355.9	502.8	88	342.5	496.4	118	350.2	499.2
30	368.4	501.2	60	351.9	501.1	90	361.1	506.3	120	349.4	498.9

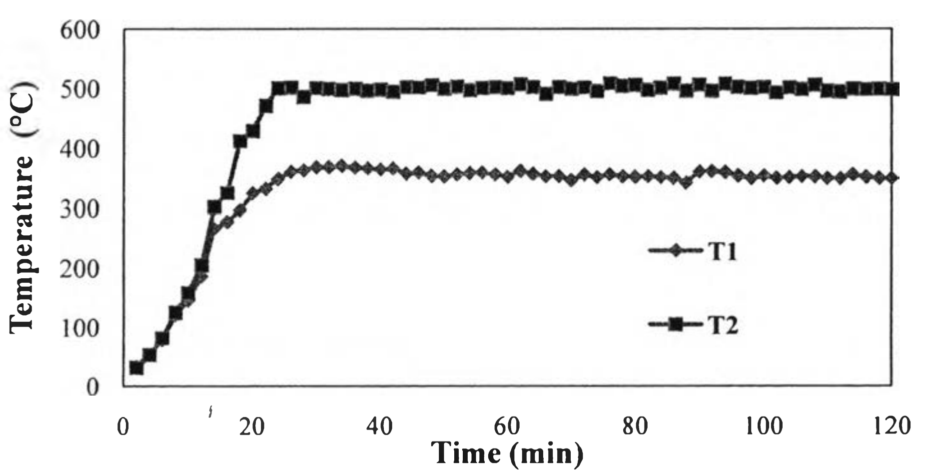

Figure A1 Temperature profiles of non-catalytic pyrolysis.

Table A2 Pyrolysis conditions: KL catalyst

Tire = 30 g, KL = 7.5g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.2	33.1	32	358.0	504.6	62	354.7	506.3	92	352.3	507.8
4	49.4	55.8	34	354.9	497.4	64	357.8	499.1	94	350.0	496.8
6	58.1	67.7	36	363.1	496.2	66	356.6	506.9	96	352.9	506.5
8	88.3	110.9	38	360.9	506.4	68	354.2	496.4	98	356.9	506.0
10	115.2	148.0	40	357.1	500.4	70	350.4	497.1	100	353.9	498.7
12	154.1	199.5	42	355.6	506.0	72	348.6	506.9	102	352.4	503.1
14	194.4	252.9	44	354.6	496.6	74	355.1	499.2	104	347.1	499.7
16	249.1	342.2	46	353.0	507.1	76	356.1	502.1	106	352.6	504.4
18	289.9	411.8	48	351.3	497.3	78	354.5	494.5	108	356.0	500.0
20	322.8	454.9	50	348.5	502.8	80	351.6	507.2	110	353.4	503.2
22	324.6	513.3	52	354.4	495.5	82	349.0	499.5	112	348.9	493.6
24	334.4	503.8	54	353.8	495.9	84	346.9	508.4	114	355.1	507.1
26	336.9	493.5	56	352.4	503.2	86	357.5	498.5	116	354.1	500.1
28	344.1	507.5	58	350.0	500.3	88	357.2	505.6	118	351.6	505.7
30	361.5	499.5	60	347.8	497.7	90	355.4	497.7	120	347.2	498.2

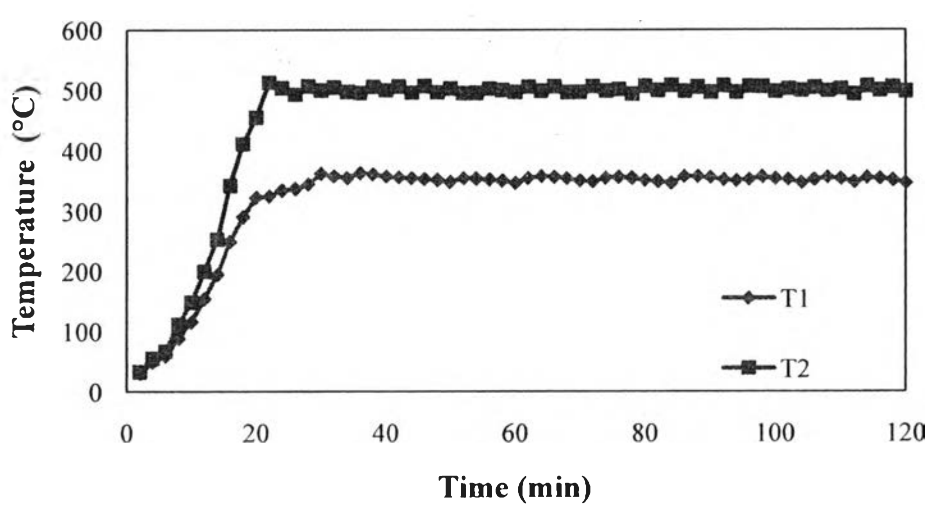

Figure A2 Temperature profiles of waste tire pyrolysis with using KL catalyst.

Table A3 Pyrolysis conditions: 1% Rh/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28.5	30.3	32	366.4	496.9	62	356.3	503.4	92	357.6	498.7
4	59.1	82.4	34	365.8	500.6	64	355.0	494.4	94	356.3	505.7
6	83.8	125.8	36	366.4	499.8	66	353.1	505.3	96	355.0	500.4
8	114.8	176.3	38	365.0	498.9	68	352.5	500.5	98	353.2	501.5
10	153.8	253.6	40	364.5	501.2	70	350.8	498.8	100	351.1	493.3
12	194.8	298.2	42	362.6	503.4	72	348.9	493.6	102	349.3	508.2
14	247.1	375.3	44	361.2	499.8	74	354.7	506.1	104	355.1	496.3
16	305.8	426.2	46	359.5	505.6	76	356.5	498.1	106	357.3	501.7
18	320.8	468.3	48	358.1	494.9	78	356.5	503.1	108	356.7	495.1
20	340.3	507.5	50	356.5	506.2	80	354.4	494.1	110	355.1	507.7
22	350.5	497.5	52	354.6	496.8	82	352.4	506.5	112	353.3	497.1
24	358.4	503.8	54	352.9	502.9	84	351.3	499.5	114	351.1	500.5
26	364.7	505.1	56	350.9	493.5	86	349.1	499.7	116	349.1	493.9
28	366.2	499.5	58	348.9	508.1	88	353.9	503.4	118	347.1	502.5
30	367.1	507.1	60	354.9	498.9	90	358.2	502.4	120	355.7	504.3

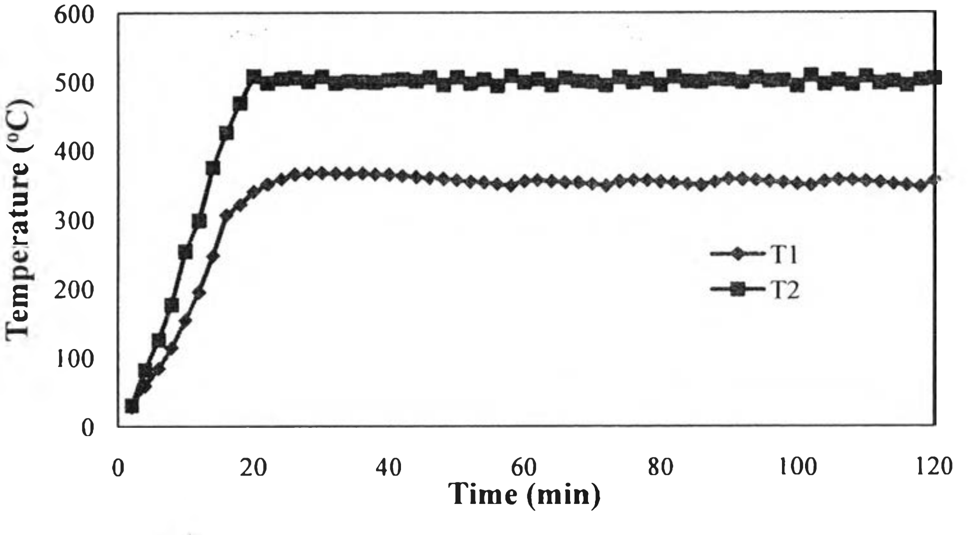

Figure A3 Temperature profiles of waste tire pyrolysis with using 1%Rh/KL catalyst.

Table A4 Pyrolysis conditions: 1% Ni/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.8	27.6	32	360.5	497.1	62	345.5	499.5	92	356.8	504.9
4	37.6	41.3	34	356.9	503.6	64	349.9	504.6	94	350.9	503.4
6	57.4	69.3	36	356.4	501.9	66	355.8	499.7	96	347.8	501.4
8	83.3	106.5	38	354.8	503.2	68	365.6	502.1	98	357.6	494.7
10	114.5	149.8	40	352.3	492.8	70	362.5	506.5	100	355.2	505.6
12	155.7	205.7	42	350.8	505.9	72	370.6	497.5	102	351.4	497.4
14	204.9	272.7	44	351.1	499.9	74	368.1	504.5	104	351.7	501.2
16	251.7	332.1	46	353.5	503.6	76	366.6	497.3	106	352.1	499.6
18	290.7	408.1	48	347.5	493.3	78	365.7	504.4	108	353.6	493.1
20	307.1	442.8	50	345.7	502.9	80	364.5	504.6	110	346.4	501.3
22	312.5	493.5	52	350.3	502.7	82	356.5	498.3	112	350.7	502.1
24	332.4	504.2	54	356.4	504.9	84	363.7	505.1	114	357.7	501.8
26	340.5	502.1	56	356.1	500.1	86	365.6	497.4	116	353.7	493.5
28	355.1	499.7	58	355.8	494.4	88	368.4	500.3	118	349.2	505.8
30	365.7	497.8	60	344.4	503.4	90	362.6	494.4	120	357.2	497.3

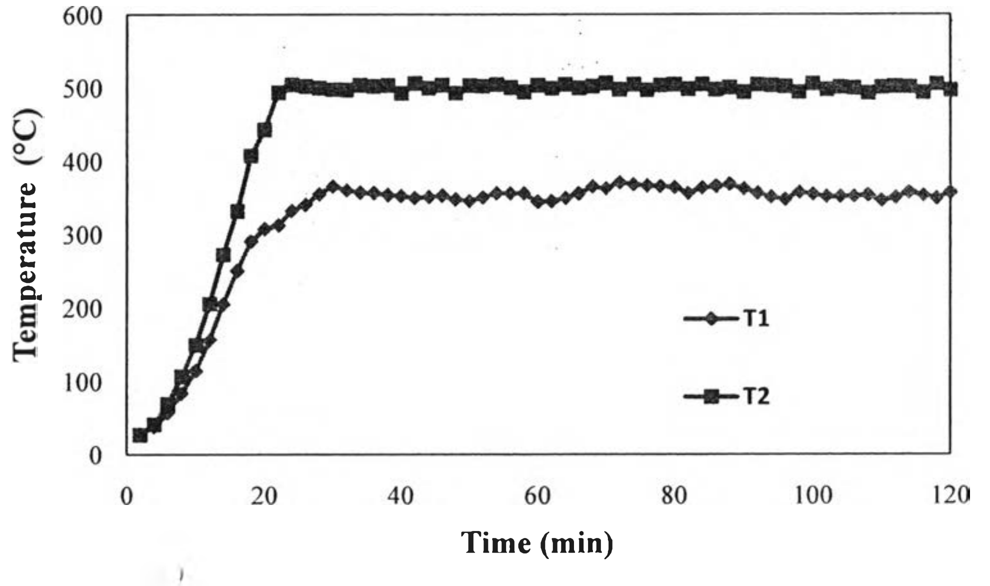

Figure A4 Temperature profiles of waste tire pyrolysis with using 1% Ni/KL catalyst.

Table A5 Pyrolysis conditions: 5% Ni/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.6	28.0	32	345.4	506.6	62	354	499.6	92	347.9	498
4	36.1	43.8	34	350.1	496.1	64	355.8	500.9	94	348.5	499.8
6	51.5	68.0	36	354.3	498.5	66	355.4	500.3	96	348.8	501.8
8	110.8	160.3	38	355.1	499.2	68	354.2	501.2	98	349.0	500.2
10	149.1	198.2	40	355.9	499.1	70	356.0	501.0	100	349.6	499.7
12	157.8	227.8	42	358.7	500.1	72	355.6	500.3	102	350.2	500.6
14	215.7	302.1	44	359.3	500.1	74	356.6	500.9	104	349.0	497.5
16	253.2	348.6	46	359.0	500.2	76	356.9	499.7	106	349.8	501.8
18	291.3	395.7	48	358.4	500.4	78	354.2	499.1	108	350.4	497.5
20	320.1	428.3	50	356.7	500.4	80	355.4	500.1	110	349.3	501.8
22	300.1	504.7	52	354.1	500.1	82	353.9	499.4	112	350.2	499.4
24	322.1	500.2	54	353.7	500.2	84	356.7	499.7	114	349.6	500.1
26	337.3	504.7	56	352.3	499.3	86	358.2	498.3	116	349.4	498.9
28	340.1	500.2	58	351.2	500.2	88	357.4	498.7	118	348.4	499.5
30	344.1	496.9	60	350.9	500.3	90	357.3	499.1	120	349.4	501.4

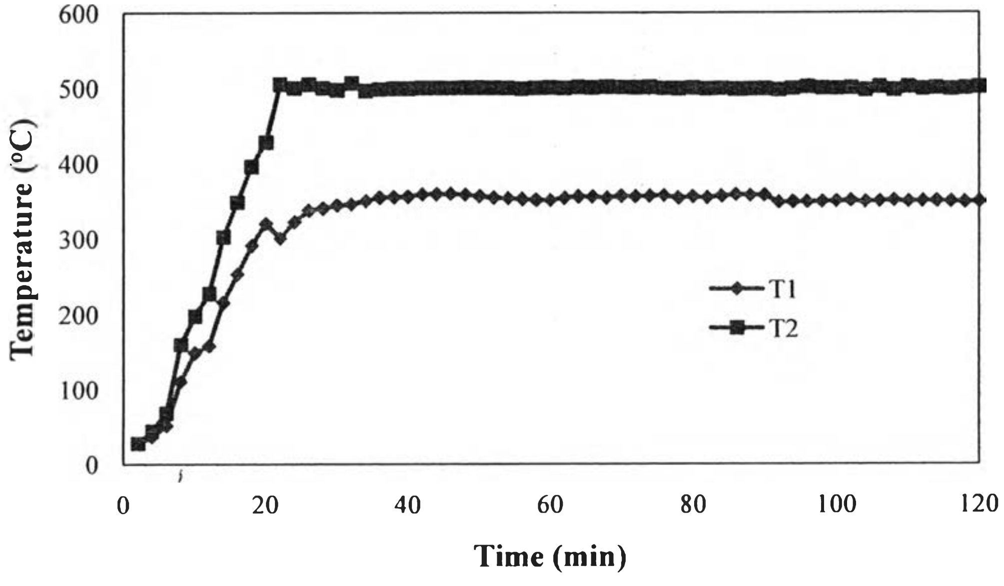

Figure A5 Temperature profiles of waste tire pyrolysis with using 5% Ni/KL catalyst

Table A6 Pyrolysis conditions: 10% Ni/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28.1	28.2	32	381.6	505.9	62	356.5	494.1	92	350.1	498.7
4	40.8	47.5	34	383.9	501.2	64	355.1	506.4	94	344.5	505.8
6	57.9	70.6	36	382.6	502.6	66	346.2	497.5	96	353.9	494.7
8	84.6	106.9	38	379.8	493.9	68	356.6	503.6	98	358.6	505.2
10	102.5	157.8	40	373.4	505.4	70	355.9	494.9	100	347.8	503.5
12	163.7	212.8	42	366.0	499.1	72	351.5	503.6	102	347.6	506.5
14	202.2	265.6	44	357.4	503.1	74	352.7	499.4	104	358.4	497.1
16	250.7	332.6	46	354.9	495.1	76	353.2	505.6	106	352.2	501.2
18	281.9	400.3	48	347.4	504.0	78	347.7	495.1	108	346.9	498.9
20	321.0	440.9	50	356.2	498.1	80	348.4	501.6	110	355.7	500.4
22	357.8	499.8	52	354.5	505.6	82	358.5	506.1	112	358.1	495.8
24	370.7	515.8	54	346.9	497.1	84	354.7	501.3	114	353.6	507.4
26	376.5	509.1	56	352.5	506.8	86	350.1	501.6	116	352.1	496.9
28	380.2	501.5	58	355.9	497.3	88	354.4	494.5	118	356.1	506.5
30	381.9	503.6	60	346.8	502.2	90	354.1	502.1	120	351.3	500.9

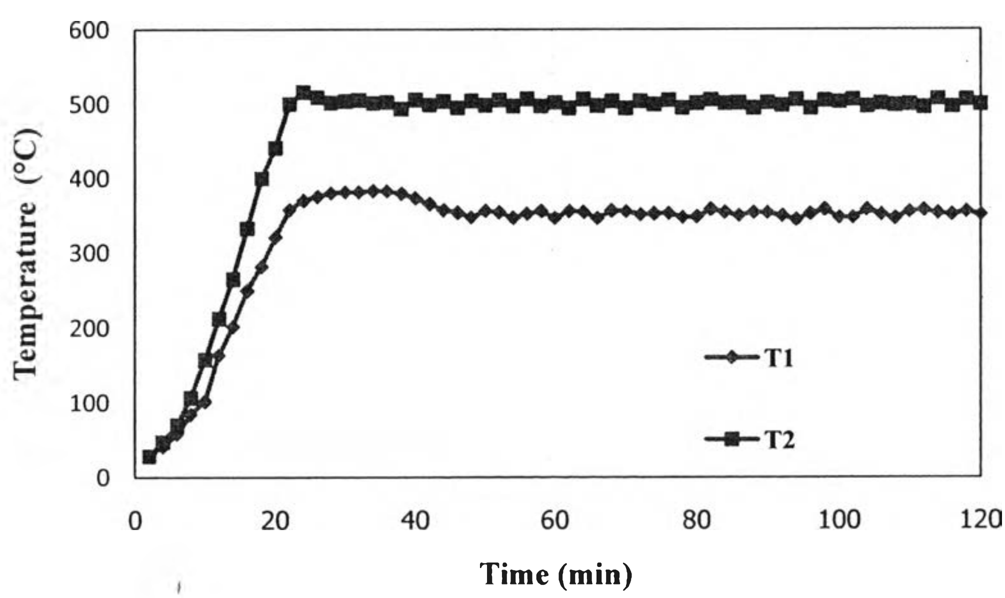

Figure A6 Temperature profiles of waste tire pyrolysis with using 10% Ni/KL catalyst.

Table A7 Pyrolysis conditions: 15% Ni/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	36.9	43.2	32	365.6	500.5	62	352.1	504.6	92	350.2	502.9
4	54.2	68.7	34	365.7	499.0	64	356.5	503.1	94	346.7	496.8
6	81.4	107.7	36	363.7	502.3	66	355.1	496.9	96	357.0	508.7
8	110.9	148.9	38	361.8	503.6	68	350.7	504.8	98	357.3	503.0
10	150.8	202.2	40	356.9	498.9	70	348.9	497.7	100	353.7	506.4
12	210.2	284.1	42	353.6	503.3	72	355.8	503.5	102	351.1	504.4
14	246.1	334.5	44	349.5	498.1	74	352.9	496.2	104	348.7	499.5
16	279.2	398.4	46	352.4	504.1	76	348.3	507.3	106	356.1	495.3
18	299.6	439.4	48	354.4	497.9	78	349.1	503.2	108	352.2	505.1
20	293.9	484.1	50	351.8	504.7	80	358.1	501.8	110	349.2	499.7
22	308.9	504.2	52	350.4	500.6	82	355.3	505.2	112	345.5	506.1
24	325.5	500.8	54	348.3	498.6	84	351.4	494.5	114	354.0	499.2
26	358.4	503.2	56	353.9	494.7	86	349.2	507.3	116	357.2	496.3
28	362.3	497.1	58	350.9	506.1	88	355.2	499.1	118	354.7	498.3
30	364.9	506.8	60	346.7	500.1	90	351.9	506.6	120	350.2	499.7

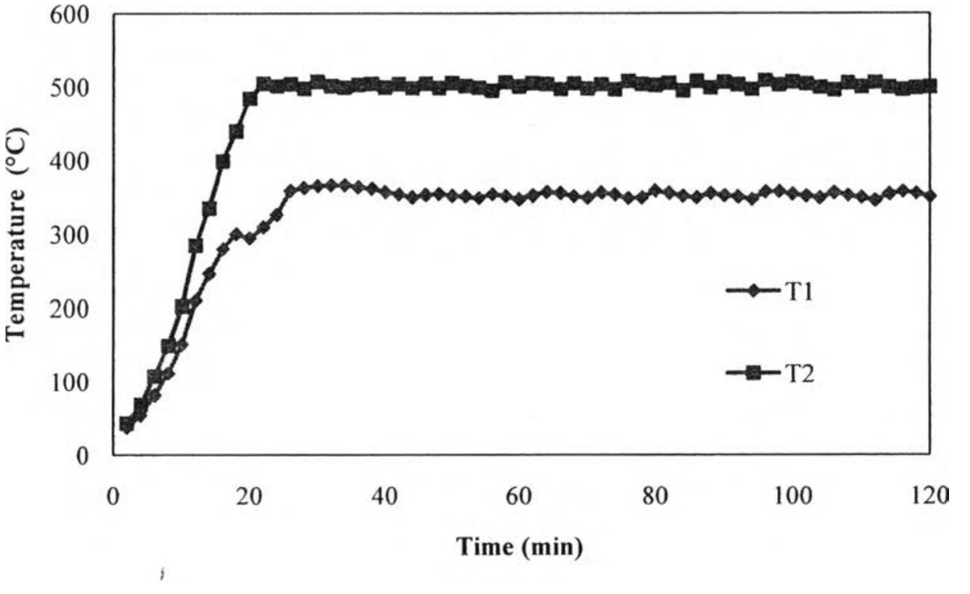

Figure A7 Temperature profiles of waste tire pyrolysis with using 15% Ni/KL catalyst.

