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APPENDICES

Appendix A Pyrolysis Data

Table A1 Non-catalytic pyrolysis 500°C 25 min residence time

1. Sample = 30 g
2. Carbon black = 14.31 g
3. Pyrolysis oils = 12.36 g *Temp 1 = Catalysis zone
4. Pyrolysis gas = 3.33 g **Temp 2 = Pyrolysis zone

Time (min)	*Temp 1	**Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	28.2	27.7	40	403.7	502.2	80	391.8	502.7
2	42.2	35.5	42	405.7	499.6	82	387.9	504.7
4	59.8	46	44	409.3	501.8	84	390.2	501.3
6	65.9	79.7	46	401.2	499.7	86	392.7	501.9
8	85.3	109.6	48	402.3	505.7	88	386.2	503.8
10	117.9	130	50	403.1	499.2	90	390.7	499.7
12	143.2	185.2	52	402.9	502.1	92	387.2	501.1
14	165.2	243.7	54	402.7	495.2	94	384.7	501
16	198.7	272.8	56	402.1	502.7	96	388.2	502.7
18	252.2	364.7	58	402.1	500.3	98	385.7	500.2
20	273.4	425.2	60	401.8	502.2	100	383.1	503.2
22	344.7	486.7	62	401	499.7	102	382.5	501.7
24	378.2	514.7	64	400.2	502.5	104	381.8	501.2
26	389.7	512.2	66	400.1	501.7	106	379.7	498.1
28	394.3	506.7	68	397.6	502	108	381.8	502.7
30	401.9	502.2	70	397.2	499.7	110	377.7	496.9
32	401.7	503.7	72	395.7	502.1	112	380.2	504.3
34	403.2	499.2	74	392.7	502.4	114	377.7	502.2
36	402.9	501.6	76	392.2	503.1			
38	405.7	503.7	78	391.5	500.2			

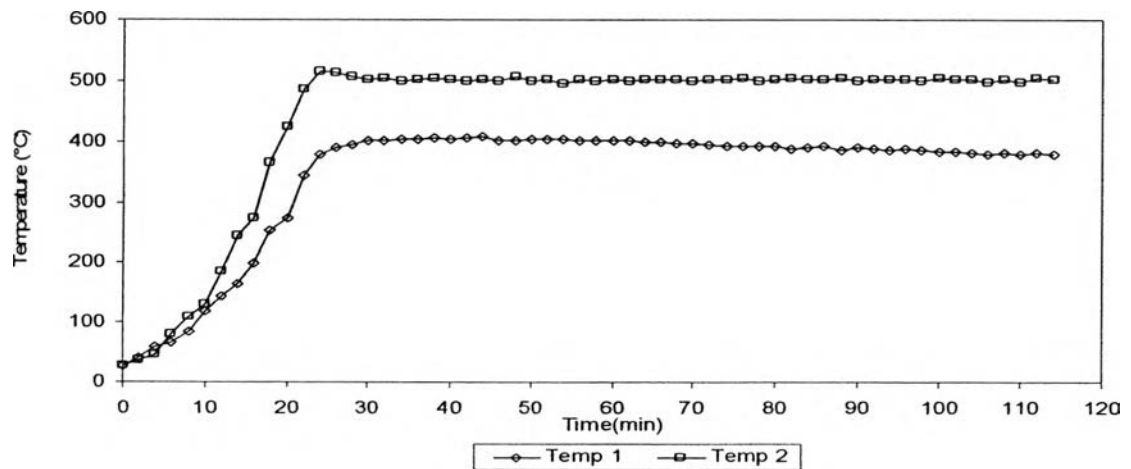


Figure A1 Operating temperature of 500°C 25 min residence time.