Table A8 Pyrolysis conditions: 20% Ni/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	40	41.3	32	367.2	504.9	62	350.1	495.4	92	347.8	494
4	59.1	72.1	34	372.4	500.3	64	356.7	507.1	94	356.0	506.5
6	87.4	111.3	36	373.1	500.5	66	354.6	498.3	96	357.4	499.3
8	123.6	131.3	38	373.8	498.1	68	352.1	503.2	98	354.6	505.2
10	166.7	217.4	40	375.3	503.5	70	349.7	494.7	100	357.9	495.6
12	219.5	271.3	42	372.3	499.2	72	355.1	501.2	102	351.6	499.5
14	266.2	346.1	44	370.5	502.1	74	355.4	494.1	104	349.3	506.3
16	292.3	408.1	46	368.5	504.7	76	353.6	504.3	106	356.0	502.4
18	290.0	462.4	48	366.2	499.3	78	351.5	496.1	108	354.1	494.3
20	282.7	506.5	50	363.7	499.5	80	349.6	504.8	110	351.4	508.8
22	295.5	495.1	52	361.5	503.1	82	355.0	501.9	112	348.5	494.3
24	326.7	500.3	54	359.4	504.5	84	356.8	500.9	114	355.8	508.0
26	358.6	508.1	56	357.1	496.1	86	355.0	505.7	116	357.5	499.1
28	368.7	499.4	58	354.8	504.2	88	352.1	498.1	118	355.9	502.4
30	361.7	503.8	60	352.4	502.1	90	350.5	503.7	120	353.5	499.3

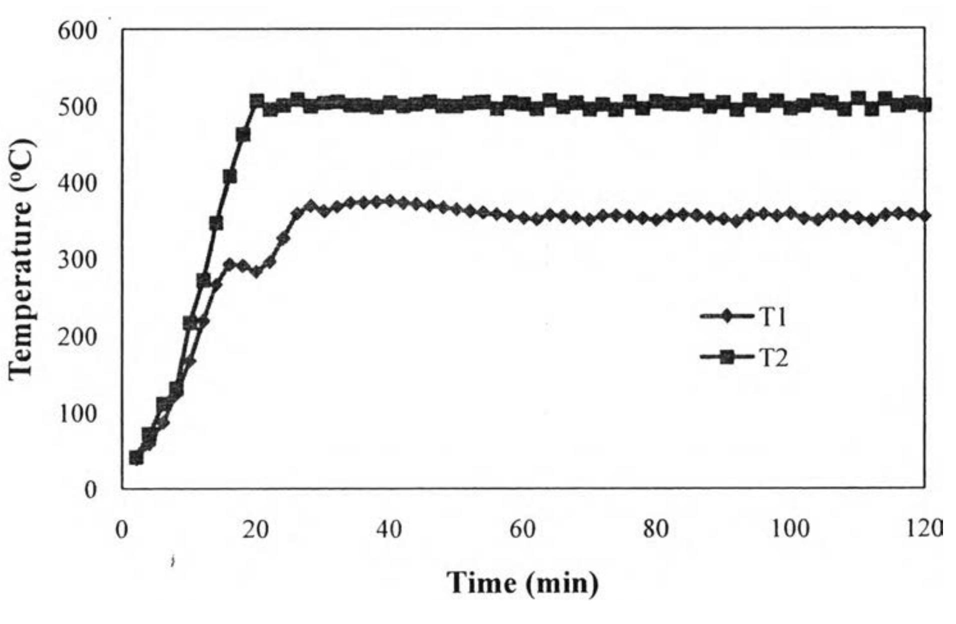

Figure A8 Temperature profiles of waste tire pyrolysis with using 20% Ni/KL catalyst.

Table A9 Pyrolysis conditions: 1% Co/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28.1	27.2	32	370.5	506.1	62	350.7	499.6	92	355.2	496.5
4	43.2	49.3	34	363.7	503.1	64	346.3	504.8	94	352.1	504.3
6	54.9	64.8	36	361.0	504.7	66	350.4	496.6	96	349.3	492.9
8	88.4	110.6	38	359.7	495.5	68	357.8	504.7	98	353.5	506.1
10	123.5	155.0	40	358.9	500.1	70	356.3	492.9	100	354.0	498.9
12	163.4	204.9	42	355.1	495.7	72	353.1	505.9	102	352.1	503.6
14	197.3	249.2	44	352.0	507.1	74	348.8	496.9	104	348.2	498.9
16	244.6	307.0	46	348.6	494.5	76	355.8	503.4	106	356.4	505.4
18	283.1	382.7	48	356.2	496.2	78	355.7	493.4	108	355.7	500.7
20	308.4	427.9	50	353.6	499.1	80	352.0	506.1	110	354.5	507.5
22	303.5	473.1	52	351.2	503.8	82	349.6	503.0	112	350.9	496.3
24	304.6	502.8	54	349.5	495.8	84	345.6	498.5	114	354.9	506.3
26	345.4	497.1	56	355.7	500.6	86	344.9	503.7	116	356.2	501.9
28	360.3	504.5	58	354.8	496.8	88	358.6	503.1	118	354.6	503.0
30	365.1	495.0	60	352.4	500.4	90	356.8	505.0	120	348.8	493.2

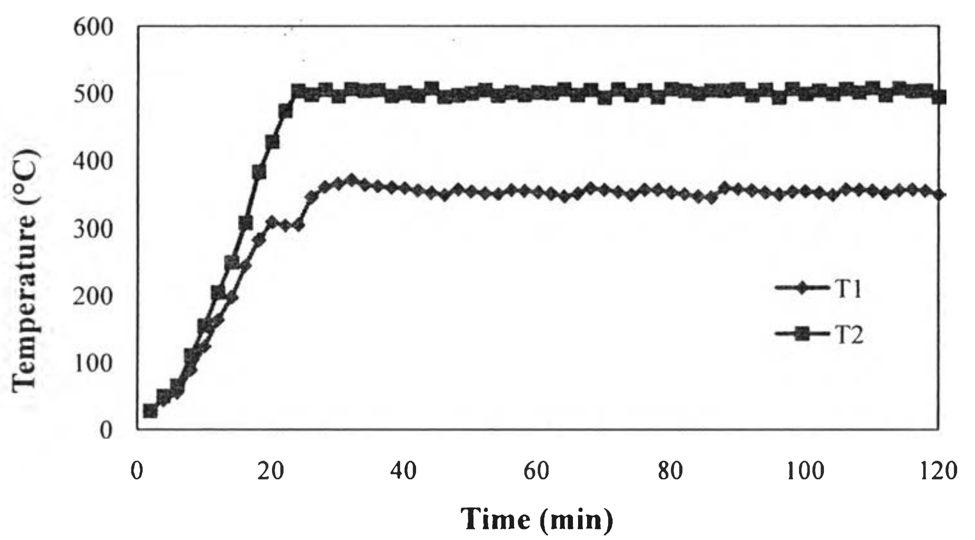

Figure A9 Temperature profiles of waste tire pyrolysis with using 1% Co/KL catalyst.

Table A10 Pyrolysis conditions: 5% Co/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.4	29.4	32	364.8	497.9	62	354.9	506.9	92	351.3	499.8
4	43.5	47.8	34	361.9	502.0	64	356.0	496.6	94	348.8	504.1
6	54.6	65.6	36	360.9	502.5	66	352.7	504.4	96	356.4	491.9
8	91.3	113.4	38	358.4	497.5	68	349.5	505.1	98	353.1	503.5
10	117.3	148.9	40	354.4	494.5	70	356.1	501.8	100	349.5	498.6
12	151.9	193.5	42	352.7	497.0	72	356.3	494.9	102	349.5	504.1
14	194.5	253.0	44	350.1	504.2	74	352.4	503.1	104	357.6	498.1
16	236.0	304.2	46	350.4	500.4	76	349.8	498.9	106	354.8	505.2
18	279.9	387.7	48	356.9	502.4	78	352.5	501.7	108	349.7	497.2
20	303.1	439.6	50	352.3	504.4	80	356.2	493.7	110	349.4	505.1
22	297.0	472.7	52	348.6	498.3	82	353.0	505.8	112	355.8	502.1
24	324.4	511.0	54	352.3	504.1	84	349.1	498.9	114	353.2	505.9
26	335.2	513.8	56	355.9	496.1	86	352.2	500.7	116	349.1	497.5
28	357.7	506.8	58	352.7	500.4	88	358.5	501.8	118	348.9	504.5
30	363.4	504.7	60	348.1	501.6	90	355.4	500.9	120	356.0	500.8

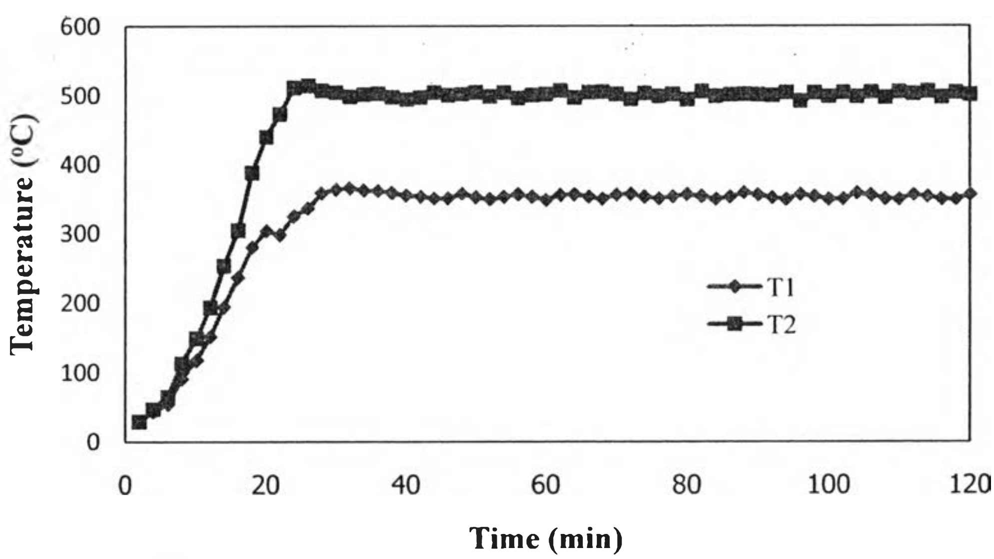

Figure A10 Temperature profiles of waste tire pyrolysis with using 5% Co/KL catalyst.

Table A11 Pyrolysis conditions: 10% Co/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	31.8	35.3	32	370.4	505.2	62	356.7	506.5	92	357.2	506.2
4	45.8	53.8	34	373.4	503.6	64	355.1	501.1	94	355.2	498.0
6	60.4	73.5	36	372.6	497.2	66	351.9	499.1	96	351.3	503.6
8	94.9	124.3	38	372.4	503.7	68	349.0	505.7	98	349.8	498.1
10	164.2	208.1	40	370.8	500.6	70	354.5	501.3	100	353.7	505.9
12	174.8	253.8	42	368.7	501.9	72	357.1	507.8	102	357.3	498.1
14	236.0	304.2	44	366.5	501.2	74	355.2	501.3	104	354.9	506.8
16	279.9	387.8	46	363.9	496.9	76	352.1	504.1	106	350.9	497.8
18	303.1	439.6	48	362.2	505.5	78	349.0	496.7	108	348.1	504.8
20	304.3	484.9	50	358.7	497.0	80	352.3	506.1	110	355.5	497.4
22	307.1	506.6	52	356.4	504.4	82	356.2	496.8	112	355.6	506.2
24	327.8	504.7	54	354.4	497.2	84	355.7	505.3	114	353.3	499.2
26	347.3	501.8	56	351.3	504.0	86	352.4	499.5	116	351.6	498.4
28	359.6	511.0	58	350.2	493.0	88	349.1	504.7	118	348.8	504.9
30	367.7	501.5	60	356.2	499.7	90	354.3	498.4	120	356.1	506.8

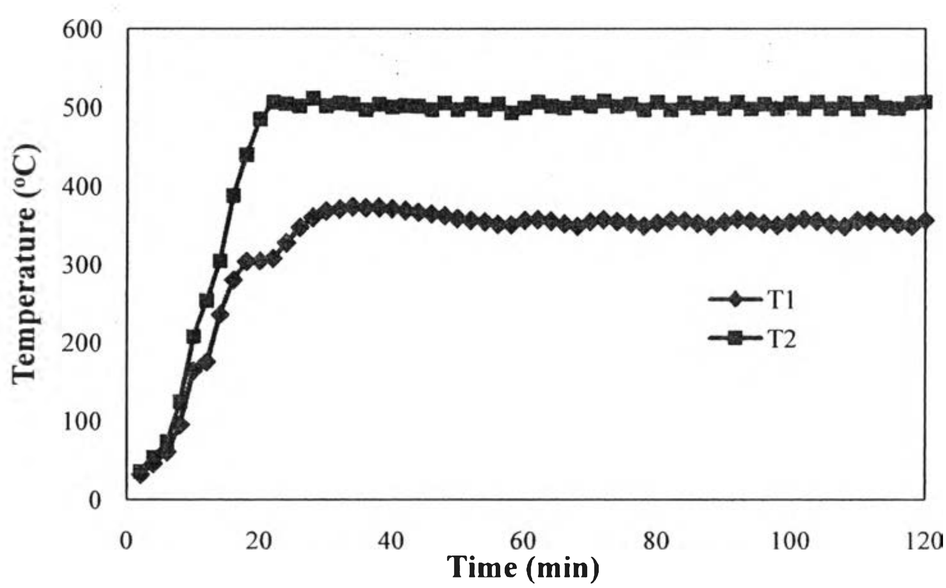

Figure A11 Temperature profiles of waste tire pyrolysis with using 10% Co/KL catalyst.

Table A12 Pyrolysis conditions: 15% Co/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	49.1	37.8	32	371.4	504.8	62	362.2	498.7	92	357.1	500.2
4	62.4	57.8	34	371.7	504.5	64	360.3	504.9	94	355.1	494.2
6	80.9	84.9	36	371.6	498.1	66	358.0	497.6	96	353.1	506.7
8	110.7	125.9	38	367.5	501.9	68	360.9	506.1	98	349.5	504.1
10	186.7	215.4	40	365.3	497.7	70	360.2	497.1	100	355.1	498.9
12	222.1	280.7	42	361.4	487.5	72	357.2	500.4	102	357.5	505.6
14	251.2	301.2	44	352.6	486.6	74	354.1	499.3	104	353.9	494.0
16	271.7	340.1	46	356.2	500.5	76	351.0	506.9	106	351.0	507.9
18	303.2	416.1	48	356.7	509.2	78	348.7	500.5	108	349.7	506.0
20	322.9	451.4	50	359.4	501.4	80	357.7	505.0	110	350.9	498.2
22	324.4	503.7	52	362.6	504.0	82	357.2	501.0	112	358.9	507.4
24	335.1	504.1	54	362.5	506.4	84	354.2	498.4	114	357.2	500.4
26	342.1	505.6	56	365.3	500.1	86	351.3	507.9	116	352.8	498.3
28	358.2	506.1	58	364.9	499.9	88	348.5	499.8	118	350.3	507.9
30	361.9	502.8	60	362.7	501.5	90	358.2	507.3	120	348.6	502.5

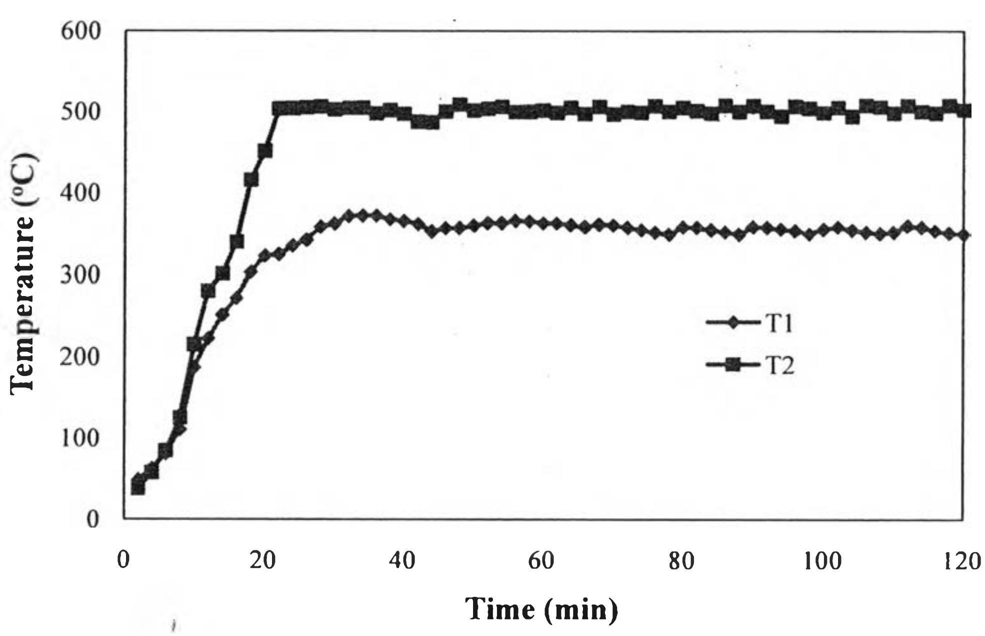

Figure A12 Temperature profiles of waste tire pyrolysis with using 15% Co/KL catalyst.

Table A13 Pyrolysis conditions: 20% Co/KL catalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.9	34.4	32	364.9	495.9	62	350.2	503.2	92	347.4	504.6
4	41.5	51.4	34	367.9	498.5	64	350.0	499.1	94	348.7	500.6
6	64.7	86.2	36	369.3	500.1	66	356.5	499.3	96	349.5	499.3
8	91.4	125.7	38	369.4	499.4	68	356.6	499.9	98	349.5	502.3
10	126.8	176.5	40	368.5	500.8	70	355.1	500.6	100	349.8	499.8
12	171.7	235.1	42	367.9	500.8	72	353.1	500.4	102	349.9	502.1
14	220.9	331.9	44	366.4	499.8	74	350.5	497.6	104	349.9	494.9
16	277.6	381.3	46	364.5	500.1	76	349.3	500.3	106	349.9	503.1
18	318.2	423.4	48	363.6	499.6	78	355.8	500.1	108	349.3	500.3
20	309.5	464.7	50	361.7	497.7	80	356.2	498.1	110	350.2	498.4
22	336.9	508.0	52	359.7	498.7	82	354.7	499.7	112	350.3	500.2
24	341.2	497.6	54	358.1	500.2	84	352.9	499.1	114	350.2	500.1
26	346.8	503.9	56	356.1	500.3	86	351.0	500.2	116	349.0	494.3
28	355.1	507.1	58	354.4	501.7	88	349.4	499.2	118	350.0	497.8
30	360.0	500.3	60	352.7	496.9	90	347.6	499.8	120	350.4	498.0

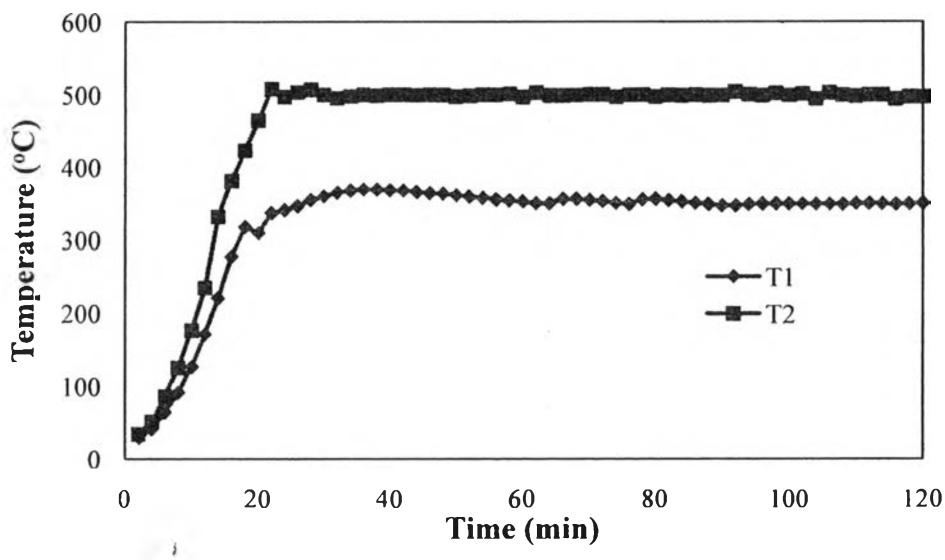

Figure A13 Temperature profiles of waste tire pyrolysis with using 20% Co/KL catalyst.

Table A14 Pyrolysis conditions: 0.05Rh0.95Nicatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.4	30.3	32	380.1	499.2	62	351.2	504.6	92	347.8	499.6
4	40.7	49.4	34	380.9	503.6	64	349.2	495.3	94	349.2	500.6
6	60.6	81.6	36	379.7	500.2	66	353.9	504.9	96	349.3	499.9
8	89.6	123.7	38	377.7	505.2	68	355.1	505.2	98	349.5	499.3
10	125.4	175.3	40	375.7	495.4	70	356.2	496.5	100	349.8	501.2
12	164.7	230.8	42	373.5	504.7	72	354.4	501.6	102	349.9	500.3
14	205.5	292.6	44	371.6	499.5	74	352.1	495.7	104	350.1	499.5
16	251.7	368.9	46	369.3	503.2	76	350.5	504.5	106	349.5	501.9
18	297.5	412.5	48	366.2	495.6	78	352.5	499.5	108	350.1	499.3
20	298.4	458.2	50	363.9	506.2	80	356.3	503.5	110	349.8	500.6
22	330.5	495.2	52	361.2	497.9	82	355.5	494.3	112	350.2	499.3
24	347.2	506.1	54	358.5	504.2	84	353.4	495.1	114	349.8	500.6
26	356.3	499.4	56	357.5	496.7	86	350.7	499.5	116	350.1	499.3
28	365.1	504.9	58	356.2	496.5	88	348.7	497.7	118	350.2	499.1
30	370.6	501.2	60	357.3	503.1	90	347.4	500.4	120	350.0	499.5

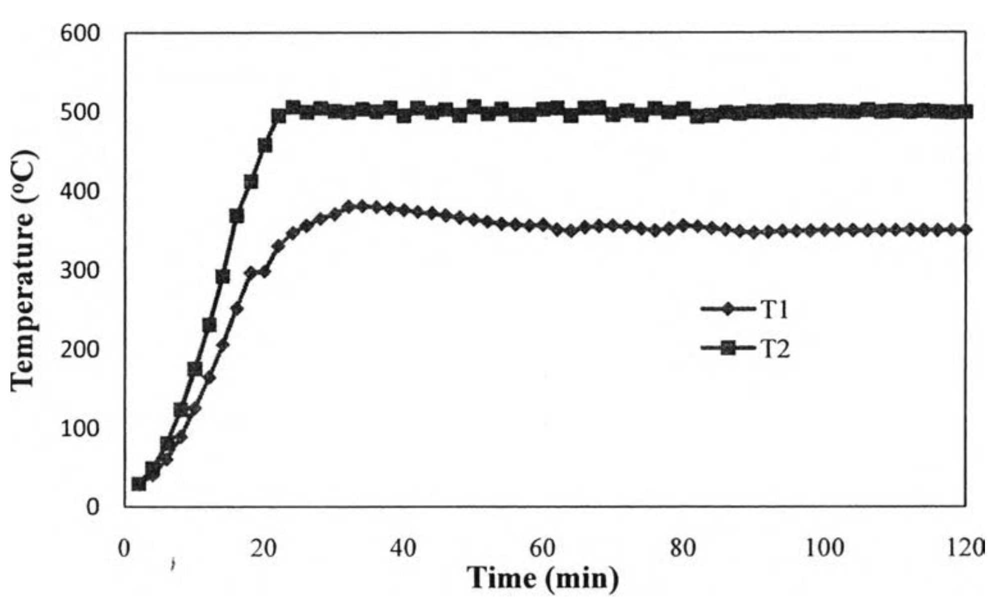

Figure A14 Temperature profiles of waste tire pyrolysis with using 0.05Rh0.95Ni catalyst.