Table A2 Non-catalytic pyrolysis 700°C 25 min residence time

1. Sample = 30.06 g
2. Carbon black = 13.87 g
3. Pyrolysis oils = 12.74 g
4. Pyrolysis gas = 3.45 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	27.7	28.2	42	436	696.4	84	462	697.5
2	34.2	35	44	453.8	696.5	86	463.7	700.8
4	65.4	52	46	443.2	703.3	88	463	700
6	87.6	70.6	48	446.1	698.7	90	462.9	695.1
8	118	100.5	50	448.2	691.5	92	463.3	698.3
10	198.1	189.3	52	450.2	674.6	94	463.6	700.6
12	245.9	243.1	54	451.5	710.3	96	463.8	698
14	293.7	306.9	56	451	711.9	98	463.6	696.2
16	317.7	384.7	58	452.7	699.1	100	463.8	700
18	356	447.3	60	454.2	693.9	102	463.7	703.5
20	370.3	472.9	62	455.5	702	104	463.8	699.8
22	385.1	512.6	64	456.4	704.9	106	463.9	694.6
24	410	551.7	66	457.1	690.8	108	463.9	701.3
26	409	607	68	458	702	110	464.1	696.4
28	414	649	70	459	694.6	112	464.5	700
30	418	682.2	72	459.3	699.8	114	464.1	693.8
32	417	702	74	460	701.1	116	463.8	697.6
34	426.3	701.1	76	460.8	703.5	118	464.5	703.2
36	429	675.9	78	461.1	694.2	120	464.3	691.5
38	436	673.6	80	461.5	700.3			
40	431.8	698.3	82	462.2	704.4			

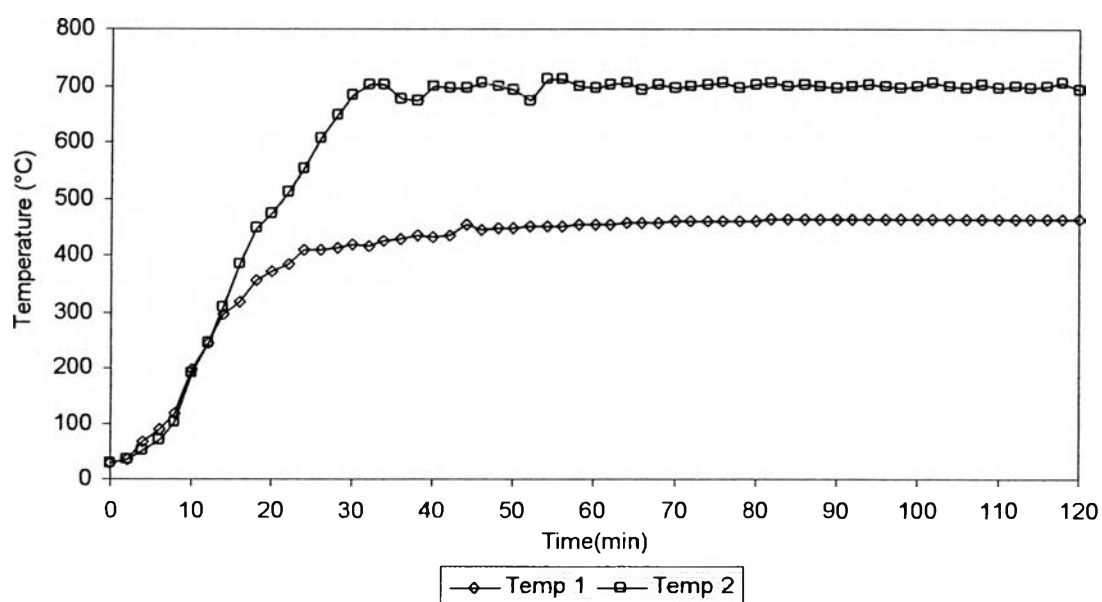
**Figure A2** Operating temperature of 700°C 25 min residence time.