Table A15 Pyrolysis conditions: 0.25Rh0.75Nicatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	26.8	29.7	32	350.5	499.7	62	355.4	498.4	92	352.1	493.5
4	30.6	51.8	34	353.3	501.3	64	352.9	503.1	94	350.1	505.5
6	59.5	87.7	36	359.1	505.6	66	350.9	503.2	96	350.7	501.7
8	113.5	177.3	38	362.2	497.4	68	349.5	500.3	98	356.8	500.3
10	151.3	227.8	40	362.6	497.6	70	355.1	498.2	100	355.4	505.7
12	193.8	289.4	42	361.3	504.8	72	357.6	501.2	102	353.5	496.4
14	241.6	352.4	44	359.6	497.6	74	353.5	507.4	104	351.7	502.5
16	292.6	412.4	46	356.9	500.2	76	353.6	497.5	106	349.4	493.5
18	306.6	444.7	48	355.2	495.1	78	351.7	507.1	108	347.6	507.2
20	305.4	494.8	50	354.5	505.8	80	349.6	498.7	110	347.3	499.9
22	329.2	503.3	52	351.9	506.9	82	351.1	503.6	112	348.1	498.2
24	332.4	504.5	54	349.6	497.4	84	356.3	492.8	114	349.1	507.5
26	337.3	498.9	56	352.2	503.9	86	355.3	506.5	116	350.3	497.7
28	343.9	490.6	58	358.2	498.5	88	353.5	496.6	118	350.2	502.6
30	345.4	506.5	60	357.7	501.9	90	353.8	503.1	120	349.7	493.9

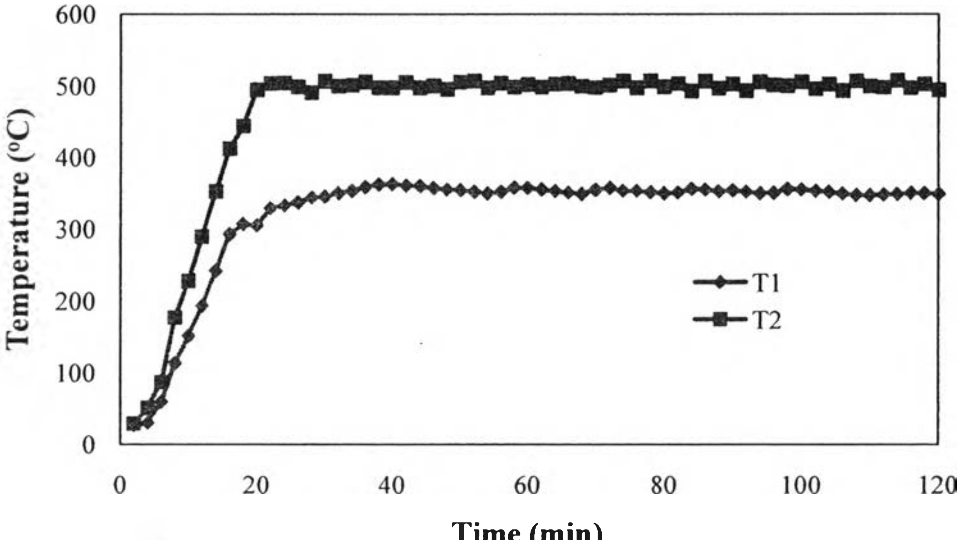

Figure A15 Temperature profiles of waste tire pyrolysis with using 0.25Rh0.75Ni catalyst.

Table A16 Pyrolysis conditions: 0.50Rh0.50Nicatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	36.8	43.6	32	334.5	504.7	62	353.1	499.9	92	347.8	499.2
4	38.3	46.9	34	346.4	499.4	64	355.2	499.6	94	347.6	499.6
6	66.5	92.2	36	349.9	501.2	66	355.4	498.7	96	350.1	500.2
8	83.7	116.9	38	352.2	506.9	68	354.7	499.6	98	352.3	499.7
10	116.1	167.8	40	357.9	498.3	70	354.1	499.7	100	351.7	499.8
12	163.7	233.6	42	359.1	505.3	72	352.9	501.2	102	353.1	500.2
14	190.7	297.1	44	360.1	496.8	74	350.3	499.6	104	350.2	499.8
16	278.7	391.6	46	358.7	505.4	76	349.4	500.1	106	349.7	499.9
18	291.4	409.3	48	357.6	497.4	78	354.7	499.9	108	349.9	500.1
20	307.3	441.5	50	356.6	498.1	80	355.9	500.2	110	349.8	499.2
22	300.3	497.1	52	354.6	504.5	82	355.3	501.1	112	349.7	500.6
24	317.8	503.3	54	355.4	497.7	84	352.1	500.1	114	349.7	497.1
26	323.5	505.9	56	352.7	504.9	86	351.7	500.9	116	349.6	498.7
28	328.3	494.3	58	351.6	496.7	88	350.9	500.5	118	349.7	499.8
30	334.5	498.9	60	350.7	497.1	90	349.1	499.9	120	349.9	498.9

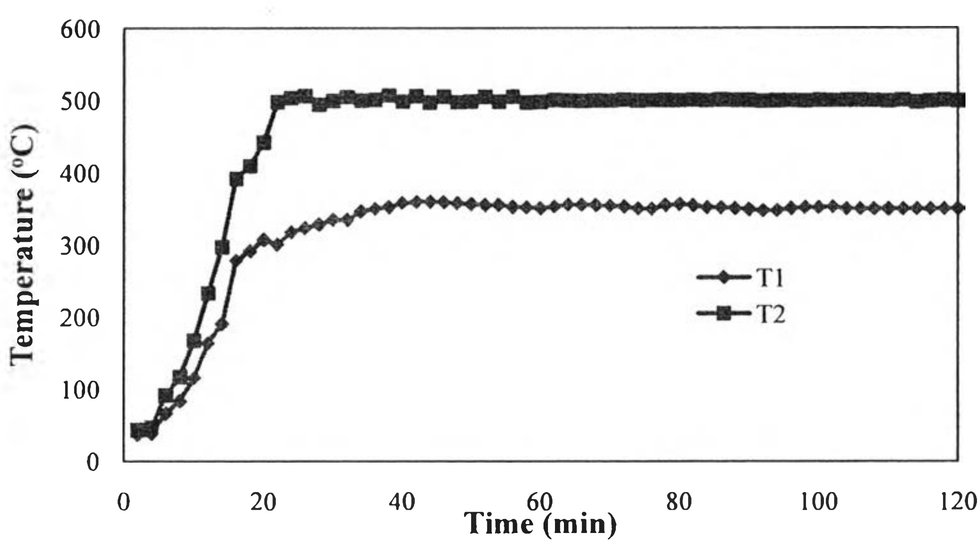

Figure A16 Temperature profiles of waste tire pyrolysis with using 0.50Rh0.50Ni catalyst.

Table A17 Pyrolysis conditions: 0.75Rh0.25Nicatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	25.4	30.3	32	350.1	502.1	62	354.6	499.1	92	349.7	499.1
4	46.1	56.2	34	341.6	501.1	64	352.1	500.1	94	349.5	498.7
6	55.9	70.4	36	346.4	504.6	66	351.1	500.1	96	347.1	499.6
8	92.5	120.5	38	356.6	497.3	68	349.7	499.9	98	346.9	499.9
10	123.2	168.9	40	360.1	497.3	70	356.9	500.7	100	348.9	499.8
12	154.1	198.7	42	369.2	500.3	72	357.1	500.3	102	347.9	499.9
14	186.5	241.4	44	373.5	500.1	74	355.3	499.8	104	349.1	501.8
16	239.4	307.4	46	373.9	499.2	76	352.7	499.6	106	346.2	498.7
18	282.5	370.4	48	372.4	499.7	78	350.2	499.6	108	350.1	501.4
20	301.1	390.4	50	370.5	499.9	80	353.4	498.4	110	349.8	501.5
22	312.2	467.3	52	367.6	500.1	82	354.6	499.1	112	349.8	502.2
24	330.1	504.9	54	363.2	500.7	84	355.4	500.4	114	353.4	499.8
26	335.1	498.2	56	362.1	500.3	86	354.4	500.1	116	351.9	499.4
28	337.1	501.1	58	359.3	500.2	88	357.8	499.9	118	351.4	499.3
30	353.2	489.9	60	357.3	499.9	90	357.3	498.6	120	350.2	500.3

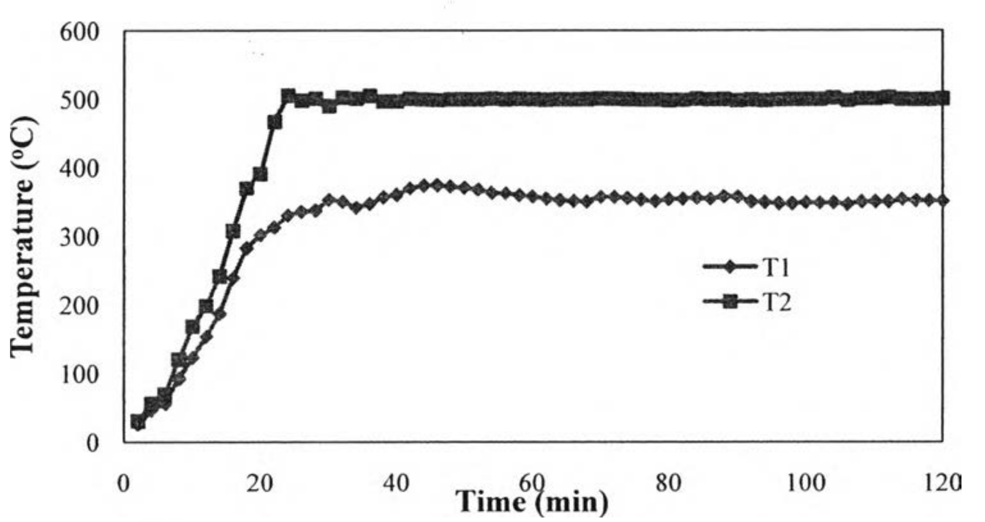

Figure A17 Temperature profiles of waste tire pyrolysis with using 0.75Rh0.25Ni catalyst.

Table A18 Pyrolysis conditions: 0.05Rh0.95Cocatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.3	29.7	32	365.4	504.1	62	358.6	503.4	92	350.4	499.8
4	40.5	48.3	34	366.4	505.4	64	358.1	503.2	94	349.5	500.6
6	70.9	94.1	36	367.8	503.0	66	354.3	502.3	96	350.2	499.7
8	84.1	113.2	38	368.5	503.6	68	355.4	501.0	98	350.1	499.8
10	115.6	257.9	40	368.9	501.5	70	353.2	501.6	100	348.3	499.6
12	154.2	270.1	42	365.7	499.6	72	353.9	501.7	102	349.4	499.9
14	199.9	290.6	44	368.9	499.2	74	355.6	501.4	104	349.5	499.3
16	250.2	339.2	46	367.6	499.5	76	356.6	500.1	106	348.2	500.1
18	292.6	395.8	48	366.9	500.4	78	355.4	500.7	108	347.9	500.1
20	312.4	424.2	50	364.7	500.3	80	355.7	502.3	110	348.3	499.9
22	298.4	483.1	52	363.8	499.9	82	354.8	501.5	112	348.2	499.5
24	325.4	507.4	54	361.0	500.5	84	354.8	500.4	114	348.9	499.4
26	349.8	502.9	56	360.5	500.2	86	355.9	500.2	116	349.2	499.6
28	351.2	500.1	58	358.9	499.6	88	353.9	499.9	118	349.8	499.7
30	354.9	505.3	60	359.3	502.3	90	352.9	500.3	120	349.1	499.5

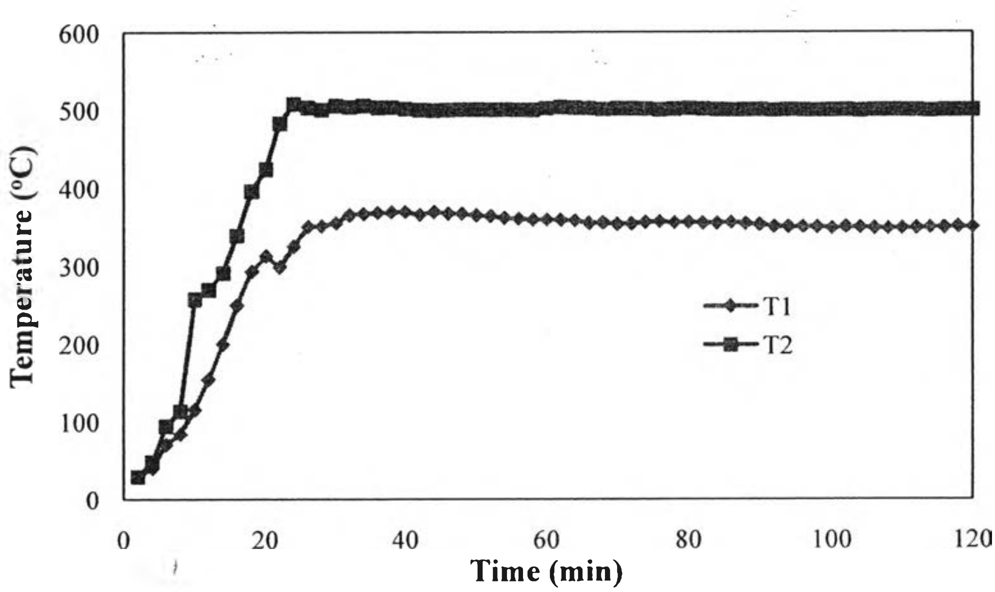

Figure A18 Temperature profiles of waste tire pyrolysis with using 0.05Rh0.95Co catalyst.

Table A19 Pyrolysis conditions: 0.25Rh0.75Cocatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.6	34.8	32	356.5	507.0	62	355.4	500.3	92	350.9	500.3
4	43.6	57.1	34	360.1	501.8	64	355.1	499.3	94	349.9	499.6
6	61.7	87.1	36	359.9	504.6	66	354.2	498.7	96	348.2	499.9
8	101.1	149.2	38	363.6	499.5	68	351.3	498.9	98	348.6	499.6
10	195.6	257.5	40	363.1	501.7	70	353.7	499.1	100	350.4	501.3
12	254.1	362.8	42	363.7	495.4	72	355.4	499.6	102	350.5	500.3
14	278.9	390.9	44	365.6	500.2	74	353.2	500.4	104	349.9	500.4
16	280.8	400.9	46	361.7	502.6	76	354.2	500.5	106	349.3	500.1
18	300.3	441.9	48	360.7	500.2	78	350.8	501.6	108	351.3	500.2
20	317.3	445.9	50	359.3	496.4	80	350.1	500.4	110	350.5	499.9
22	314.9	490.1	52	355.2	499.4	82	349.9	502.3	112	349.4	498.3
24	341.2	521.9	54	354.2	500.6	84	348.4	500.1	114	350.2	501.7
26	349.9	499.9	56	350.2	501.3	86	348.2	503.4	116	350.7	501.2
28	350.3	525.4	58	349.1	497.9	88	348.1	501.0	118	350.2	501.3
30	359.9	517.7	60	354.8	500.1	90	348.2	502.4	120	350.3	500.5

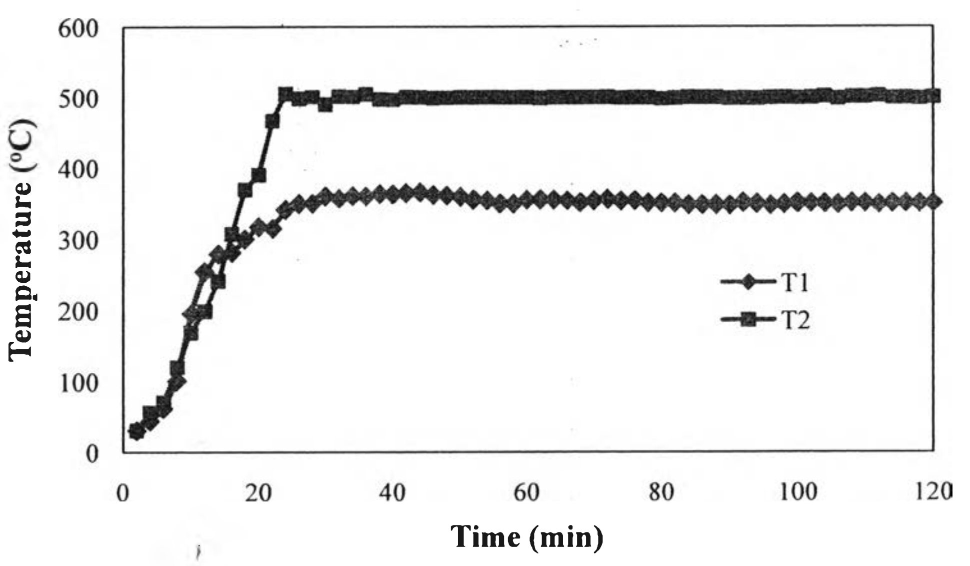

Figure A19 Temperature profiles of waste tire pyrolysis with using 0.25Rh0.75Co catalyst.

Table A20 Pyrolysis conditions: 0.50Rh0.50Cocatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.3	31.1	32	338.5	496.5	62	356.0	499.6	92	349.5	499.4
4	38.5	46.2	34	339.9	501.1	64	353.5	500.1	94	349.2	501.7
6	50.7	65.2	36	345.9	507.4	66	351.6	498.4	96	348.5	499.8
8	104.3	148.9	38	347.4	496.8	68	349.7	499.6	98	349.1	502.2
10	121.4	176.3	40	349.1	501.5	70	352.8	498.8	100	349.1	500.3
12	173.4	248.3	42	357.4	500.2	72	358.2	503.2	102	349.4	498.0
14	204.2	286.8	44	357.0	501.1	74	355.8	500.4	104	349.6	500.3
16	264.1	358.4	46	357.2	494.4	76	354.3	502.7	106	350.1	500.0
18	292.6	408.1	48	355.8	500.4	78	352.4	499.3	108	349.6	498.5
20	312.5	451.9	50	354.9	501.2	80	349.5	503.1	110	349.2	500.9
22	299.5	495.4	52	352.3	497.2	82	347.9	496.2	112	350.2	501.4
24	304.1	509.1	54	356.1	499.9	84	346.5	498.1	114	349.8	499.4
26	317.7	496.8	56	349.3	500.6	86	346.3	500.4	116	350.3	499.8
28	322.8	504.3	58	355.8	499.9	88	346.5	499.3	118	350.3	500.5
30	330.7	489.5	60	357.8	500.4	90	349.3	499.9	120	349.7	501.8

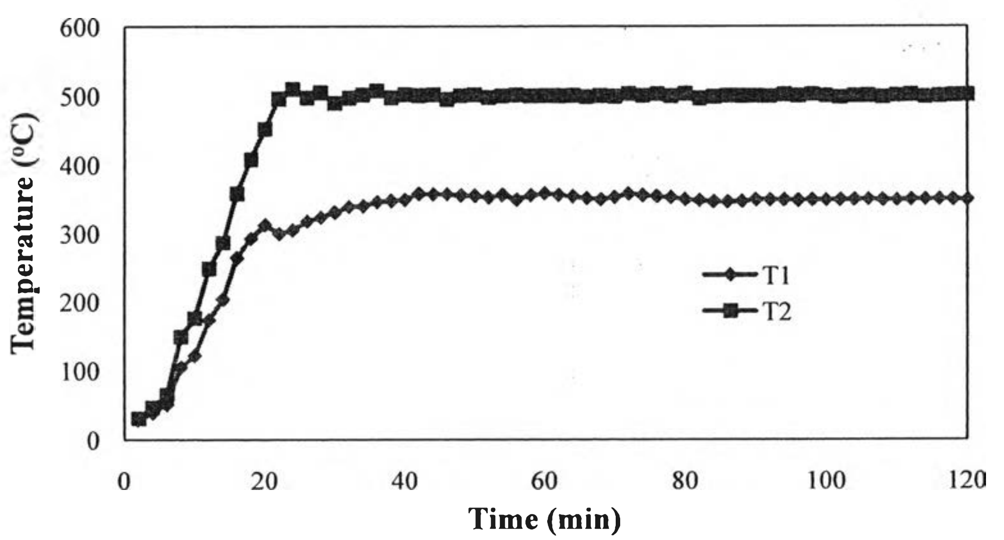

Figure A20 Temperature profiles of waste tire pyrolysis with using 0.5Rh0.5Co catalyst.

Table A21 Pyrolysis conditions: 0.75Rh0.25Cocatalyst

Tire = 30 g, N_2 flow = 30 ml/min

Pyrolysis Temperature (T2) = 500 °C

Catalytic Temperature (T1) = 350 °C

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	31.6	34.1	32	356.7	495.5	62	349.3	500.3	92	349.2	499.8
4	41.8	50.0	34	363.5	495.7	64	359.2	500.7	94	350.4	500.4
6	57.9	74.1	36	366.4	500.2	66	359.7	500.3	96	350.4	500.2
8	72.9	95.5	38	367.1	500.6	68	358.5	500.2	98	349.5	499.9
10	121.9	161.4	40	367.8	499.4	70	356.6	499.9	100	348.7	498.9
12	221.3	286.5	42	366.5	499.9	72	354.3	500.3	102	350.2	499.8
14	271.1	309.8	44	358.9	500.4	74	350.1	498.9	104	349.4	500.2
16	299.2	387.5	46	359.8	499.1	76	349.9	499.6	106	349.9	500.3
18	310.6	411.1	48	359.8	498.5	78	352.3	499.7	108	349.3	499.8
20	321.9	427.5	50	350.4	498.9	80	358.2	500.1	110	349.5	498.5
22	303.1	467.6	52	354.4	500.2	82	355.4	500.5	112	350.1	501.1
24	309.8	511.1	54	355.5	500.4	84	357.2	499.8	114	351.2	500.9
26	312.1	509.1	56	356.6	500.9	86	355.6	499.1	116	349.5	499.6
28	339.9	500.2	58	349.9	499.3	88	354.3	499.9	118	349.8	500.8
30	348.6	496.9	60	349.4	499.5	90	351.6	500.0	120	349.8	498.8

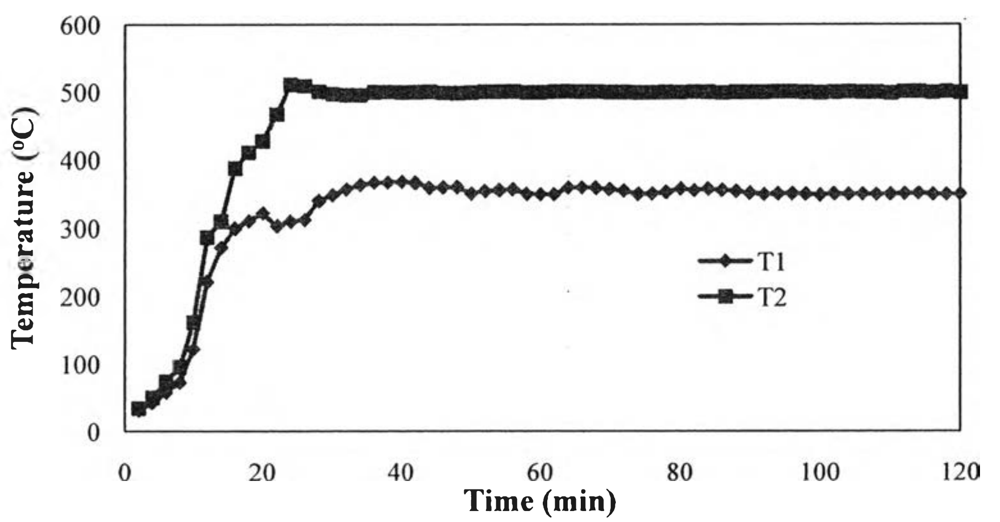

Figure A21 Temperature profiles of waste tire pyrolysis with using 0.75Rh0.25Co catalyst.

APPENDIX B Yields of Pyrolysis Products

Table B1 Yield of product obtained from using monometallic catalysts

Sample	%Metal loading	Yield (%)		
		Gas	Liquid	Solid
Non-catalyst	-	13.20	42.81	44.00
KL	0	19.25	36.98	43.78
Rh/KL	1	24.10	32.57	43.33
Ni/KL	1	20.13	35.97	43.90
	5	20.00	35.63	44.37
	10	20.63	36.19	43.15
	15	23.25	33.38	43.37
	20	22.17	34.27	43.57
Co/KL	1	25.12	29.58	45.03
	5	20.34	36.00	43.63
	10	20.40	35.83	43.77
	15	15.60	41.10	43.30
	20	19.47	37.83	42.67

Table B2 Yield of product obtained from using bimetallic catalysts

Sample	%Metal loading		Yield (%)		
	Ni or Co	Rh	Gas	Liquid	Solid
RhNi/KL	0.95	0.05	18.53	37.97	43.50
	0.75	0.25	22.30	34.00	43.70
	0.50	0.50	27.27	29.33	43.40
	0.25	0.75	18.03	38.70	43.27
RhCo/KL	0.95	0.05	20.17	36.67	43.17
	0.75	0.25	24.83	31.93	43.23
	0.50	0.50	22.57	34.43	43.00
	0.25	0.75	18.20	38.37	43.27

APPENDIX C Gas Yield (%)

Table C1 Yield of gas composition obtained from pyrolysis with 1%Rh/KL

Sample / Component	Non-Catalyst	KL	1%Rh/KL
Methane	3.042	3.855	5.160
Ethylene	1.332	1.822	2.006
Ethane	2.404	3.379	4.675
Propylene	1.519	2.248	2.565
Propane	1.132	1.736	2.570
C4	2.585	4.158	4.874
C5	1.148	2.043	2.164
C6	0.035	0.008	0.048
C7	0.001	0.001	0.005
C8	0.001	0.001	0.032
Total	**13.20**	**19.25**	**24.10**

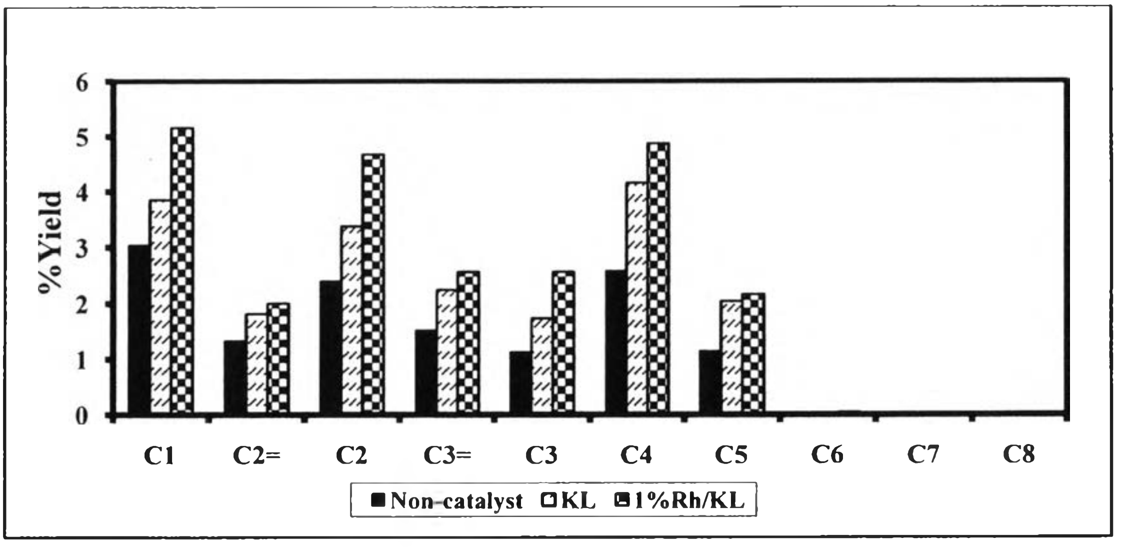

Figure C1 Distribution of gas composition obtained from pyrolysis with 1%Rh/KL catalyst

Table C2 Yield of gas composition obtained from pyrolysis with varied %Ni/KL

Sample / Component	Non-Catalyst	KL	1%Ni/KL	5%Ni/KL	10%Ni/KL	15%Ni/KL	20%Ni/KL
Methane	3.042	3.855	4.630	4.413	4.350	4.902	4.739
Ethylene	1.332	1.822	1.909	1.801	1.821	2.068	1.979
Ethane	2.404	3.379	3.670	3.398	3.588	4.154	4.015
Propylene	1.519	2.248	2.306	2.176	2.214	2.529	2.356
Propane	1.132	1.736	1.839	1.775	1.915	2.198	2.073
C4	2.585	4.158	4.068	4.104	4.432	4.870	4.528
C5	1.148	2.043	1.634	2.258	2.243	2.457	2.408
C6	0.035	0.008	0.039	0.045	0.045	0.048	0.040
C7	0.001	0.001	0.007	0.004	0.006	0.006	0.005
C8	0.001	0.001	0.030	0.027	0.016	0.019	0.027
Total	**13.20**	**19.25**	**20.13**	**20.00**	**20.63**	**23.25**	**22.17**

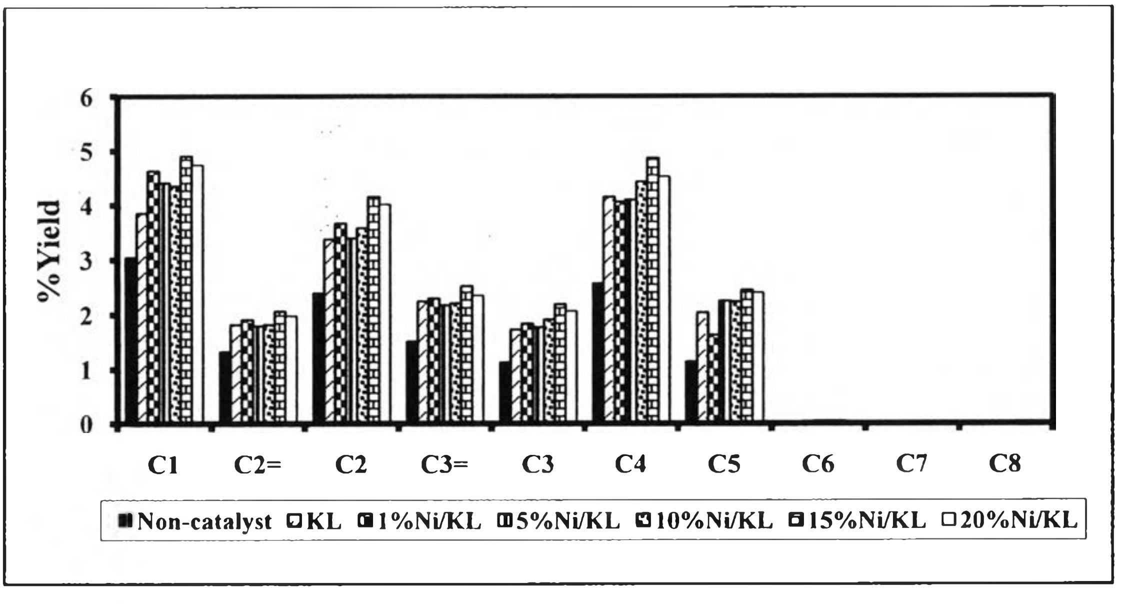

Figure C2 Distribution of gas composition obtained from pyrolysis with various Ni loading catalysts.

Table C3 Yield of gas composition obtained from pyrolysis with varied %Co/KL

Sample / Component	Non-Catalyst	KL	1%Co/KL	5%Co/KL	10%Co/KL	15%Co/KL	20%Co/KL
Methane	3.042	3.855	5.672	4.739	4.499	3.239	4.100
Ethylene	1.332	1.822	2.211	1.738	1.795	1.330	1.713
Ethane	2.404	3.379	4.567	3.801	3.793	2.879	3.471
Propylene	1.519	2.248	2.736	2.185	2.198	1.652	2.055
Propane	1.132	1.736	2.302	1.924	1.948	1.551	1.797
C4	2.585	4.158	4.950	4.185	4.105	3.343	4.030
C5	1.148	2.043	2.596	1.697	1.993	1.560	2.241
C6	0.035	0.008	0.050	0.041	0.036	0.031	0.037
C7	0.001	0.001	0.006	0.005	0.004	0.004	0.004
C8	0.001	0.001	0.031	0.027	0.029	0.010	0.021
Total	**13.20**	**19.25**	**25.12**	**20.34**	**20.40**	**15.60**	**19.47**

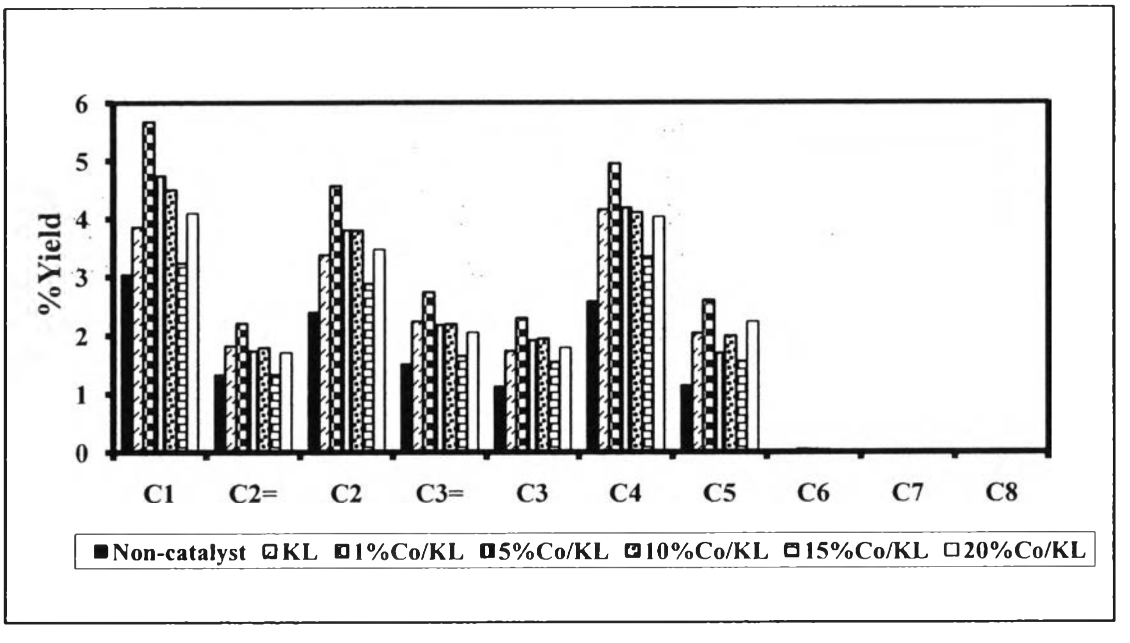

Figure C3 Distribution of gas composition obtained from pyrolysis with various Co loading catalysts.

Table C4 Yield of gas composition obtained from pyrolysis with varied composition of bimetallic catalysts (RhNi/KL)

Sample	α_{Ni}=Ni/(Rh+Ni)					
Component	**α=0**	**α=0.25**	**α=0.50**	**α=0.75**	**α=0.95**	**α=1**
Methane	5.160	3.927	6.010	4.808	3.998	3.634
Ethylene	2.006	1.551	2.372	1.991	1.709	1.498
Ethane	4.675	3.396	5.250	4.181	3.384	2.880
Propylene	2.565	1.952	2.943	2.433	2.000	1.810
Propane	2.570	1.806	2.747	2.202	1.745	1.443
C4	4.874	3.843	5.588	4.682	3.836	3.193
C5	2.164	1.495	2.306	1.958	1.796	1.282
C6	0.048	0.034	0.038	0.033	0.037	0.030
C7	0.005	0.004	0.002	0.002	0.004	0.005
C8	0.032	0.022	0.013	0.010	0.022	0.024
Total	**24.10**	**18.03**	**27.27**	**22.30**	**18.53**	**15.80**

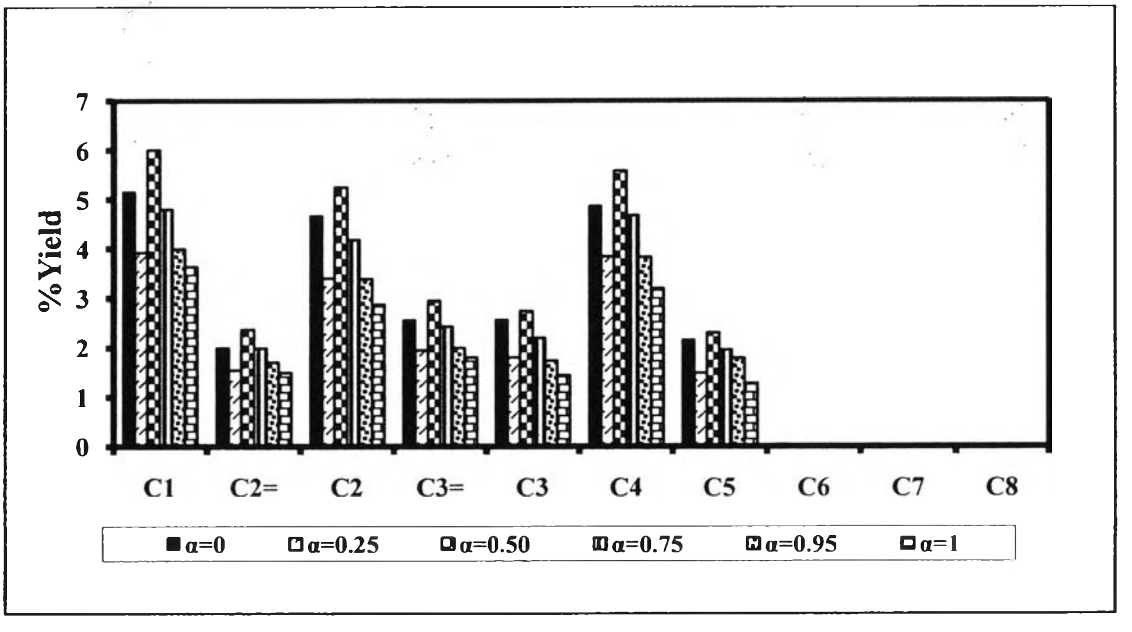

Figure C4 Distribution of gas composition obtained from pyrolysis with varied composition of bimetallic catalysts (RhNi/KL).

Table C5 Yield of gas composition obtained from pyrolysis with varied composition of bimetallic catalysts (RhCo/KL)

Sample	α_{Co}=Co/(Rh+Co)					
Component	**α=0**	**α=0.25**	**α=0.50**	**α=0.75**	**α=0.95**	**α=1**
Methane	5.160	3.951	4.970	5.062	4.376	5.672
Ethylene	2.006	1.605	1.959	2.483	1.796	2.211
Ethane	4.675	3.523	4.310	4.540	3.786	4.567
Propylene	2.565	2.000	2.427	2.863	2.176	2.736
Propane	2.570	1.882	2.280	2.354	2.000	2.302
C4	4.874	3.707	4.706	5.235	4.191	4.950
C5	2.164	1.475	1.876	2.235	1.800	2.596
C6	0.048	0.027	0.030	0.033	0.029	0.050
C7	0.005	0.002	0.002	0.004	0.002	0.006
C8	0.032	0.029	0.009	0.023	0.012	0.031
Total	**24.10**	**18.20**	**22.57**	**24.83**	**20.17**	**25.12**

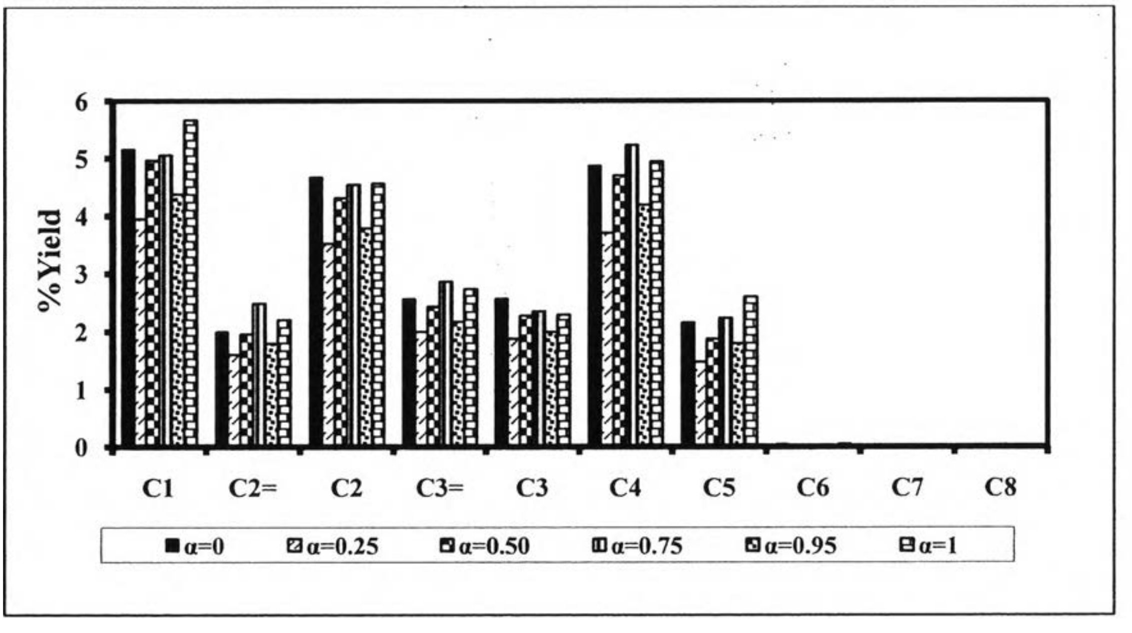

Figure C5 Distribution of gas composition obtained from pyrolysis with varied composition of bimetallic catalysts (RhCo/KL).

APPENDIX D Chemical Compositions of Maltenes

Table D1 Effect of 1%Rh/KL

Chemicals	Non-catalyst	KL	1%Rh/KL
Saturated HCs	51.51	54.40	55.29
Mono-aromatics	8.25	12.88	30.21
Di-aromatics	17.10	14.52	6.34
Poly-aromatics	17.10	13.91	4.83
Polar-aromatics	6.04	4.29	3.32

Table D2 Effect of varied Ni loading

Chemicals	Non-catalyst	KL	%Ni				
			1	5	10	15	20
Saturated HCs	51.51	54.40	52.91	49.37	50.97	43.84	46.65
Mono-aromatics	8.25	12.88	19.31	24.05	25.97	24.93	29.57
Di-aromatics	17.10	14.52	13.23	12.03	6.82	13.42	10.67
Poly-aromatics	17.10	13.91	10.58	10.76	12.99	13.70	9.45
Polar-aromatics	6.04	4.29	3.97	3.80	3.25	4.11	3.66

Table D3 Effect of varied Co loading

Chemicals	Non-catalyst	KL	%Co				
			1	5	10	15	20
Saturated HCs	51.51	54.40	47.20	47.73	43.45	45.51	50.73
Mono-aromatics	8.25	12.88	22.12	32.95	34.82	31.09	31.75
Di-aromatics	17.10	14.52	10.91	9.09	9.90	9.29	6.93
Poly-aromatics	17.10	13.91	14.75	5.97	7.67	9.94	6.93
Polar-aromatics	6.04	4.29	5.01	4.26	4.15	4.17	3.65

Table D4 Effect of RhNi/KL

Chemicals	α_{Ni}=Ni/(Rh+Ni)					
	0	**0.25**	**0.5**	**0.75**	**0.95**	**1**
Saturated HCs	55.29	60.06	58.42	53.89	52.86	52.91
Mono-aromatics	30.21	24.78	21.99	31.15	30.98	19.31
Di-aromatics	6.34	7.58	8.93	4.36	4.71	13.23
Poly-aromatics	4.83	2.92	5.84	4.05	4.04	10.58
Polar-aromatics	3.32	4.66	4.81	6.54	7.41	3.97

Table D5 Effect of RhCo/KL

Chemicals	α_{Co}=Co/(Rh+Co)					
	0	**0.25**	**0.5**	**0.75**	**0.95**	**1**
Saturated HCs	55.29	60.00	53.24	61.23	73.72	47.20
Mono-aromatics	30.21	21.14	29.71	23.08	15.71	22.12
Di-aromatics	6.34	7.43	7.65	4.92	3.02	10.91
Poly-aromatics	4.83	7.71	5.00	5.54	3.63	14.75
Polar-aromatics	3.32	3.71	4.41	5.23	3.93	5.01

APPENDIX E Petroleum Fractions of Derived Oils

Table E1 Effect of 1%Rh/KL

Fractions	Non-catalyst	KL	1%Rh/KL
Naphtha	29.00	42.00	37.50
Kerosene	26.00	28.00	30.50
Gas oil	35.00	26.00	28.00
Long residues	10.00	4.00	4.00

Table E2 Effect of varied Ni/KL

Fractions	Non-catalyst	KL	%Ni				
			1	5	10	15	20
Naphtha	29.00	42.00	33.00	34.00	34.00	35.00	36.00
Kerosene	26.00	28.00	27.00	30.00	29.00	28.00	29.50
Gas oil	35.00	26.00	36.00	32.00	33.00	31.00	30.50
Long residues	10.00	4.00	4.00	4.00	4.00	6.00	4.00

Table E3 Effect of varied Co/KL

Fractions	Non-catalyst	KL	%Co				
			1	5	10	15	20
Naphtha	29.00	42.00	37.50	39.50	36.50	28.00	30.00
Kerosene	26.00	28.00	27.50	29.50	27.50	24.00	27.00
Gas oil	35.00	26.00	28.00	26.00	30.00	37.50	37.50
Long residues	10.00	4.00	7.00	5.00	6.00	10.50	5.50

Table E4 Effect of RhNi/KL

Fractions	Non-catalyst	KL	α_{Ni}= Ni/(Rh+Ni)					
			1	0.95	0.75	0.50	0.25	0
Naphtha	29.00	42.00	36.00	31.00	34.00	36.00	29.50	37.00
Kerosene	26.00	28.00	29.00	26.00	27.00	30.00	28.50	31.00
Gas oil	35.00	26.00	30.00	38.00	34.00	30.50	30.00	28.00
Long residues	10.00	4.00	5.00	5.00	5.00	3.50	12.00	4.00

Table E5 Effect of RhCo/KL

Fractions	Non-catalyst	KL	α_{Co}= Co/(Rh+Co)					
			1	0.95	0.75	0.50	0.25	0
Naphtha	29.00	42.00	37.50	29.00	26.00	28.00	29.00	35.00
Kerosene	26.00	28.00	27.50	27.00	32.00	29.00	33.00	28.00
Gas oil	35.00	26.00	28.00	34.50	35.00	38.00	34.00	31.00
Long residues	10.00	4.00	7.00	9.50	7.00	5.00	4.00	6.00

APPENDIX F Asphaltene

Table F1 Effect of monometallic catalysts

Catalysts	Loading(%)	Asphaltene (g/g oil)
Non-catalyst	-	0.00222000
KL	0	0.00067821
Rh	1	0.00028287
Ni	1	0.00010000
	5	0.00025545
	10	0.00025333
	15	0.00026002
	20	0.00025600
Co	1	0.00030000
	5	0.00030333
	10	0.00033002
	15	0.00038178
	20	0.00037400

Table F2 Effect of bimetallic catalysts

Catalysts	α_{Ni}=Ni/(Rh+Ni)	Asphaltene (g/g oil)
RhNi/KL	0	0.00028287
	0.25	0.00043303
	0.50	0.00013600
	0.75	0.00016503
	0.95	0.00006574
	1	0.00010000
Catalysts	**α_{Co}=Co/(Rh+Co)**	**Asphaltene (g/g oil)**
RhCo/KL	0	0.00028287
	0.25	0.00032033
	0.50	0.00026748
	0.75	0.00033267
	0.95	0.00038171
	1	0.00010222

APPENDIX G Sulfur And Coke Deposition On Spent Catalyst

Table G1 Effect of monometallic catalysts

Catalyst	Metal loading(%)	Sulfur (%wt)	Coke (g/g cat)
KL	0	0.69	0.20
Rh/KL	1	0.79	0.27
Ni/KL	1	0.66	0.20
	5	1.32	0.21
	10	1.09	0.18
	15	1.17	0.21
	20	1.33	0.18
Co/KL	1	0.48	0.20
	5	0.89	0.19
	10	1.02	0.20
	15	1.26	0.15
	20	1.31	0.17

Table G2 Effect of bimetallic catalysts

Catalysts	α_{Ni}=Ni/(Rh+Ni)	Sulfur (%wt)	Coke (g/g cat)
RhNi/KL	0	0.79	0.27
	0.25	0.71	0.22
	0.50	0.66	0.21
	0.75	0.71	0.22
	0.95	0.70	0.20
	1	0.66	0.18
Catalysts	**α_{Co}=Co/(Rh+Co)**	**Sulfur (%wt)**	**Coke (g/g cat)**
RhCo/KL	0	0.79	0.27
	0.25	0.61	0.22
	0.50	0.66	0.23
	0.75	0.71	0.25
	0.95	1.27	0.23
	1	0.48	0.20