Table A3 Non-catalytic pyrolysis 500°C 50 min residence time

1. Sample = 30.05 g
2. Carbon black = 14.2 g
3. Pyrolysis oils = 12.1 g
4. Pyrolysis gas = 3.75 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	50	64.7	40	408.1	499.6	80	387.9	505.1
2	69.8	84.8	42	411	501.8	82	390	501.3
4	91.3	105.8	44	405.6	499	84	392.6	501.6
6	109.6	124.7	46	408.5	506.1	86	386.2	503.8
8	130	145.1	48	408.8	497	88	390.4	498.8
10	149.9	164.8	50	407	504.5	90	388.6	502.3
12	168.7	183.5	52	404.7	495.2	92	384.2	501
14	198.2	200.6	54	404.3	503.7	94	388.2	506.1
16	225.1	224.3	56	404.9	500.3	96	385.3	500.2
18	274.1	421.8	58	401.8	502.5	98	383	503.2
20	345.3	434.2	60	401	497	100	382.5	500.1
22	381.6	478.3	62	400.7	502.5	102	381.8	507.5
24	392.5	513.9	64	397.2	501.1	104	379.2	498.1
26	394.3	505.9	66	397.6	502	106	381.5	502.1
28	402.1	501.9	68	395.2	499.3	108	377.5	496
30	401.2	505.9	70	395.8	503.1	110	380	506
32	403.6	498.5	72	392.7	502.4	112	376.8	498.8
34	402	501.6	74	391.5	503.1	114	378.8	505
36	407.6	503.9	76	390.1	500.5			
38	407.8	503.2	78	391.8	503.9			

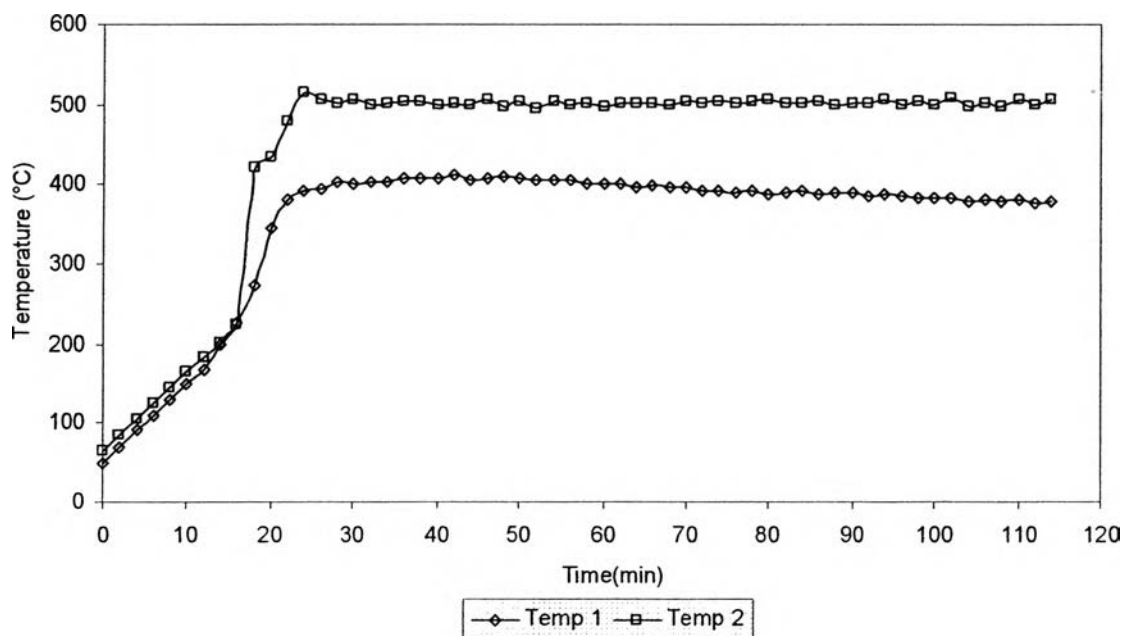
**Figure A3** Operating temperature of 500°C 50 min residence time.