APPENDIX H Sulfur in Derived Oil

Table H1 Effect of monometallic catalysts

Catalyst	Metal loading(%)	Sulfur in oil (%wt)
Non-catalyst	-	1.40
KL	0	0.91
Rh/KL	1	0.35
Ni/KL	1	1.04
	5	0.48
	10	0.40
	15	0.74
	20	0.49
Co/KL	1	1.12
	5	1.00
	10	0.99
	15	0.79
	20	0.42

Table H2 Effect of bimetallic catalysts

Catalysts	α_{Ni}=Rh/(Rh+Ni)	Sulfur in oil (%wt)
RhNi/KL	0	0.52
	0.05	0.64
	0.25	0.72
	0.50	0.80
	0.75	0.63
	1	0.35
Catalysts	**α_{Co}=Co/(Rh+Co)**	**Sulfur in oil (%wt)**
RhCo/KL	0	0.35
	0.25	1.24
	0.50	1.10
	0.75	1.14
	0.95	1.25
	1	1.12

APPENDIX I True Boiling Point Distillation (°C)

Table I1. Non-catalytic

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	50.4	168.7	76.7	22.7	71.0	22.7
5	147.6	192.7	271.6	79.8	72.9	185.6
10	150.2	206.2	283.9	148.0	73.2	203.7
15	168.2	213.1	290.3	327.1	73.6	210.1
20	180.5	220.1	295.1	336.2	74.0	218.5
25	191.6	226.3	301.5	343.9	74.4	228.1
30	203.3	231.9	305.0	350.3	75.2	238.5
35	212.4	238.7	309.8	355.9	77.5	246.1
40	221.1	245.8	315.0	361.6	218.5	255.1
45	229.4	253.7	318.7	367.4	260.1	266.3
50	239.2	261	323.8	373.3	290.3	277.3
55	250.8	269.1	329.1	379.6	316.2	289.3
60	262.9	275.7	334.0	386.5	338.4	301.8
65	274.5	284.1	341.2	394.2	354.6	315.2
70	287.6	293.8	349.6	402.8	370.4	330.4
75	302.2	306.3	359.6	412.4	384.6	347.4
80	320.6	323.2	370.5	424.8	390.5	366.7
85	342.2	345.8	382.9	440.0	407.1	388.3
90	371.4	376.0	400.4	459.7	429.1	418.3
95	405.9	410.5	426.4	488.8	464.7	462.3
100	485.5	484.1	510.7	554.4	538.0	544.1

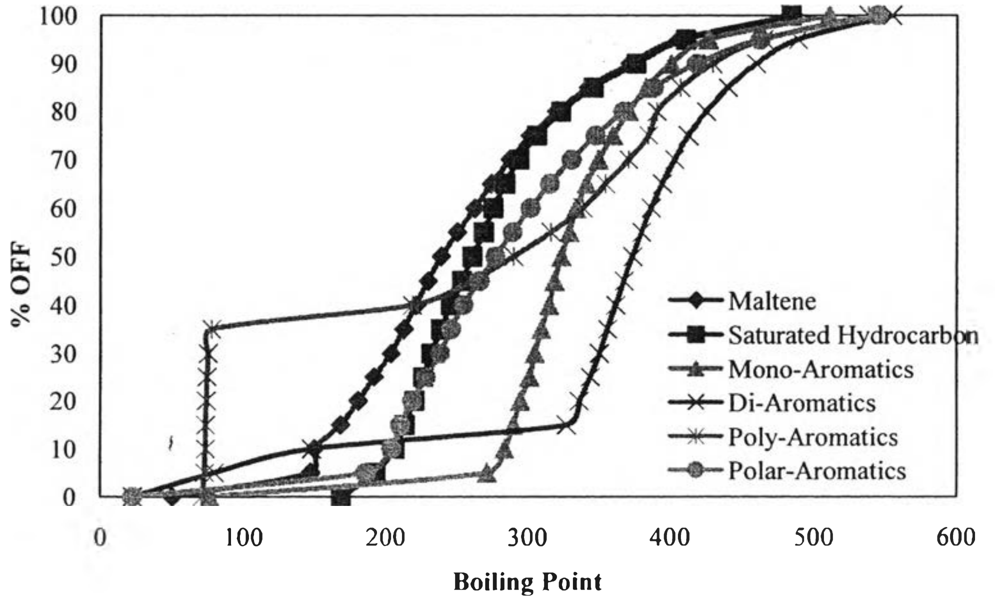

Figure I1. True boiling point distillation (°C) of Non-catalytic.

Table I2. KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	22.7	39.8	37.3	27.1	33.7	29.4
5	116.9	79.4	239.1	42.8	72.3	38.3
10	148.7	148.6	258.0	302.7	73.5	44.0
15	150.5	163.4	269.9	312.8	73.9	243.9
20	161.4	179.1	275.6	319.0	74.3	258.8
25	169.6	188.7	279.9	323.9	74.7	270.3
30	178.1	195.0	286.2	328.8	75.0	278.5
35	187.3	204.6	291.9	333.5	75.4	287.0
40	195.2	210.1	297.3	338.2	75.8	296.2
45	205.0	216.6	303.5	342.8	76.2	305.4
50	212.8	222.5	309.1	347.4	76.6	314.4
55	220.5	228.0	315.4	352.4	76.9	324.2
60	228	235.5	321.5	357.7	77.3	334.3
65	237.7	243.1	327.6	363.2	77.7	344.9
70	249.6	252.8	333.7	368.8	79.6	356.5
75	262.9	263.0	340.6	374.4	252.8	368.1
80	278.1	275.1	349.8	380.8	286.0	379.0
85	296.1	283.3	362.0	388.1	327.3	389.8
90	321.6	306.9	375.4	397.0	360.8	400.8
95	359.1	337.6	393.8	409.7	386.3	423.2
100	426.5	397.4	466.0	451.7	432.1	585.1

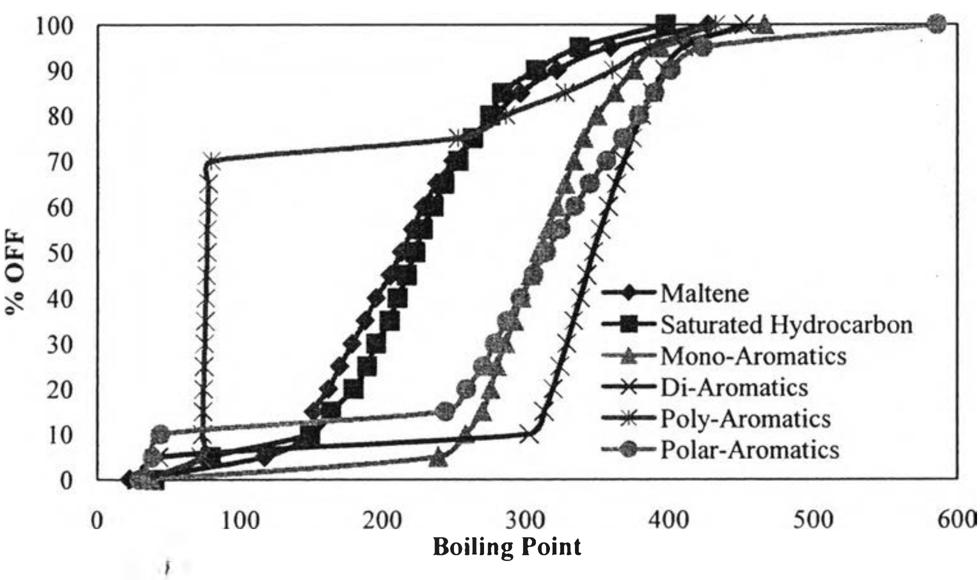

Figure I2. True boiling point distillation (°C) of KL.

Table I3 1% Rh/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	113.1	149.3	74.0	61.2	22.7	22.7
5	148.3	181.1	152.5	255.4	272.1	32.0
10	149.8	191.4	171.1	273.7	301.3	171.4
15	157.5	201.9	186.7	283.2	315.6	199.1
20	169.0	207.8	194.5	290.9	326.2	204.5
25	176.9	213.0	205.6	298.0	335.3	213.2
30	187.6	218.0	213.2	304.9	343.8	225.0
35	196.6	223.1	219.9	311.9	352.0	239.4
40	205.6	228.8	226.0	319.5	360.1	252.0
45	213.7	233.9	232.3	327.3	368.1	267.8
50	220.7	240.0	239.3	335.3	375.7	284.6
55	226.8	246.0	247.4	343.5	383.4	300.9
60	235.3	253.0	256.0	352.3	391.3	317.6
65	244.1	259.5	264.9	362.1	399.7	335.6
70	255.2	267.4	273.8	372.8	408.7	354.3
75	266.8	274.3	282.2	384.0	418.4	373.3
80	278.3	284.0	294.4	397.1	429.5	390.8
85	293.6	297.4	314.8	412.4	442.9	409.6
90	318.3	318.8	346.2	431.2	460.3	431.6
95	361.9	358.3	398.6	458.9	487.1	465.5
100	447.3	439.1	487.0	525.9	543.8	549.5

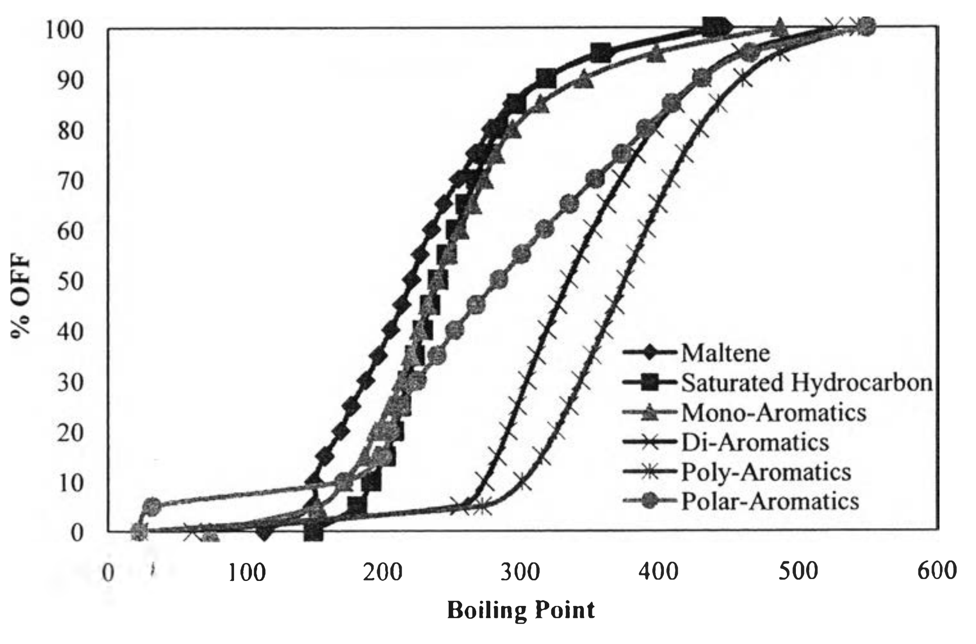

Figure I3 True boiling point distillation (°C) of 1% Rh/KL.

Table I4 1% Ni/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	110.1	77.8	24.4	128.7	72.7	22.7
5	148.7	160.0	153.7	278.1	75.3	29.2
10	150.8	173.3	193.4	288.7	202.4	41.9
15	164.8	187.3	210.7	292.3	214.1	212.2
20	171.8	196.3	221.2	296.2	222.8	234.9
25	184.7	206.2	231.1	300.2	231.3	244.1
30	194.6	213.8	239.4	304.0	240.1	254.5
35	205.9	220.8	249.3	307.9	248.0	267.1
40	215.0.	226.8	256.6	311.7	256.8	278.2
45	223.3	234.1	265.0	315.8	267.1	286.8
50	231.4	241.1	271.7	320.9	278.7	296.8
55	239.7	249.5	276.5	326.9	291.1	308.0
60	249.8	257.7	282.4	333.9	304.1	320.0
65	259.6	266.3	288.2	342.3	318.5	333.0
70	270.3	274.4	293.6	352.5	335.2	346.9
75	279.3	282.6	300.7	364.9	352.9	363.0
80	289.6	291.8	308.5	379.5	372.8	381.2
85	301.5	302.9	320.7	397.7	394.8	402.1
90	319.2	319.4	338.9	422.3	422.5	428.2
95	353.1	350.3	378.8	460.8	463.3	470.6
100	459.0	453.5	520.5	547.7	551.9	557.5

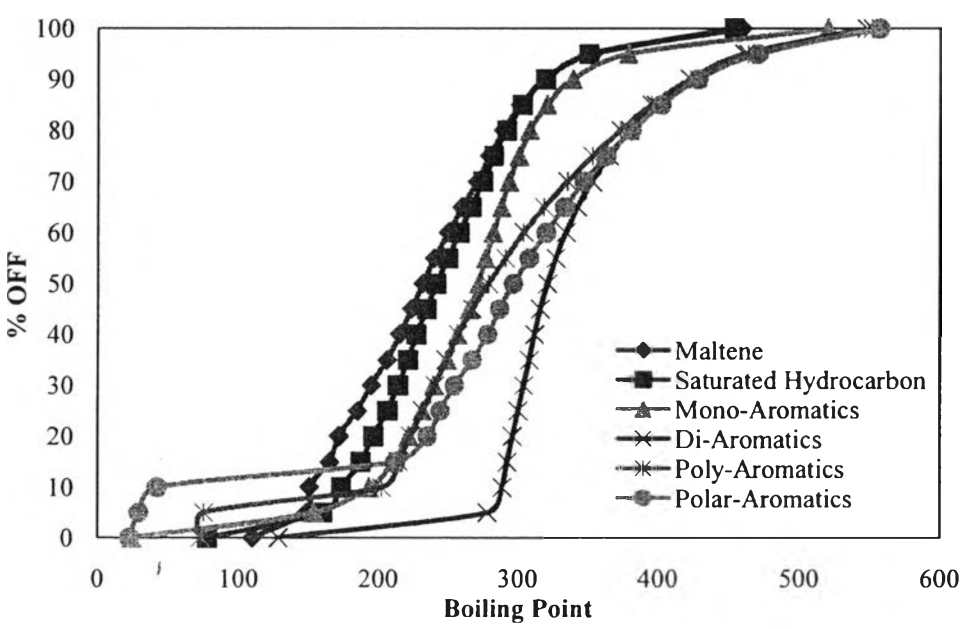

Figure I4 True boiling point distillation (°C) of 1% Ni/KL.

Table I5 5% Ni/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	25.2	76.3	80.7	38.1	75.0	70.7
5	120.5	169.0	187.4	260.3	257.6	194.6
10	148.8	182.2	202.1	270.9	279.9	207.3
15	153.3	191.1	212.8	274.1	290.6	213.7
20	169.0	199.7	219.9	277.7	296.8	221.2
25	179.0	206.4	227.7	282.6	303.7	229.4
30	190.0	213.0	233.7	287.7	309.4	238.4
35	201.1	219.4	239.4	291.7	314.4	247.5
40	209.2	224.1	247.1	295.3	320.3	256.8
45	217.3	230.0	252.9	300.0	326.8	267.0
50	225.2	236.7	259.1	304.2	334.4	277.6
55	233.4	243.2	265.6	308.5	343.3	289.6
60	242.7	251.6	272.0	315.0	352.5	301.8
65	252.8	259.0	277.9	321.1	362.4	315.7
70	262.7	268.0	284.7	329.3	373.3	332.3
75	273.3	275.4	292.7	337.3	384.9	351.0
80	284.0	285.2	302.5	349.8	398.2	371.9
85	297.4	297.5	317.8	367.2	413.6	394.1
90	318.0	314.7	341.0	388.2	433.4	419.2
95	359.7	350.9	382.9	418.4	464.0	454.9
100	481.0	454.9	488.2	489.7	527.8	535.3

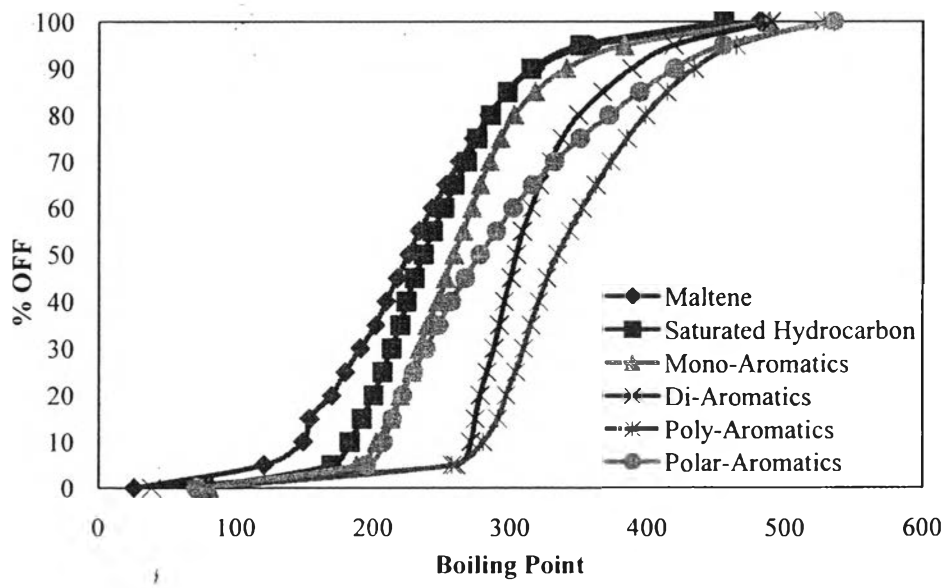

Figure I5 True boiling point distillation (°C) of 5% Ni/KL.

Table I6 10% Ni/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	26.2	41.5	76.0	22.9	44.0	23.1
5	121.3	166.0	175.6	34.5	122.8	206.5
10	148.9	177.2	196.5	180.5	149.9	227.1
15	155.3	188.7	211.3	198.5	171.9	239.2
20	168.0	198.5	221.7	213.6	189.5	249.9
25	179.2	207.6	230.9	231.0	203.4	259.1
30	191.1	215.4	239.7	257.9	215.8	268.3
35	202.3	222.5	250.2	302.6	229.6	277.6
40	209.9	229.0	259.7	327.2	244.1	287.5
45	218.2	236.5	269.8	343.4	260.1	296.5
50	226.1	243.9	277.5	355.7	279.6	306.0
55	233.9	252.7	286.7	366.8	301.1	316.3
60	242.1	260.9	296.0	376.5	315.4	327.7
65	253.1	270.1	306.7	386.0	333.3	340.0
70	261.1	278.8	318.4	395.8	342.7	352.8
75	273.5	288.5	330.2	405.4	357.9	366.4
80	284.5	300.9	343.8	414.7	374.9	380.3
85	297.1	316.6	362.3	427.2	390.0	395.8
90	318.2	339.2	382.2	441.4	408.2	414.7
95	359.1	376.1	409.3	463.5	435.0	440.9
100	482.0	437.2	462.6	542.6	498.8	496.8

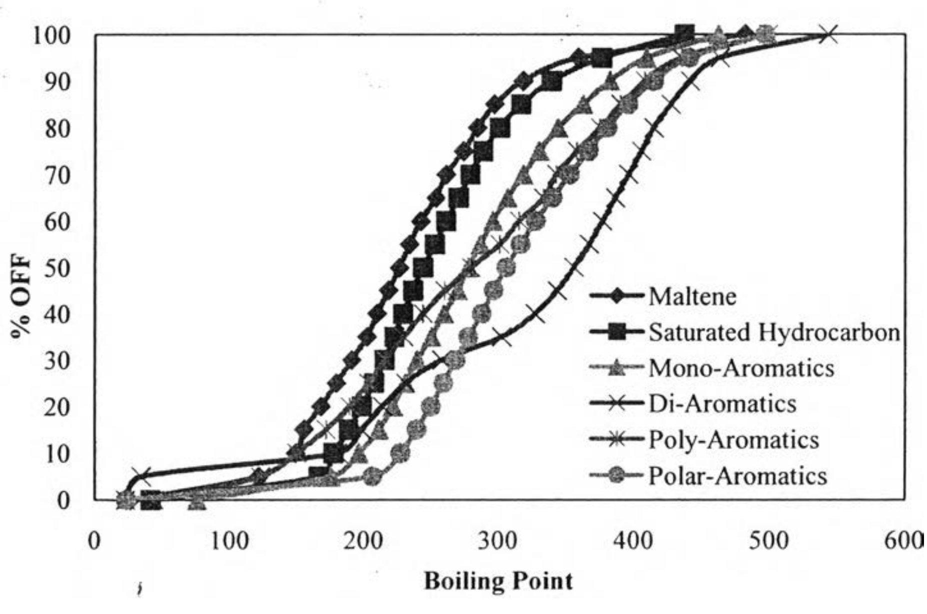

Figure I6 True boiling point distillation (°C) of 10% Ni/KL.

Table I7 15% Ni/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	45.5	23.3	23.3	23.1	22.7	121.9
5	148.5	36.6	40.7	32.6	25.6	193.9
10	150.2	155.4	168.8	75.0	30.3	204.0
15	161.9	177.5	193.1	270.6	36.4	212.2
20	170.3	190.1	207.4	287.1	43.4	221.6
25	181.3	200.6	216.8	297.0	76.8	232.3
30	190.4	208.9	226.4	305.7	263.4	242.1
35	200.4	216.6	234.2	313.8	305.0	251.3
40	209.4	223.7	242.9	320.9	325.8	263.1
45	217.8	230.4	251.8	328.8	339.2	275.3
50	225.5	238.4	261.5	335.3	351.0	287.8
55	234.3	247.1	271.8	344.2	361.8	300.3
60	243.6	257.4	280.9	354.2	373.2	314.2
65	255.3	268.5	292.2	365.1	384.3	330.0
70	268.1	279.7	305.0	376.1	396.0	347.1
75	281.5	293.8	320.9	387.6	408.4	364.9
80	298.0	312.0	338.1	400.6	420.7	383.3
85	319.3	336.7	362.4	413.2	438.3	401.5
90	346.7	374.6	389.6	430.7	465.9	423.7
95	384.0	420.3	428.1	464.8	511.9	458.0
100	443.7	553.5	553.0	563.3	574.0	546.0

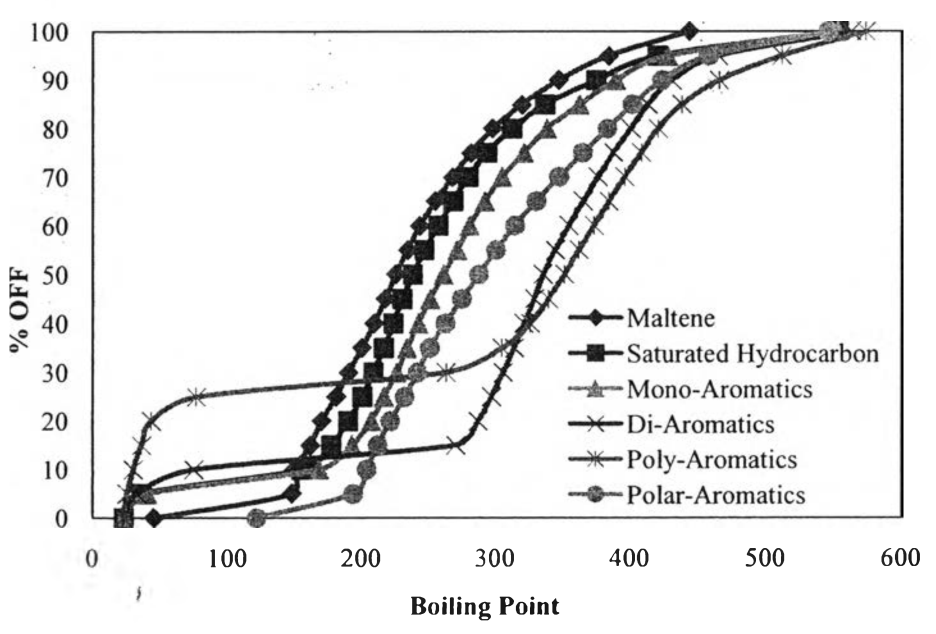

Figure I7 True boiling point distillation (°C) of 15% Ni/KL.

Table I8 20% Ni/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	45.5	23.3	46.6	38.5	23.5	115.2
5	148.5	39.6	174.7	259.1	33.5	193.8
10	150.2	149.3	193.9	270.9	75.0	197.5
15	161.9	166.9	206.5	276.0	251.2	205.2
20	170.3	177.4	213.8	281.6	279.9	218.2
25	181.3	188.8	219.9	288.6	294.9	236.0
30	190.4	198.7	226.4	293.4	305.9	246.2
35	200.4	207.0	230.8	298.8	312.8	264.3
40	209.4	214.5	235.4	303.5	320.2	279.1
45	217.8	221.5	242.6	308.2	328.2	291.6
50	225.5	227.2	247.4	314.6	336.7	303.9
55	234.3	235.1	254.0	319.6	344.4	315.4
60	243.6	243.0	260.7	326.1	352.9	328.5
65	255.3	253.1	267.6	332.0	361.9	343.0
70	268.1	263.0	274.8	339.0	371.8	358.2
75	281.5	274.3	282.8	348.9	382.4	374.3
80	298.0	287.4	292.6	361.3	394.8	388.8
85	319.3	304.7	305.8	375.6	410.1	404.9
90	346.7	332.9	325.4	392.9	430.9	423.1
95	384.0	389.1	356.9	417.1	474.7	451.5
100	443.7	541.8	425.8	471.4	567.3	525.5

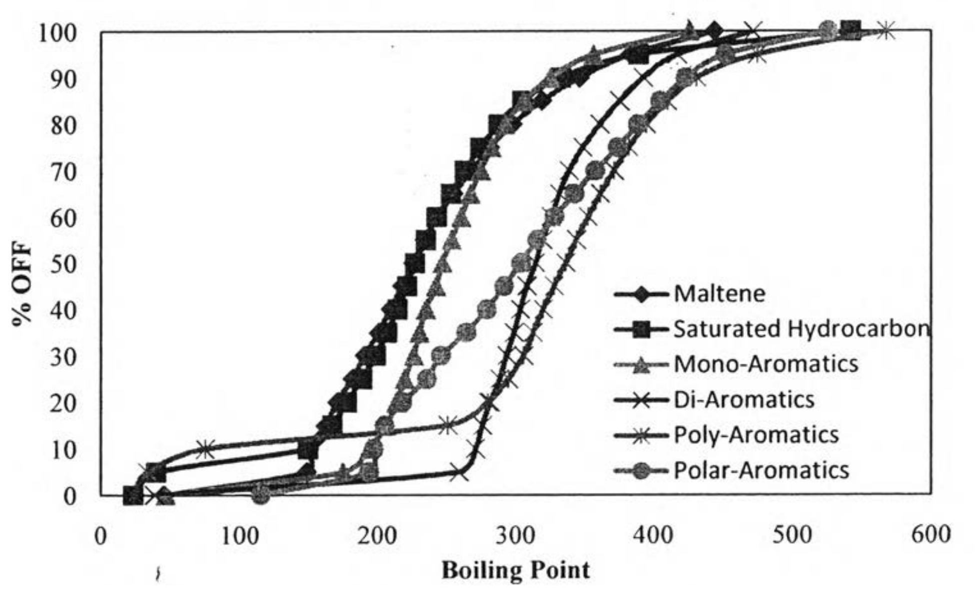

Figure I8 True boiling point distillation (°C) of 20% Ni/KL.

Table I9 1% Co/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	83.2	23.7	22.7	24.2	37.5	22.0
5	126.7	75.0	26.3	40.7	201.0	27.1
10	148.5	178.3	32.4	72.1	216.5	33.7
15	151.2	190.8	40.9	347.5	230.4	35.8
20	163.5	199.5	75.3	364.2	243.8	37.7
25	171.2	206.6	243.0	371.9	253.6	39.6
30	183.0	213.6	293.3	377.7	267.4	41.7
35	191.2	219.6	306.7	382.9	282.3	43.2
40	199.8	224.7	317.0	387.7	297.6	44.5
45	209.1	231.5	325.4	392.2	311.8	48.3
50	216.3	238.3	333.4	396.8	321.2	71.3
55	225.6	246.9	341.4	401.2	335.4	71.9
60	232.4	256.5	350.7	405.6	344.4	104.5
65	241.1	267.4	361.0	409.9	356.1	126.8
70	249.0	277.6	371.8	414.5	372.8	133.2
75	265.1	289.8	383.2	420.0	385.7	139.0
80	279.4	305.3	397.5	426.5	389.6	145.6
85	298.2	326.8	414.1	434.0	403.7	282.9
90	324.3	358.8	439.2	443.3	420.7	334.0
95	369.0	404.9	490.5	456.7	447.0	363.8
100	441.1	543.0	571.6	487.6	506.9	593.5

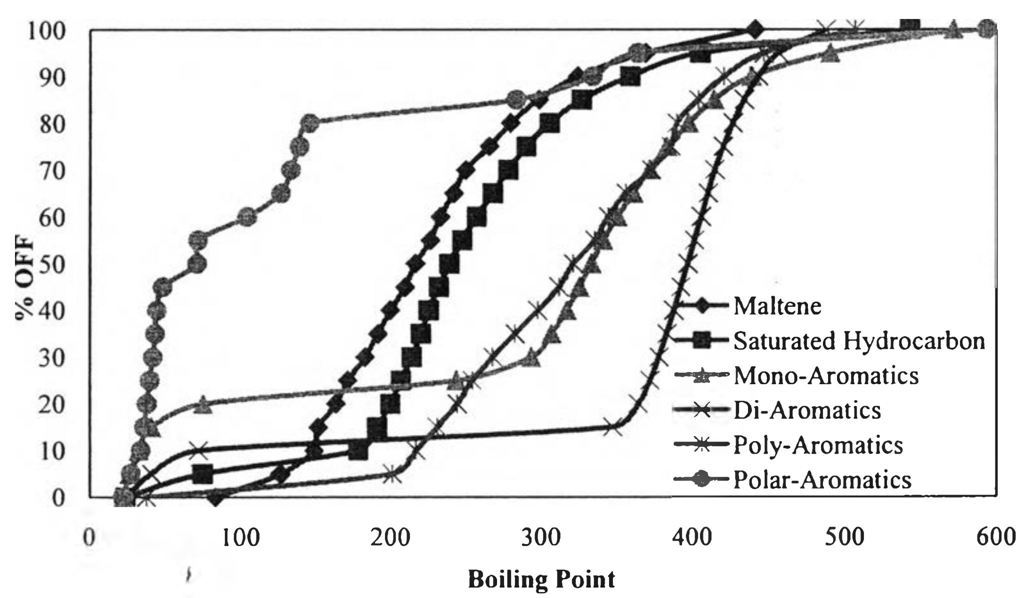

Figure I9 True boiling point distillation (°C) of 1% Co/KL.

Table I10 5% Co/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	83.7	23.5	23.5	23.3	22.9	154.9
5	126.8	39.6	39.2	73.1	33.7	185.4
10	149.0	85.5	150.7	165.7	78.9	195.4
15	151.0	154.5	171.1	178.1	208.4	196.8
20	165.2	170.1	186.3	192.6	232.8	199.2
25	170.7	180.8	196.2	206.6	250.8	204.5
30	182.0	188.9	207.1	221.5	273.2	211.9
35	191.3	197.6	215.1	239.5	295.0	219.2
40	200.4	205.9	222.3	260.5	310.6	230.6
45	208.8	212.7	230.0	275.8	322.0	239.3
50	216.6	220.3	236.6	288.7	333.7	247.9
55	224.3	226.4	245.4	299.7	344.6	262.6
60	232.6	234.7	254.2	310.5	354.8	277.5
65	241.2	243.8	264.5	321.7	365.3	292.1
70	252.6	255.6	276.1	333.1	375.4	309.3
75	265.0	268.8	288.6	347.4	385.7	328.4
80	279.1	283.4	305.1	365.4	397.2	350.4
85	297.3	303.8	328.6	384.8	410.8	374.0
90	324.4	337.1	363.5	407.5	429.6	400.8
95	368.6	400.1	414.0	439.3	467.7	435.3
100	440.8	544.8	552.6	548.1	561.0	533.6

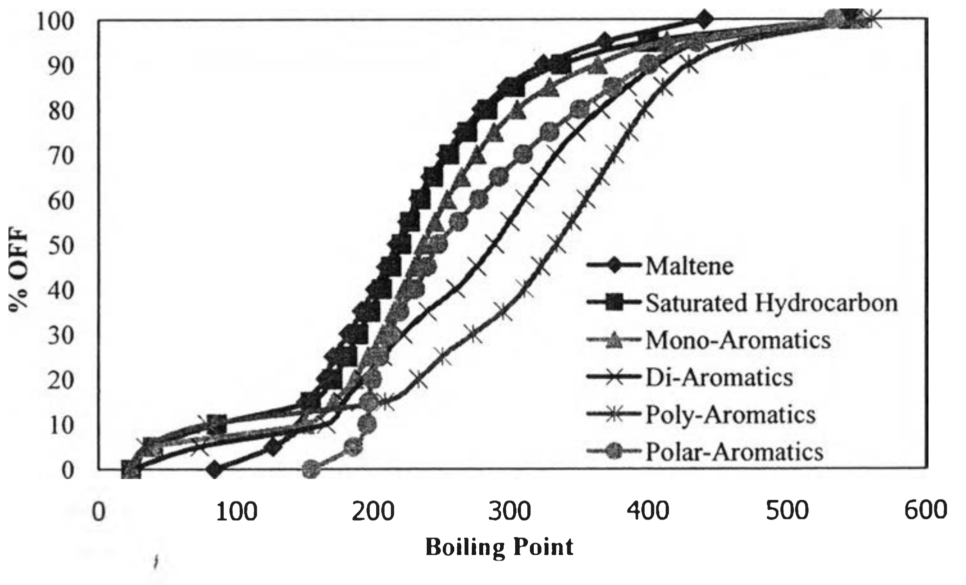

Figure I10 True boiling point distillation (°C) of 5% Co/KL.

Table I11 10% Co/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	75.7	33.9	32.0	24.6	23.1	22.5
5	146.9	150.3	179.0	251.4	37.9	27.1
10	149.3	168.7	196.7	272.6	256.9	34.7
15	152.9	177.5	209.6	280.7	298.0	168.7
20	168.3	187.4	215.8	290.3	316.1	208.7
25	174.0	195.3	224.1	297.1	326.9	220.5
30	187.4	204.2	230.6	304.0	336.1	232.9
35	197.2	209.5	235.9	310.4	344.9	244.4
40	207.3	216.6	244.1	317.2	352.8	254.2
45	215.7	222.8	250.2	323.8	360.2	266.3
50	223.7	228.2	257.4	330.8	367.9	279.4
55	232.1	236.1	265.6	336.8	375.1	292.4
60	240.9	243.5	273.8	345.1	382.4	306.2
65	252.3	253.6	281.3	354.6	389.7	321.8
70	264.1	263.4	290.8	365.3	397.5	339.5
75	276.9	273.7	301.8	376.7	405.8	358.6
80	291.6	286.0	316.8	389.1	414.5	378.9
85	311.0	301.4	334.6	403.5	425.1	400.8
90	338.2	326.1	360.9	418.8	439.4	426.0
95	378.9	371.7	396.2	441.9	461.8	463.7
100	447.9	451.9	469.8	500.2	510.2	558.6

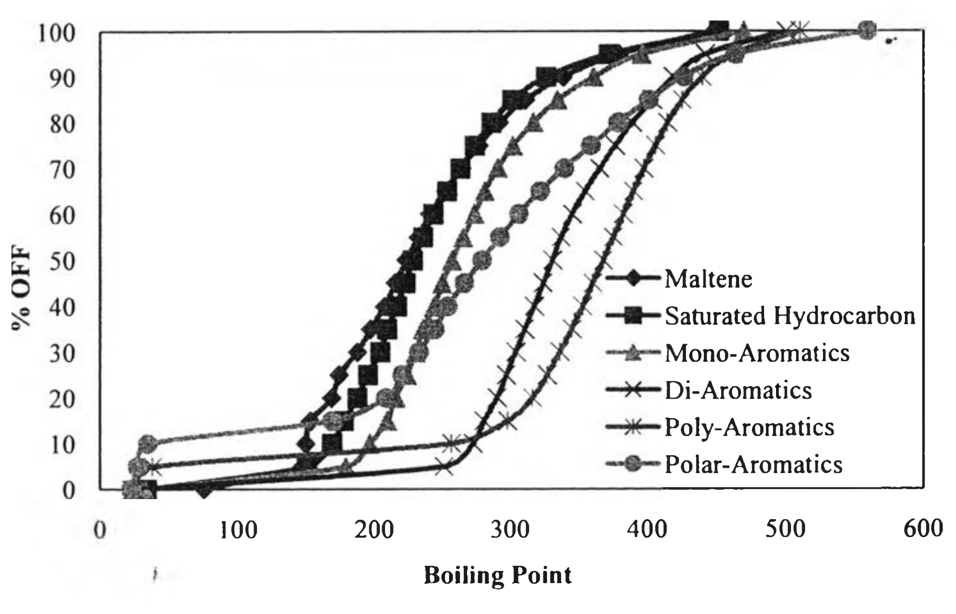

Figure I11 True boiling point distillation (°C) of 10% Co/KL.

Table I12 15% Co/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	44.5	150.5	76.7	128.9	84.7	22.5
5	148.5	175.8	197.7	281.2	127.3	24.4
10	150.7	191.8	215.2	293.3	159.6	27.3
15	166.7	203.2	226.5	301.4	251.4	31.3
20	177.6	210.3	235.3	309.0	319.7	36.4
25	192.5	218.4	245.9	316.2	361.4	42.6
30	205.5	224.9	253.5	323.8	381.3	238.1
35	215.7	232.1	261.4	331.7	394.2	260.8
40	225.0	239.2	269.1	339.2	405.0	277.4
45	234.8	247.1	275.2	347.5	414.5	293.0
50	245.4	255.9	281.9	356.9	423.6	307.5
55	256.7	264.2	289.5	367.1	432.4	323.2
60	268.3	272.9	297.5	377.5	441.4	340.6
65	278.4	280.9	307.8	388.2	450.7	358.9
70	289.9	290.3	320.7	399.7	460.7	377.3
75	303.3	301.7	334.6	411.0	471.8	395.5
80	321.4	317.4	353.8	423.4	484.6	415.0
85	343.5	338.7	375.9	437.4	499.8	434.6
90	373.4	372.1	401.6	454.5	522.0	457.6
95	406.8	412.2	432.5	480.9	546.9	493.1
100	466.4	486.1	498.2	558.0	581.0	565.7

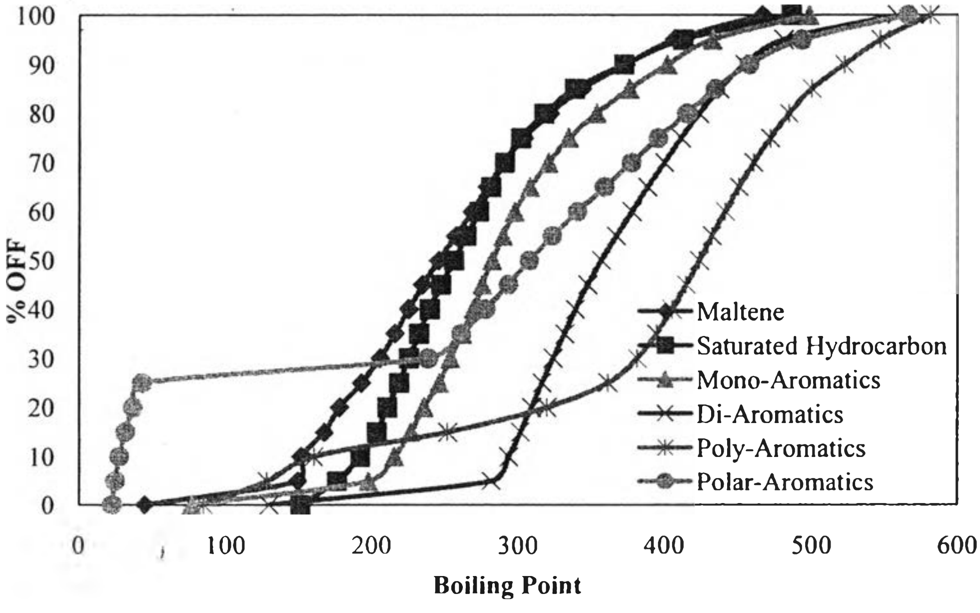

Figure I12 True boiling point distillation (°C) of 15% Co/KL.

Table I13 20% Co/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	43.6	83.0	25.0	22.7	22.5	22.9
5	148.8	168.8	182.5	276.2	271.8	37.1
10	151.8	182.7	209.9	283.9	305.6	182.7
15	165.7	192.7	220.7	291.3	322.1	199.2
20	173.9	203.5	229.8	296.5	333.7	205.1
25	187.8	209.7	236.6	301.6	343.3	215.4
30	199.2	217.6	245.8	306.8	352.0	229.0
35	209.7	224.1	251.9	312.2	360.5	241.5
40	219.0	230.8	258.9	318.0	368.8	253.8
45	227.2	238.1	265.5	324.4	376.4	269.7
50	236.2	245.4	272.4	331.4	384.1	285.1
55	245.4	254.4	277.2	338.7	391.7	300.3
60	255.8	262.3	283.7	346.7	399.6	315.8
65	266.1	271.4	290.2	356.0	407.8	332.5
70	276.5	279.2	297.4	366.8	416.4	350.2
75	286.8	288.7	307.1	378.4	426.0	368.8
80	299.3	300.6	320.5	391.7	437.0	386.7
85	314.8	317.1	337.3	407.8	449.4	404.8
90	337.7	343.2	365.4	428.0	464.3	426.5
95	374.3	389.9	404.5	458.5	484.6	460.0
100	443.6	489.8	526.4	528.5	524.9	545.0

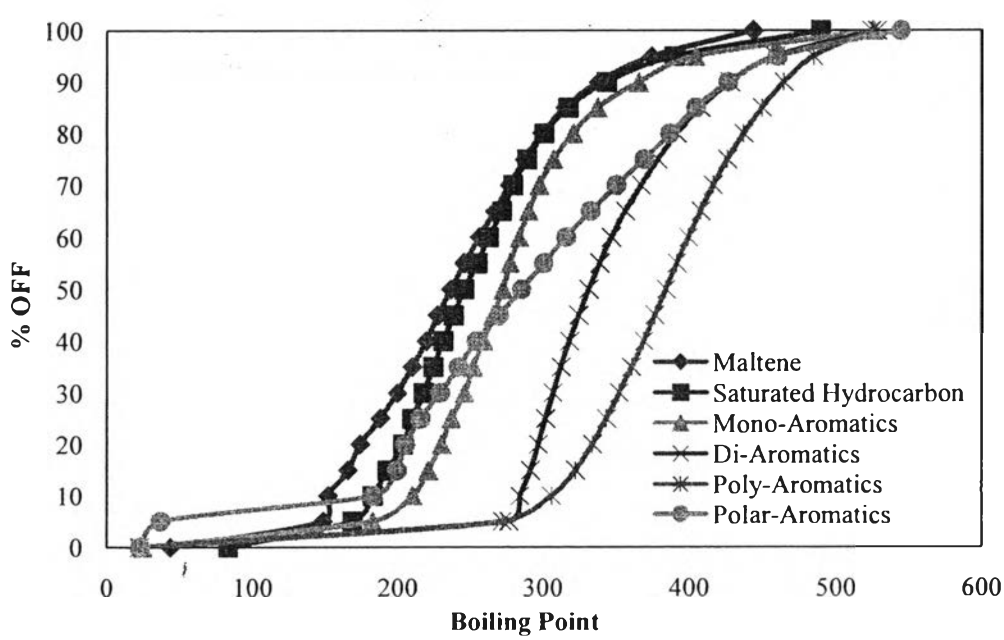

Figure I13 True boiling point distillation (°C) of 20% Co/KL.

Table I14 0.05Rh 0.95Ni /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	79.7	81.8	24.6	141.5	22.5	22.5
5	148.5	168.8	170.2	271.6	264.2	29
10	150.4	182.2	194.3	289.5	293.3	41.9
15	165.2	192.3	209.5	297.7	313.0	198.4
20	172.5	202.5	219.1	305.8	329.4	209.2
25	187.1	209.1	228.0	312.2	343.7	221.2
30	198.4	216.0	235.9	319.2	355.8	235.8
35	208.9	222.9	245.8	326.3	366.6	249.0
40	217.8	228.6	254.0	333.4	375.9	263.4
45	225.9	235.6	261.9	341.2	384.2	279.2
50	234.9	242.7	270.2	349.7	391.9	294.2
55	244.1	250.9	275.8	358.0	399.6	309.9
60	254.5	258.4	282.5	366.8	407.5	325.7
65	264.4	266.7	289.3	375.8	415.5	342.6
70	274.4	274.3	296.7	385.3	423.9	360.0
75	284.5	283.1	305.9	395.9	433.1	377.7
80	296.2	293.1	319.0	407.5	443.6	394.1
85	311.6	305.7	335.4	420.8	456.0	412.1
90	335.6	326.9	362.6	438.3	471.6	433.5
95	376.4	370.0	402.2	463.7	494.9	467.2
100	457.4	463.5	509.1	527.6	538.8	552.4

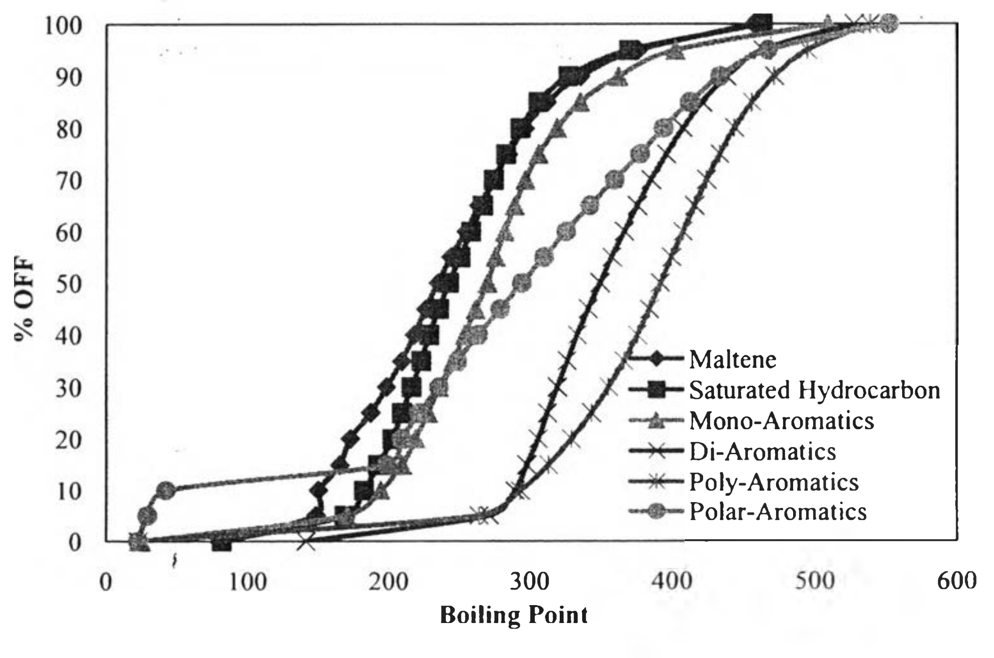

Figure I14 True boiling point distillation (°C) of 0.05Rh0.95Ni /KL.