Table A4 Non-catalytic pyrolysis 700°C 50 min residence time

1. Sample = 30.01 g
2. Carbon black = 13.81 g
3. Pyrolysis oils = 12.65 g
4. Pyrolysis gas = 3.55 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	36	44	42	429.1	705.5	84	444.3	704.8
2	40.7	46.4	44	430.9	704.1	86	444.6	701.1
4	53.9	55	46	437.6	698.7	88	444.7	695.8
6	75.7	73	48	442.7	694.3	90	444	697.5
8	103.2	100.9	50	445.2	705.1	92	443.5	702.9
10	136.2	135.8	52	444.1	700.1	94	444.2	702.2
12	173.5	179.7	54	442.5	697.9	96	445	698.2
14	227.3	250.1	56	447.9	696.3	98	444	700
16	262.2	300	58	450.7	699.8	100	444.6	705.3
18	305.2	379.6	60	447	702.8	102	444.4	701.4
20	305.5	404	62	448.5	696.7	104	444.9	696.7
22	385.3	458.1	64	449.5	701.2	106	441.7	704.4
24	396.4	524.3	66	447.5	697.5	108	444.8	697.9
26	400	595.7	68	444.4	697.3	110	443.7	700.4
28	410.5	618.8	70	444.8	697.2	112	442.8	703.3
30	412	663.4	72	444.9	700.3	114	440.3	703.8
32	407.6	706.6	74	444.3	702.3	116	442.2	700.1
34	410.2	696.7	76	444.5	703.5	118	444.8	705.5
36	415.5	698.7	78	445.1	696.1	120	440.8	697
38	413.4	700.8	80	445.3	698	122	440.2	700.1
40	420	697.1	82	444.6	700.1			

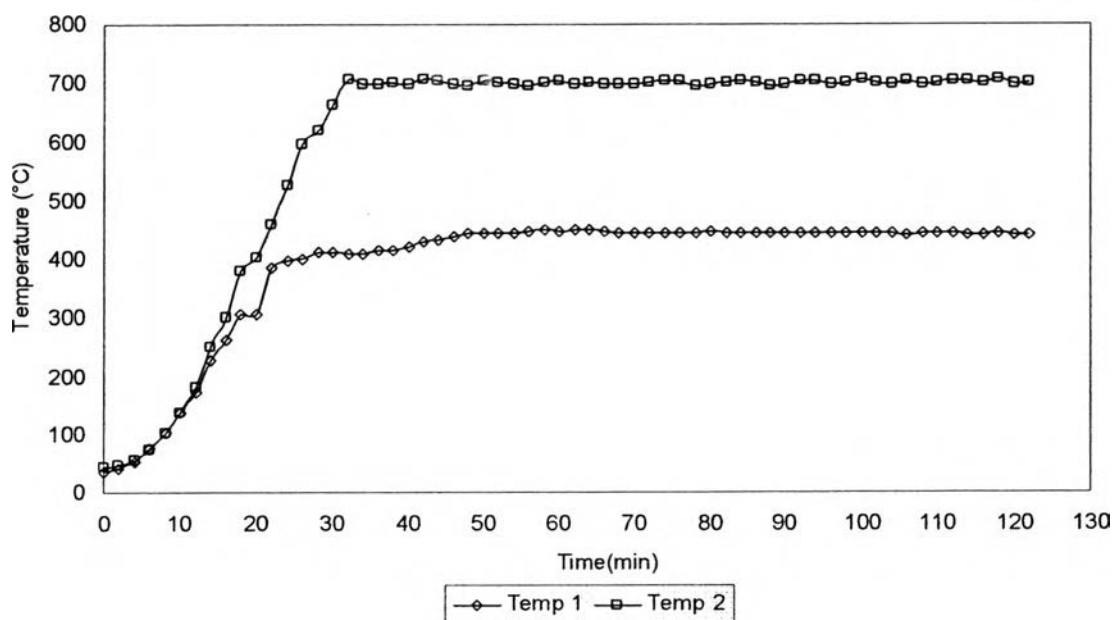
**Figure A4** Operating temperature of 700°C 50 min residence time.