Table I15 0.25Rh0.75Ni /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	107.9	76.7	24.8	125.3	90.5	22.7
5	145.0	153.1	151.6	257.6	296.3	26.9
10	149.3	170.8	180.4	280.7	320.0	34.7
15	153.6	184.6	196.2	291.4	334.5	162.2
20	168.8	193.0	209.7	298.2	345.3	204.3
25	178.5	203.4	218.8	305.4	354.7	212.0
30	190.8	209.6	227.5	312.7	363.2	221.7
35	202.7	216.6	235.2	319.9	371.1	233.1
40	211.8	223.4	244.5	327.7	378.4	244.5
45	220.6	229.6	252.3	335.7	385.5	254.6
50	228.4	236.5	259.8	344.3	392.4	267.0
55	237.2	243.8	267.1	353.7	399.7	280.6
60	247.1	252.1	273.9	363.6	407.0	294.7
65	256.9	259.6	280.0	373.7	414.7	310.9
70	267.2	268.3	287.9	384.3	422.9	330.6
75	276.8	275.8	296.8	395.8	431.9	353.0
80	287.9	285.5	309.5	408.2	442.2	376.7
85	302.3	298.0	328.6	422.1	454.7	400.0
90	327.1	316.6	357.2	440.6	470.8	424.9
95	371.8	359.7	401.8	469.1	495.7	460.2
100	459.6	462.2	533.0	546.6	545.9	546.2

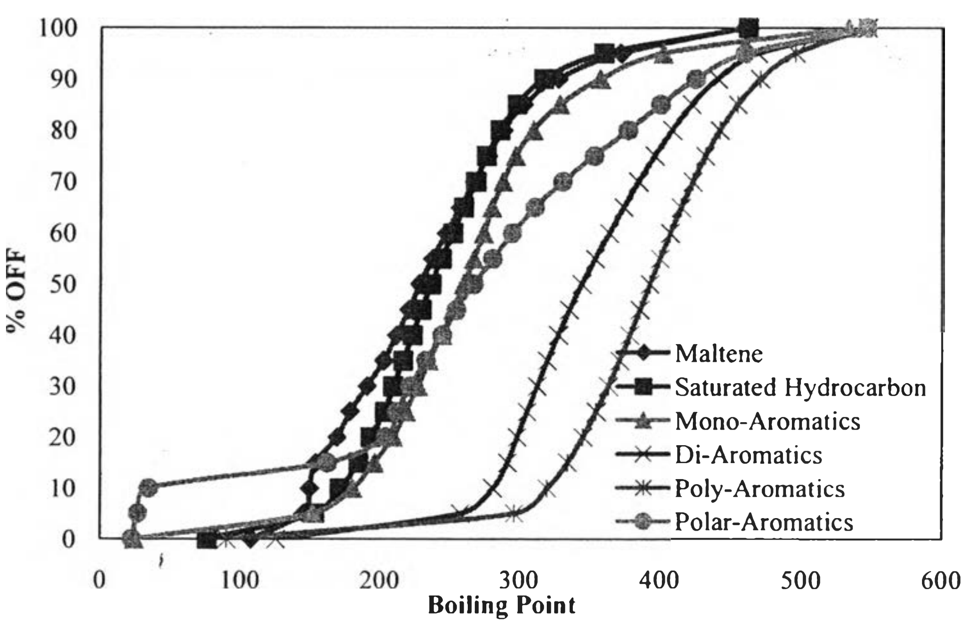

Figure I15 True boiling point distillation (°C) of 0.25Rh0.75Ni /KL.

Table I16 0.50Rh0.50Ni /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	110.4	77.5	23.7	74.9	75.2	74.6
5	147.9	150.2	110.1	291.7	205.4	184.0
10	149.4	166.6	194.6	313.7	262.5	197.9
15	153.7	173.0	209.8	324.2	280.3	200.6
20	168.5	186.2	218.9	332.2	294.8	204.1
25	175.1	193.8	227.2	339.1	306.7	209.5
30	187.7	203.8	234.8	345.8	318.0	216.2
35	197.5	209.8	242.7	352.4	329.3	224.3
40	207.2	216.6	250.9	359.2	340.3	234.3
45	215.3	223.4	258.3	366.1	350.8	243.5
50	222.9	229.1	266.5	373.1	361.1	252.5
55	230.2	236.1	273.9	380.4	371.7	264.3
60	238.1	243.5	280.5	388.2	382.2	276.7
65	247.6	252.3	288.7	396.8	393.2	291.1
70	257.6	260.6	297.2	406.3	404.6	307.0
75	268.9	270.7	307.6	416.5	417.4	326.2
80	279.7	279.8	320.9	427.9	431.7	348.8
85	293.9	292.2	336.8	441.9	449.1	375.1
90	314.0	310.0	362.3	459.7	471.4	405.1
95	349.8	344.4	405.2	486.4	504.0	446.8
100	436.6	477.7	540.4	552.6	570.6	543.0

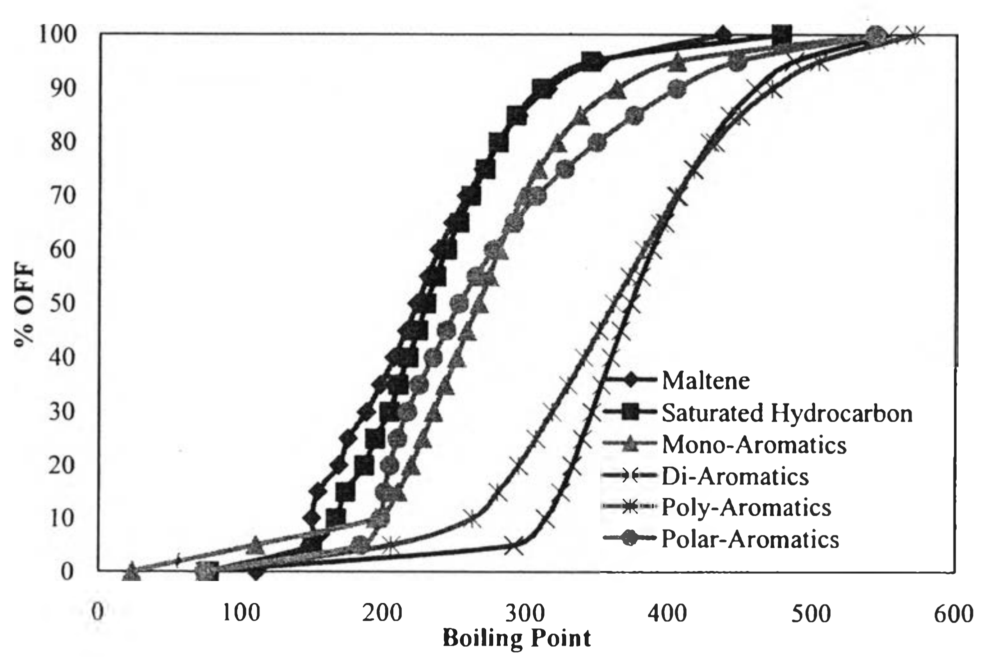

Figure I16 True boiling point distillation (°C) of 0.50Ni 0.50Rh/KL.

Table I17 0.75Rh0.25Ni /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	111.9	76.3	21.2	24.4	22.7	76.8
5	149	149.4	156.7	174.6	25.0	193.6
10	152.6	165.3	186.6	193.8	29.2	202.4
15	168.1	171.8	202.7	205.0	34.5	207.8
20	177.2	185.3	214.2	212.6	41.7	215.2
25	190.1	193.2	223.6	221.3	262.4	223.7
30	201.6	203.0	231.9	229.6	295.3	233.8
35	210.9	211.0	239.9	241.3	314.8	243.0
40	219.5	218.7	249.1	259.0	328.0	251.9
45	227.1	225.1	256.7	284.2	339.1	263.1
50	235.8	233.0	265.1	303.0	349.8	274.8
55	245.0	240.7	272.6	314.4	360.1	287.0
60	254.8	250.0	278.2	325.9	370.6	288.6
65	264.2	258.9	285.5	336.6	380.9	314.1
70	273.9	269.1	292.6	348.9	391.2	330.7
75	283.2	278.0	301.1	360.3	402.8	349.4
80	294.1	288.7	311.8	372.6	416.0	370.3
85	307.7	302.0	326.5	386.0	431.7	393.1
90	328.5	323.4	348.6	402.9	452.7	420.3
95	367.9	367.5	391.3	425.4	486.5	459.4
100	456.2	468.0	531.0	486.8	562.3	548.6

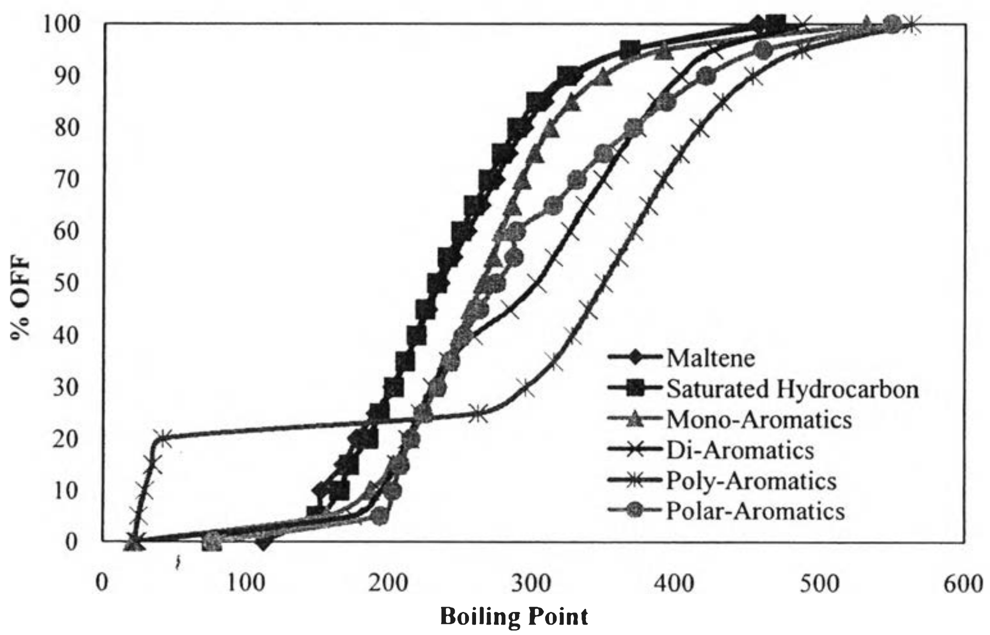

Figure I17 True boiling point distillation (°C) of 0.75Rh0.25Ni /KL.

Table I18 0.05Rh 0.95Co /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	23.7	73.9	24.6	81.0	22.7	22.9
5	113.6	148.9	173.5	216.5	206.1	39.0
10	150.3	166.2	198.2	242.7	227.8	181.6
15	165.7	176.9	212.6	261.8	241.4	196.6
20	174.0	189.9	222.1	278.1	250.3	199.0
25	188.5	200.7	230.6	292.7	260.0	203.7
30	199.9	209.1	238.0	307.2	269.7	212.3
35	210.1	216.6	247.1	321.2	279.1	220.1
40	219.1	223.9	255.1	333.5	288.2	230.5
45	227.1	230.9	262.6	345.0	297.6	239.4
50	236.0	237.8	270.7	354.7	307.9	247.5
55	245.6	246.1	276.9	363.8	319.9	259.3
60	255.9	254.4	284.8	372.2	333.3	272.0
65	266.5	262.4	292.8	380.6	347.8	285.3
70	277.1	271.6	302.6	389.6	363.5	300.9
75	289.2	279.9	315.4	399.9	381.0	320.8
80	304.9	290.7	331.4	411.2	397.6	345.7
85	328.9	304.7	352.3	425.1	415.0	373.8
90	366.8	328.6	379.6	443.5	434.7	403.2
95	422.5	372.4	418.2	471.9	460.8	439.3
100	558.6	474.2	532.1	547.4	509.0	533.6

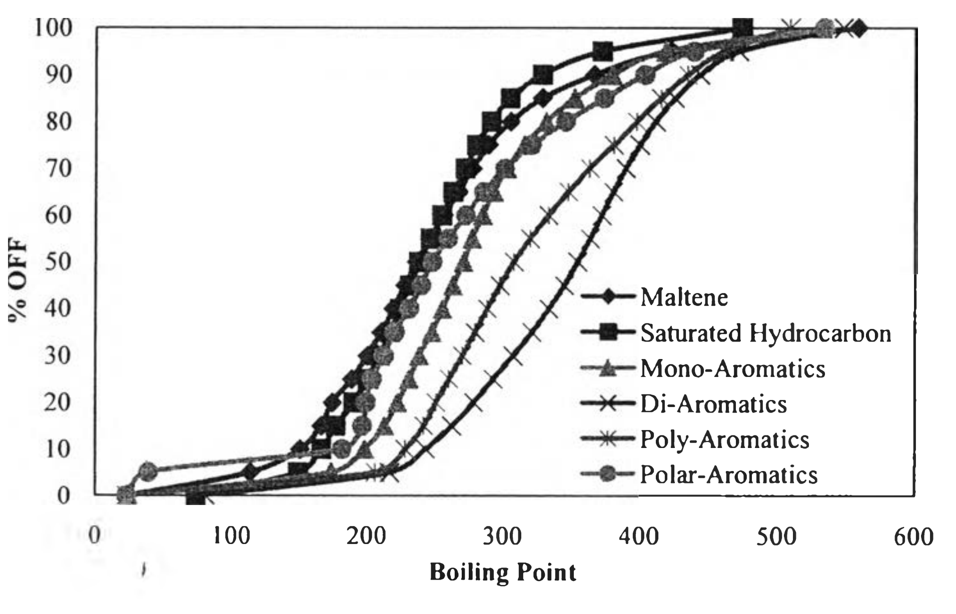

Figure I18 True boiling point distillation (°C) of 0.05Rh0.95Co /KL.

Table I19 0.75Co 0.25Rh/KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	113.9	74.8	25.8	56.9	22.5	22.9
5	152.5	149.9	171.1	276.7	25.6	35.4
10	167.4	168.2	195.1	286.2	30.9	180.7
15	176.1	176.0.	211.6	294.0	38.1	196.6
20	188.1	187.6	221.2	300.5	75.7	198.6
25	197.1	194.9	229.8	307.1	273.2	201.7
30	206.5	204.5	236.7	313.7	303.7	207.8
35	214.2	210.1	246.1	320.7	322.1	216.1
40	221.4	216.4	252.6	328.0	335.5	227.1
45	228.0	223.0	259.8	335.5	347.2	237.7
50	235.7	228.1	266.0	342.9	357.5	246.0
55	243.6	235.1	273.2	351.1	367.4	258.7
60	253.0	242.2	278.3	360.3	376.8	273.1
65	262.4	250.8	285.8	370.3	386.3	288.7
70	273.0	259.4	293.8	380.8	396.2	306.7
75	283.7	269.7	305.2	392.4	407.2	327.8
80	297.4	279.5	320.6	405.5	419.5	352.5
85	316.3	293.1	338.4	420.3	434.5	379.0
90	345.5	314.0	366.4	439.8	454.3	406.9
95	392.1	356.5	403.0	469.7	486.5	443.2
100	501.0.	459.2	515.2	544.6	561.3	538.4

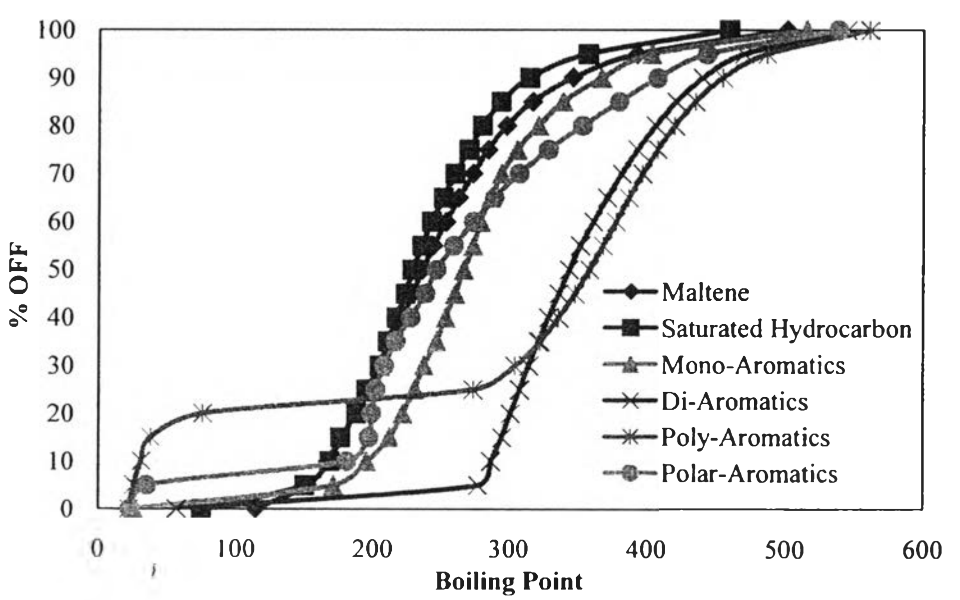

Figure I19 True boiling point distillation (°C) of 0.25Rh0.75Co /KL.

Table I20 0.50Rh0.50Co /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	113.2	76.3	26.9	132.5	22.7	23.7
5	149.9	150.9	153.7	222.9	25.8	172.0
10	158.1	169.1	181.1	253.5	31.1	193.6
15	170.9	179.4	195.5	276.5	38.3	195.2
20	182.4	189.5	210.3	285.5	74.9	196.3
25	193.4	199.2	218.7	292.6	270.5	198.9
30	204.2	207.5	227.8	298.0	300.4	207.2
35	213.0	215.1	234.6	303.1	314.3	214.0
40	221.4	222.0	244.5	308.7	324.8	227.0
45	228.9	228.0	251.4	314.8	334.9	236.7
50	237.2	235.8	258.5	321.7	345.6	241.9
55	246.1	243.2	265.7	329.6	356.1	254.8
60	255.6	252.1	272.9	338.4	367.0	268.6
65	264.8	260.2	277.6	348.5	377.9	282.1
70	274.7	269.5	284.6	360.1	389.3	297.8
75	283.7	277.4	291.6	373.7	401.8	317.2
80	294.9	287.3	300.3	389.1	415.8	340.7
85	309.2	300.0	313.3	407.9	432.2	367.9
90	332.2	317.8	334.2	431.0	453.4	396.5
95	376.6	356.2	376.9	465.6	486.8	432.8
100	488.1	468.8	503.5	546.9	565.9	527.5

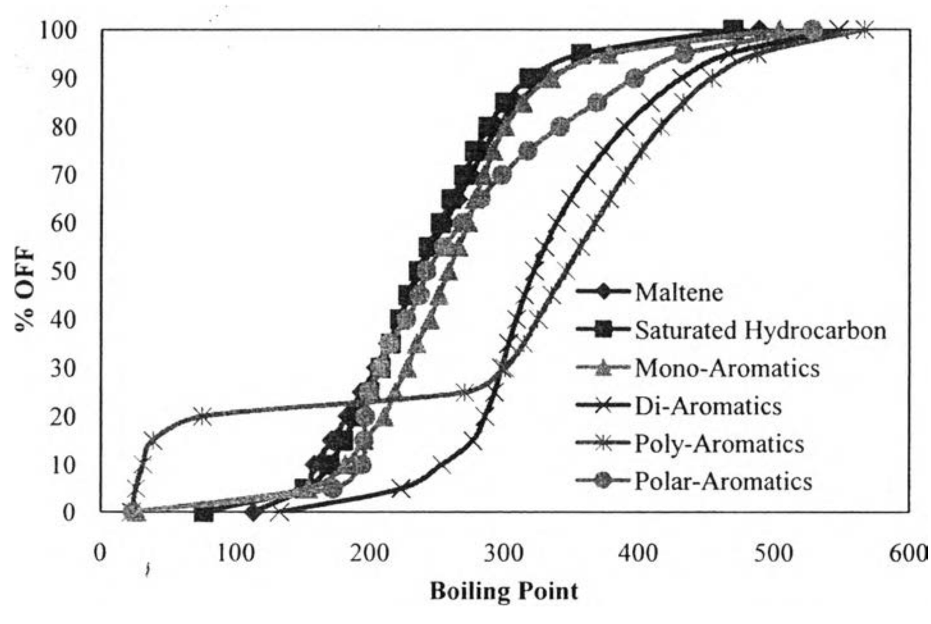

Figure I20 True boiling point distillation (°C) of 0.50Rh0.50Co /KL.

Table I21 0.75Rh0.25Co /KL

% OFF	Boiling Point					
	Maltene	Saturated Hydrocarbon	Mono-Aromatics	Di-Aromatics	Poly-Aromatics	Polar-Aromatics
0	42.6	72.2	150.5	139.8	22.7	23.1
5	149.5	114.6	185.9	215.9	27.3	40.9
10	154.8	151.4	203.8	246.1	35.6	190.6
15	169.5	169.0	215.0	274.7	74.4	197.7
20	180.0	178.0	224.8	288.2	226.0	201.5
25	191.7	188.7	233.3	294.1	265.0	210.1
30	202.7	198.5	242.5	299.4	296.6	218.1
35	211.6	207.2	251.2	305.0	316.6	229.7
40	220.1	215.0	258.8	309.4	329.9	239.2
45	227.6	222.3	266.6	313.7	341.5	247.8
50	236.1	228.9	273.6	319.0	351.7	260.9
55	245.1	236.8	279.2	324.8	361.2	273.8
60	244.9	245.6	286.2	331.6	370.9	286.1
65	264.5	255.2	292.8	339.0	380.1	300.1
70	274.6	264.7	300.0	348.5	389.8	315.9
75	284.5	274.2	307.9	359.6	400.8	334.6
80	296.0	285.1	318.6	373.1	413.3	355.8
85	310.3	298.4	331.6	389.3	428.2	379.8
90	331.0	316.9	350.6	410.7	448.2	405.3
95	366.6	352.2	384.9	443.5	480.1	439.9
100	449.8	452.2	468.2	522.5	556.3	535.7

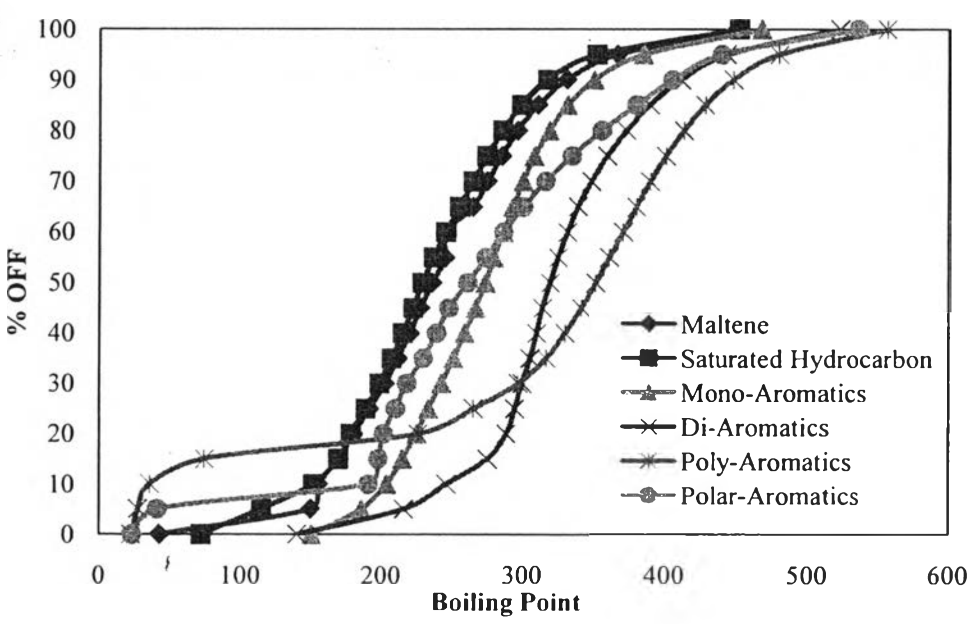

Figure I21 True boiling point distillation (°C) of 0.75Rh0.25Co /KL.