Table A5 Non-catalytic pyrolysis 600°C 50 min residence time

1. Sample = 30.07 g
2. Carbon black = 13.93 g
3. Pyrolysis oils = 12.42 g
4. Pyrolysis gas = 3.72 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	27.5	26	42	395.7	599.4	84	386.1	600.1
2	33.1	28.7	44	397.3	604	86	385.8	599.9
4	53.9	44.9	46	398.8	598.5	88	385	600.2
6	73	61.4	48	398.2	600.1	90	384.6	599.8
8	102.3	91.6	50	398.7	602.9	92	383.6	601
10	138.2	132.2	52	399.7	596.3	94	383.6	605.7
12	179.7	181.5	54	399.5	605.2	96	383.5	600.2
14	227.8	238	56	396.8	605	98	383.6	600
16	276	300.1	58	397.2	600.2	100	383.5	601.3
18	322.5	375.7	60	395.6	596.8	102	382.1	599.9
20	358.5	436.2	62	395.5	603.3	104	380.4	599.3
22	381.2	469.7	64	394.2	598.4	106	381.1	600.2
24	398.6	504.6	66	392.7	605.8	108	380.2	599.7
26	400	550	68	392	601.7	110	380	599.9
28	415.7	538.9	70	391.5	600.2	112	379.7	602.2
30	408.7	614.5	72	390.7	600	114	378.7	605.3
32	400	607.2	74	389.7	599.9	116	377.7	600.2
34	395.8	596.4	76	389	599.4	118	376.7	599.2
36	397	600.1	78	388.2	605.2	120	376.5	598.8
38	397.6	594.7	80	388	605			
40	397.2	601.1	82	387	600.2			

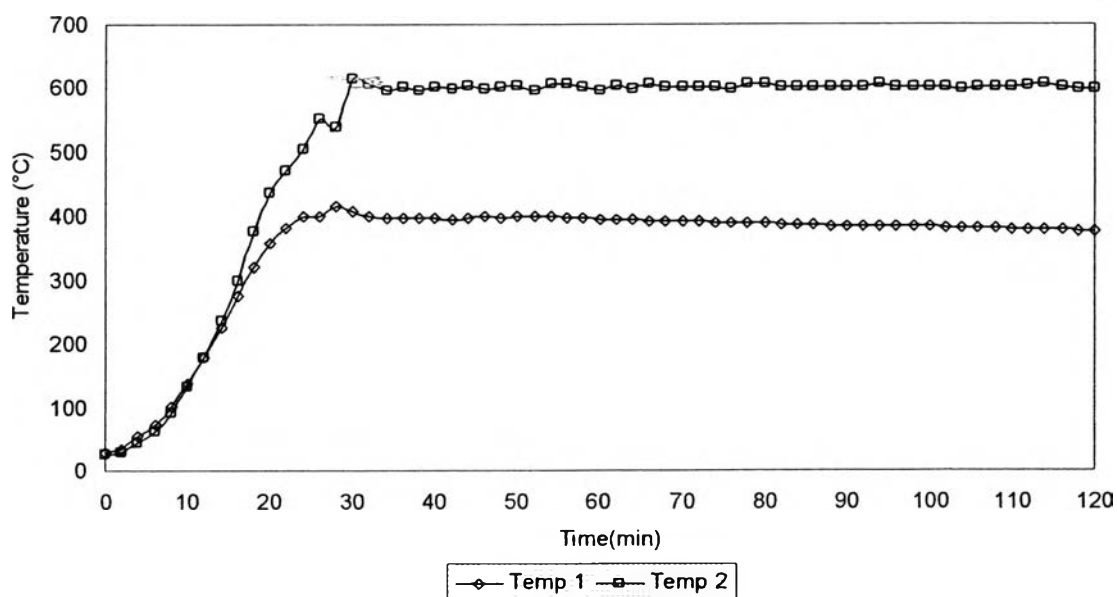
**Figure A5** Operating temperature of 600°C 50 min residence time.

Table A6 Non-catalytic pyrolysis 500°C 75 min residence time

1. Sample = 30.08 g
2. Carbon black = 13.87 g
3. Pyrolysis oils = 12.06 g
4. Pyrolysis gas = 4.15 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.6	26.1	40	400.1	499.9	80	367	497.6
2	31.7	28.2	42	401.1	507.5	82	366.9	499.3
4	48.7	37.7	44	398.1	499.7	84	365.2	500.2
6	73.7	55.6	46	398.3	504.3	86	363.2	501
8	100.7	93.6	48	395.2	499.3	88	360.5	500
10	145.7	122.3	50	394.5	506.9	90	360.2	499.6
12	193.2	170.1	52	390	500	92	359.9	497.8
14	234.6	242.2	54	388.2	507.6	94	359.2	502.2
16	287.6	286.3	56	385.2	502.1	96	359	500
18	331.4	345.5	58	380.2	502	98	358.6	497.5
20	360.3	430.4	60	379.1	506.9	100	355	507.2
22	386.2	480.1	62	375.9	500	102	353.9	497.5
24	399.3	512.9	64	377	502.2	104	352.8	504.9
26	400.1	505.6	66	374.7	504.8	106	348.4	498.1
28	408.6	511.7	68	374.5	499.6	108	350.2	500.2
30	410	507.7	70	370.2	499	110	356.6	499.7
32	409.7	501.2	72	369.8	497.8	112	354.5	505.3
34	406.7	501	74	369.3	507	114	354.4	500.7
36	402.2	500.9	76	368.8	500.4			
38	400	500.6	78	367.4	500.2			

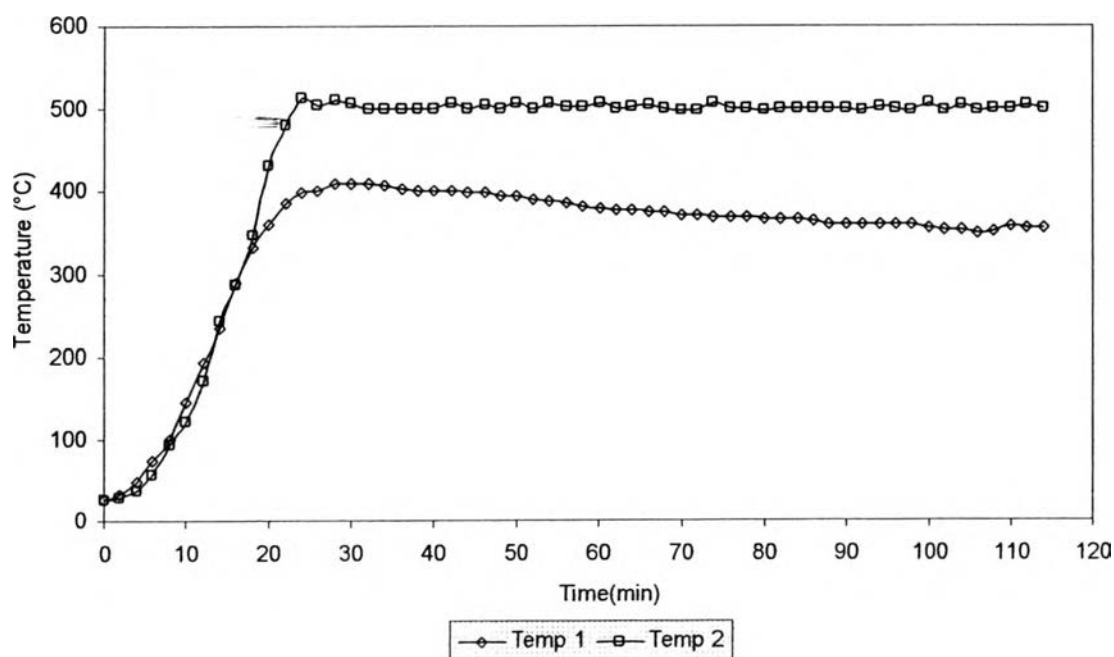
**Figure A6** Operating temperature of 500°C 75 min residence time.