APPENDIX J Carbon Number Distribution of Maltenes

Table J1 Influences of 1%Rh/KL

No. Carbon	Non-Catalst	KL	1% RhKL
4	0.000	0.000	0.013
5	0.001	0.000	0.212
6	0.057	0.042	0.705
7	0.596	0.762	1.939
8	2.432	3.825	4.309
9	5.459	8.769	7.638
10	8.375	12.556	10.848
11	10.093	13.607	12.648
12	10.442	12.530	12.576
13	9.811	10.506	11.123
14	8.679	8.359	9.086
15	7.400	6.470	7.062
16	6.174	4.946	5.336
17	5.090	3.768	3.978
18	4.175	2.878	2.953
19	3.420	2.210	2.196
20	2.808	1.710	1.643
21	2.313	1.334	1.239
22	1.915	1.050	0.942
23	1.594	0.834	0.724
24	1.335	0.668	0.561
25	1.124	0.540	0.439
26	0.952	0.440	0.346
27	0.810	0.361	0.276
28	0.693	0.298	0.221
29	0.596	0.248	0.178
30	0.514	0.207	0.145
31	0.445	0.174	0.118
32	0.387	0.147	0.097
33	0.337	0.124	0.080
34	0.294	0.105	0.066
35	0.257	0.090	0.055
36	0.225	0.076	0.046
37	0.197	0.065	0.038
38	0.172	0.056	0.032
39	0.150	0.047	0.027
40	0.131	0.040	0.022
41	0.113	0.034	0.019
42	0.098	0.029	0.015
43	0.083	0.024	0.013
44	0.070	0.020	0.010
45	0.058	0.017	0.008
46	0.047	0.013	0.007
47	0.036	0.010	0.005
48	0.025	0.007	0.003
49	0.014	0.004	0.002
50	0.003	0.001	0.000

Table J2 Influences of varied Ni loading on KL catalysts

No. Carbon	1%NiKL	5%NiKL	10%NiKL	15%NiKL	20%NiKL
4	0.000	0.153	0.033	0.000	0.053
5	0.000	0.388	0.412	0.000	0.637
6	0.044	0.906	0.932	0.032	1.380
7	0.675	1.920	1.929	0.558	2.710
8	3.207	3.642	3.605	2.852	4.760
9	7.394	6.083	5.989	6.886	7.356
10	10.952	8.817	8.708	10.521	9.886
11	12.405	11.024	10.977	12.177	11.534
12	11.956	11.963	12.025	11.923	11.806
13	10.467	11.478	11.625	10.562	10.827
14	8.662	9.994	10.162	8.820	9.130
15	6.945	8.115	8.253	7.124	7.263
16	5.480	6.294	6.382	5.654	5.567
17	4.295	4.750	4.792	4.453	4.179
18	3.364	3.536	3.544	3.502	3.108
19	2.644	2.620	2.608	2.762	2.307
20	2.089	1.944	1.921	2.189	1.718
21	1.662	1.450	1.422	1.746	1.287
22	1.332	1.089	1.060	1.403	0.972
23	1.075	0.825	0.798	1.135	0.741
24	0.875	0.631	0.605	0.926	0.569
25	0.718	0.486	0.464	0.760	0.442
26	0.593	0.378	0.359	0.629	0.346
27	0.493	0.297	0.280	0.524	0.273
28	0.412	0.235	0.220	0.439	0.217
29	0.347	0.187	0.174	0.370	0.174
30	0.293	0.150	0.139	0.313	0.140
31	0.249	0.121	0.111	0.266	0.113
32	0.212	0.098	0.090	0.227	0.092
33	0.181	0.080	0.073	0.194	0.076
34	0.156	0.065	0.059	0.167	0.062
35	0.134	0.053	0.048	0.144	0.051
36	0.115	0.044	0.039	0.124	0.042
37	0.099	0.036	0.032	0.106	0.035
38	0.085	0.030	0.027	0.092	0.029
39	0.073	0.025	0.022	0.079	0.024
40	0.063	0.020	0.018	0.068	0.020
41	0.054	0.017	0.015	0.058	0.017
42	0.046	0.014	0.012	0.050	0.014
43	0.039	0.011	0.010	0.042	0.011
44	0.032	0.009	0.008	0.035	0.009
45	0.027	0.007	0.006	0.029	0.007
46	0.021	0.006	0.005	0.023	0.006
47	0.016	0.004	0.004	0.018	0.004
48	0.011	0.003	0.003	0.012	0.003
49	0.006	0.002	0.001	0.007	0.002
50	0.001	0.000	0.000	0.001	0.000

Table J3 Influences of varied Co loading on KL catalysts

No. Carbon	1%CoKL	5%CoKL	10%CoKL	15%CoKL	20%CoKL
4	0.011	0.000	0.000	0.000	0.004
5	0.199	0.018	0.001	0.014	0.086
6	0.680	0.199	0.054	0.156	0.346
7	1.842	1.179	0.740	0.839	1.100
8	3.927	3.913	3.301	2.554	2.715
9	6.653	8.081	7.382	5.119	5.225
10	9.183	11.677	10.794	7.624	8.011
11	10.692	13.137	12.185	9.249	10.123
12	10.912	12.527	11.763	9.763	10.978
13	10.116	10.763	10.339	9.392	10.625
14	8.775	8.686	8.600	8.503	9.491
15	7.287	6.767	6.933	7.403	8.035
16	5.891	5.177	5.500	6.290	6.574
17	4.691	3.934	4.333	5.270	5.272
18	3.710	2.988	3.411	4.383	4.184
19	2.929	2.280	2.693	3.635	3.307
20	2.318	1.750	2.137	3.016	2.615
21	1.842	1.355	1.707	2.508	2.075
22	1.472	1.058	1.373	2.094	1.655
23	1.184	0.833	1.113	1.756	1.327
24	0.959	0.662	0.909	1.480	1.072
25	0.782	0.531	0.748	1.254	0.871
26	0.642	0.429	0.620	1.068	0.713
27	0.530	0.349	0.517	0.914	0.587
28	0.441	0.286	0.433	0.786	0.486
29	0.368	0.236	0.366	0.678	0.405
30	0.310	0.196	0.310	0.588	0.339
31	0.261	0.163	0.264	0.511	0.285
32	0.221	0.137	0.225	0.446	0.241
33	0.188	0.115	0.193	0.390	0.204
34	0.160	0.097	0.166	0.341	0.173
35	0.137	0.082	0.143	0.299	0.147
36	0.117	0.069	0.123	0.263	0.126
37	0.100	0.059	0.106	0.230	0.107
38	0.086	0.050	0.092	0.202	0.091
39	0.073	0.042	0.079	0.177	0.078
40	0.063	0.036	0.068	0.154	0.066
41	0.053	0.030	0.058	0.134	0.056
42	0.045	0.026	0.050	0.116	0.048
43	0.038	0.021	0.042	0.099	0.040
44	0.032	0.018	0.035	0.084	0.033
45	0.026	0.014	0.029	0.070	0.027
46	0.021	0.011	0.023	0.056	0.022
47	0.016	0.009	0.018	0.043	0.016
48	0.011	0.006	0.012	0.030	0.011
49	0.006	0.003	0.007	0.017	0.006
50	0.001	0.001	0.001	0.003	0.001

Table J4 Influences of bimetallic catalysts (RhNi/KL)

No. Carbon	0.05Rh0.95Ni	0.25 Rh0.75Ni	0.5Rh0.5Ni	0.75Rh0.25Ni
4	0.019	0.241	0.116	0.140
5	0.263	2.183	1.206	1.343
6	0.694	3.105	2.118	2.090
7	1.606	4.264	3.490	3.122
8	3.219	5.628	5.349	4.457
9	5.516	7.099	7.530	6.044
10	8.052	8.486	9.607	7.719
11	10.077	9.521	11.003	9.189
12	11.003	9.943	11.294	10.104
13	10.743	9.625	10.480	10.209
14	9.634	8.656	8.941	9.499
15	8.132	7.296	7.162	8.214
16	6.593	5.842	5.496	6.697
17	5.215	4.507	4.109	5.230
18	4.069	3.396	3.032	3.970
19	3.157	2.526	2.227	2.966
20	2.448	1.870	1.639	2.200
21	1.903	1.385	1.213	1.630
22	1.488	1.030	0.904	1.212
23	1.170	0.771	0.680	0.906
24	0.927	0.581	0.516	0.682
25	0.739	0.442	0.395	0.518
26	0.594	0.339	0.305	0.396
27	0.481	0.262	0.238	0.306
28	0.391	0.204	0.187	0.238
29	0.321	0.160	0.148	0.186
30	0.264	0.127	0.118	0.147
31	0.219	0.101	0.095	0.116
32	0.182	0.081	0.076	0.093
33	0.152	0.065	0.062	0.074
34	0.127	0.052	0.050	0.060
35	0.107	0.042	0.041	0.048
36	0.090	0.034	0.034	0.039
37	0.075	0.028	0.028	0.032
38	0.064	0.023	0.023	0.026
39	0.054	0.019	0.019	0.021
40	0.045	0.015	0.015	0.017
41	0.038	0.012	0.013	0.014
42	0.032	0.010	0.010	0.011
43	0.026	0.008	0.008	0.009
44	0.022	0.007	0.007	0.007
45	0.018	0.005	0.005	0.006
46	0.014	0.004	0.004	0.005
47	0.010	0.003	0.003	0.003
48	0.007	0.002	0.002	0.002
49	0.004	0.001	0.001	0.001
50	0.001	0.000	0.000	0.000

Table J5 Influences of bimetallic catalysts (RhCo/KL)

No. Carbon	0.05Rh0.95Co	0.25 Rh0.75Co	0.5Rh0.5Co	0.75Rh0.25Co
4	0.010	0.000	0.066	0.002
5	0.165	0.001	0.708	0.047
6	0.512	0.021	1.304	0.214
7	1.344	0.213	2.264	0.777
8	2.946	1.198	3.680	2.184
9	5.336	3.885	5.548	4.716
10	8.012	7.977	7.663	7.910
11	10.130	11.554	9.588	10.611
12	11.069	13.066	10.791	11.873
13	10.782	12.524	10.936	11.587
14	9.652	10.807	10.083	10.271
15	8.148	8.750	8.602	8.540
16	6.621	6.831	6.926	6.825
17	5.258	5.234	5.361	5.331
18	4.125	3.979	4.052	4.117
19	3.219	3.023	3.024	3.167
20	2.513	2.305	2.248	2.440
21	1.967	1.768	1.673	1.887
22	1.548	1.367	1.250	1.469
23	1.226	1.065	0.941	1.152
24	0.977	0.837	0.714	0.910
25	0.785	0.664	0.546	0.724
26	0.635	0.530	0.421	0.581
27	0.517	0.427	0.327	0.469
28	0.423	0.346	0.256	0.382
29	0.349	0.283	0.202	0.312
30	0.289	0.232	0.161	0.257
31	0.240	0.191	0.128	0.213
32	0.201	0.159	0.103	0.177
33	0.169	0.132	0.083	0.147
34	0.142	0.110	0.067	0.123
35	0.120	0.092	0.055	0.103
36	0.101	0.077	0.045	0.087
37	0.086	0.065	0.037	0.073
38	0.072	0.055	0.030	0.062
39	0.061	0.046	0.025	0.052
40	0.052	0.039	0.020	0.044
41	0.044	0.033	0.017	0.037
42	0.037	0.027	0.014	0.031
43	0.031	0.023	0.011	0.026
44	0.025	0.019	0.009	0.021
45	0.021	0.015	0.007	0.017
46	0.016	0.012	0.006	0.013
47	0.012	0.009	0.004	0.010
48	0.009	0.006	0.003	0.007
49	0.005	0.003	0.002	0.004
50	0.001	0.001	0.000	0.001

APPENDIX K Carbon Number Distribution of Mono-aromatics

Table K1 Influences of 1%Rh/KL

No. Carbon	Non-Catalst	KL	1% RhKL
2	0.018	0.000	0.000
3	0.037	0.000	0.000
4	0.072	0.000	0.000
5	0.134	0.000	0.003
6	0.238	0.000	0.027
7	0.402	0.000	0.167
8	0.647	0.000	0.776
9	0.992	0.003	2.589
10	1.448	0.021	6.116
11	2.014	0.131	10.410
12	2.670	0.617	13.404
13	3.373	2.112	13.933
14	4.067	5.190	12.466
15	4.691	9.279	10.123
16	5.191	12.587	7.756
17	5.530	13.732	5.756
18	5.696	12.800	4.210
19	5.696	10.733	3.067
20	5.555	8.420	2.240
21	5.305	6.353	1.646
22	4.980	4.694	1.220
23	4.611	3.437	0.913
24	4.223	2.512	0.690
25	3.835	1.840	0.526
26	3.460	1.355	0.405
27	3.106	1.004	0.315
28	2.778	0.750	0.247
29	2.478	0.564	0.195
30	2.205	0.427	0.155
31	1.959	0.325	0.124
32	1.737	0.249	0.100
33	1.539	0.192	0.081
34	1.361	0.149	0.065
35	1.202	0.116	0.053
36	1.060	0.091	0.043
37	0.932	0.071	0.036
38	0.818	0.056	0.029
39	0.716	0.044	0.024
40	0.624	0.035	0.020
41	0.542	0.028	0.016
42	0.467	0.022	0.013
43	0.399	0.017	0.011
44	0.336	0.014	0.009
45	0.278	0.011	0.007
46	0.223	0.008	0.005
47	0.171	0.006	0.004
48	0.120	0.004	0.003
49	0.068	0.002	0.002
50	0.014	0.000	0.000

Table K2 Influences of varied Ni loading on KL catalysts

No. Carbon	1%NiKL	5%NiKL	10%NiKL	15%NiKL	20%NiKL
2	0.020	0.000	0.000	0.000	0.000
3	0.043	0.000	0.000	0.000	0.000
4	0.091	0.000	0.000	0.000	0.000
5	0.182	0.000	0.000	0.000	0.000
6	0.345	0.002	0.005	0.001	0.000
7	0.625	0.016	0.048	0.034	0.002
8	1.087	0.101	0.295	0.367	0.034
9	1.814	0.504	1.122	1.702	0.361
10	2.909	1.898	2.851	4.364	2.110
11	4.481	5.159	5.251	7.459	6.793
12	6.591	9.984	7.560	9.716	12.963
13	9.144	14.087	9.088	10.587	16.538
14	11.703	15.342	9.608	10.277	16.015
15	13.391	13.840	9.293	9.267	13.071
16	13.290	11.033	8.464	7.978	9.679
17	11.297	8.170	7.408	6.678	6.814
18	8.356	5.815	6.321	5.501	4.692
19	5.580	4.066	5.311	4.495	3.212
20	3.505	2.830	4.425	3.662	2.206
21	2.138	1.976	3.672	2.985	1.528
22	1.295	1.391	3.046	2.441	1.070
23	0.787	0.988	2.530	2.004	0.759
24	0.484	0.710	2.108	1.653	0.545
25	0.302	0.516	1.762	1.371	0.396
26	0.191	0.379	1.479	1.143	0.291
27	0.123	0.281	1.247	0.958	0.216
28	0.080	0.210	1.056	0.808	0.162
29	0.053	0.159	0.898	0.684	0.123
30	0.035	0.121	0.766	0.581	0.094
31	0.024	0.093	0.656	0.496	0.072
32	0.016	0.072	0.564	0.425	0.056
33	0.011	0.056	0.485	0.365	0.043
34	0.008	0.044	0.418	0.314	0.034
35	0.005	0.034	0.361	0.271	0.027
36	0.004	0.027	0.313	0.234	0.021
37	0.003	0.021	0.270	0.202	0.017
38	0.002	0.017	0.234	0.174	0.013
39	0.001	0.014	0.202	0.150	0.011
40	0.001	0.011	0.174	0.129	0.008
41	0.001	0.009	0.149	0.111	0.007
42	0.001	0.007	0.127	0.095	0.005
43	0.000	0.005	0.108	0.080	0.004
44	0.000	0.004	0.090	0.067	0.003
45	0.000	0.003	0.074	0.055	0.003
46	0.000	0.003	0.059	0.044	0.002
47	0.000	0.002	0.045	0.034	0.002
48	0.000	0.001	0.032	0.023	0.001
49	0.000	0.001	0.018	0.013	0.001
50	0.000	0.000	0.004	0.003	0.000

Table K3 Influences of varied Co loading on KL catalysts

No. Carbon	1%CoKL	5%CoKL	10%CoKL	15%CoKL	20%CoKL
2	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000
4	0.000	0.001	0.000	0.000	0.000
5	0.000	0.009	0.000	0.000	0.001
6	0.000	0.066	0.000	0.000	0.005
7	0.000	0.364	0.000	0.000	0.026
8	0.001	1.404	0.006	0.001	0.116
9	0.005	3.781	0.256	0.065	0.442
10	0.021	7.296	2.141	0.734	1.398
11	0.085	10.605	6.647	3.031	3.556
12	0.291	12.350	11.366	6.645	7.092
13	0.842	12.247	13.646	9.816	11.018
14	2.035	10.886	13.317	11.347	13.581
15	4.064	9.019	11.527	11.272	13.822
16	6.701	7.159	9.321	10.199	12.197
17	9.223	5.548	7.263	8.720	9.773
18	10.840	4.251	5.556	7.209	7.376
19	11.197	3.246	4.221	5.848	5.384
20	10.477	2.482	3.206	4.700	3.868
21	9.125	1.907	2.444	3.764	2.765
22	7.565	1.475	1.875	3.017	1.981
23	6.072	1.150	1.449	2.424	1.427
24	4.777	0.903	1.129	1.957	1.037
25	3.715	0.715	0.887	1.588	0.760
26	2.874	0.571	0.702	1.296	0.562
27	2.219	0.459	0.561	1.063	0.420
28	1.715	0.372	0.450	0.877	0.316
29	1.329	0.303	0.364	0.727	0.240
30	1.033	0.248	0.297	0.606	0.184
31	0.806	0.205	0.243	0.507	0.142
32	0.631	0.169	0.200	0.426	0.110
33	0.496	0.141	0.165	0.359	0.086
34	0.392	0.117	0.137	0.303	0.067
35	0.310	0.098	0.113	0.257	0.053
36	0.247	0.082	0.095	0.218	0.042
37	0.196	0.069	0.079	0.185	0.033
38	0.157	0.058	0.066	0.157	0.027
39	0.125	0.049	0.055	0.133	0.021
40	0.101	0.041	0.046	0.113	0.017
41	0.081	0.034	0.038	0.095	0.014
42	0.065	0.029	0.032	0.080	0.011
43	0.051	0.024	0.026	0.067	0.009
44	0.041	0.019	0.022	0.056	0.007
45	0.032	0.016	0.017	0.045	0.005
46	0.025	0.012	0.014	0.036	0.004
47	0.018	0.009	0.010	0.027	0.003
48	0.012	0.006	0.007	0.019	0.002
49	0.007	0.004	0.004	0.011	0.001
50	0.001	0.001	0.001	0.002	0.000

Table K4 Influences of bimetallic catalysts (RhNi/KL)

No. Carbon	0.05Rh0.95Ni	0.25 Rh0.75Ni	0.5Rh0.5Ni	0.75Rh0.25Ni
2	0.001	0.000	0.000	0.007
3	0.004	0.000	0.000	0.018
4	0.014	0.000	0.000	0.047
5	0.041	0.000	0.000	0.112
6	0.115	0.000	0.002	0.253
7	0.295	0.002	0.021	0.537
8	0.697	0.006	0.137	1.074
9	1.508	0.020	0.646	2.012
10	2.958	0.060	2.158	3.513
11	5.172	0.169	5.105	5.644
12	7.925	0.444	8.821	8.206
13	10.511	1.083	11.729	10.616
14	12.045	2.433	12.760	12.080
15	12.069	4.954	12.036	12.092
16	10.818	8.855	10.320	10.795
17	8.918	13.318	8.332	8.799
18	6.941	16.227	6.491	6.722
19	5.213	15.853	4.961	4.928
20	3.839	12.770	3.760	3.532
21	2.803	8.944	2.846	2.506
22	2.045	5.752	2.160	1.775
23	1.496	3.541	1.648	1.262
24	1.101	2.144	1.266	0.904
25	0.817	1.297	0.979	0.653
26	0.611	0.790	0.763	0.476
27	0.461	0.486	0.600	0.350
28	0.350	0.303	0.475	0.260
29	0.268	0.191	0.378	0.194
30	0.207	0.122	0.303	0.147
31	0.161	0.079	0.244	0.111
32	0.126	0.052	0.198	0.085
33	0.099	0.034	0.161	0.066
34	0.078	0.023	0.131	0.051
35	0.062	0.015	0.108	0.040
36	0.049	0.010	0.089	0.031
37	0.039	0.007	0.073	0.024
38	0.031	0.005	0.060	0.019
39	0.025	0.003	0.050	0.015
40	0.020	0.002	0.041	0.012
41	0.016	0.002	0.034	0.009
42	0.013	0.001	0.028	0.007
43	0.010	0.001	0.023	0.006
44	0.008	0.001	0.018	0.005
45	0.007	0.000	0.015	0.004
46	0.005	0.000	0.012	0.003
47	0.004	0.000	0.009	0.002
48	0.003	0.000	0.006	0.001
49	0.001	0.000	0.003	0.001
50	0.000	0.000	0.001	0.000

Table K5 Influences of bimetallic catalysts (RhCo/KL)

No. Carbon	0.05Rh0.95Co	0.25 Rh0.75Co	0.5Rh0.5Co	0.75Rh0.25Co
2	0.000	0.000	0.018	0.014
3	0.000	0.000	0.043	0.034
4	0.000	0.001	0.096	0.076
5	0.000	0.004	0.203	0.161
6	0.002	0.018	0.405	0.324
7	0.022	0.077	0.770	0.621
8	0.153	0.287	1.394	1.131
9	0.717	0.909	2.405	1.958
10	2.305	2.387	3.942	3.216
11	5.194	5.072	6.085	4.972
12	8.604	8.604	8.713	7.154
13	11.144	11.715	11.316	9.431
14	12.018	13.143	13.001	11.207
15	11.396	12.635	12.991	11.876
16	9.917	10.860	11.303	11.222
17	8.172	8.661	8.746	9.577
18	6.516	6.597	6.219	7.542
19	5.102	4.898	4.198	5.614
20	3.961	3.594	2.760	4.036
21	3.069	2.630	1.798	2.848
22	2.382	1.929	1.174	1.996
23	1.856	1.423	0.772	1.399
24	1.455	1.058	0.514	0.986
25	1.148	0.793	0.346	0.700
26	0.912	0.599	0.236	0.501
27	0.729	0.457	0.163	0.362
28	0.587	0.351	0.114	0.264
29	0.475	0.272	0.080	0.194
30	0.387	0.212	0.057	0.144
31	0.316	0.167	0.041	0.108
32	0.260	0.132	0.030	0.081
33	0.215	0.105	0.022	0.061
34	0.178	0.083	0.016	0.047
35	0.148	0.067	0.012	0.036
36	0.123	0.054	0.009	0.028
37	0.102	0.043	0.007	0.021
38	0.085	0.035	0.005	0.017
39	0.071	0.028	0.004	0.013
40	0.060	0.023	0.003	0.010
41	0.050	0.019	0.002	0.008
42	0.041	0.015	0.002	0.006
43	0.034	0.012	0.001	0.005
44	0.028	0.010	0.001	0.004
45	0.022	0.008	0.001	0.003
46	0.018	0.006	0.001	0.002
47	0.013	0.004	0.000	0.002
48	0.009	0.003	0.000	0.001
49	0.005	0.002	0.000	0.001
50	0.001	0.000	0.000	0.000

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1. Pinket, W. and Jitkarnka, S. (2011, April 26) Catalytic Pyrolysis of Waste Tire over Co Supported on KL Zeolite. Poster presented at the 2nd Research Symposium on Petroleum, Petrochemicals, and Advanced Materials and the 17th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Queen Sirikit National Convention Centre, Bangkok, Thailand.