Table A7 Non-catalytic pyrolysis 400°C 50 min residence time

1. Sample = 30.02 g
2. Carbon black = 18.35 g
3. Pyrolysis oils = 8.42 g
4. Pyrolysis gas = 3.25 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	25.5	26.8	38	372.7	405.3	76	370.1	405.6
2	32.3	30.8	40	366.2	399.9	78	353.4	402.2
4	51.9	45.6	42	367.8	402.2	80	355.7	398.2
6	78.4	70.4	44	368.4	401.5	82	355.5	404
8	115.6	107.8	46	364	399.5	84	355	400.9
10	154.8	149.3	48	354.5	406.1	86	354.3	398.4
12	206.2	208.3	50	357.3	406.8	88	353.9	396.7
14	261.5	273.4	52	365	400.6	90	355.3	408
16	298.4	322.8	54	351.7	405.1	92	355	406.2
18	341.1	368.6	56	353.7	403.2	94	354.5	405.3
20	366	432.1	58	356.2	400.1	96	355	399.7
22	375.6	413.9	60	358.6	394.9	98	358.2	404.3
24	378.4	422.4	62	358.1	407.2	100	358	404
26	380	428.4	64	356.9	405.3	102	357.2	403.2
28	394	431.6	66	355.2	404.9	104	356.9	402.9
30	368.4	426.3	68	353.6	405.7	106	356	400.9
32	383.4	420	70	354.2	404	108	355	400.6
34	379.6	414.4	72	352.9	400.2	110	352.5	400.2
36	373.1	410.2	74	352.1	398.2			

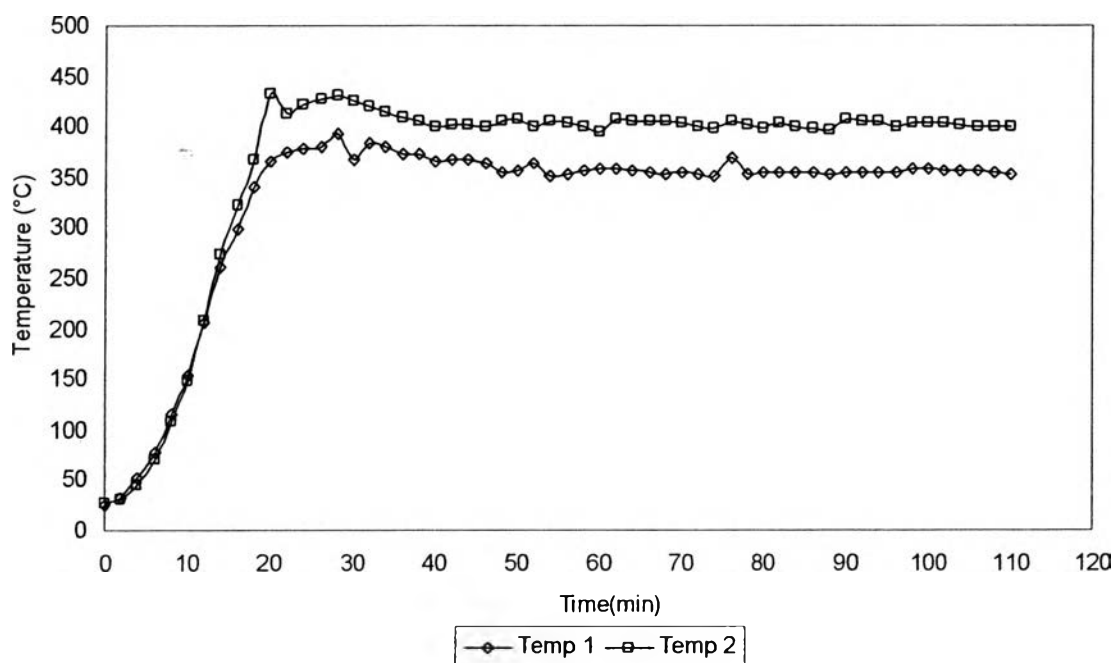
**Figure A7** Operating temperature of 400°C 50 min residence time.

Table A8 Non-catalytic pyrolysis 700°C 75 min residence time

1. Sample = 30.08 g
2. Carbon black = 13.7 g
3. Pyrolysis oils = 12.64 g
4. Pyrolysis gas = 3.74 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	27.2	25.2	42	476.4	700.1	84	481.9	700
2	32.8	27.7	44	479.4	703.8	86	481.7	700.4
4	60.6	48.8	46	486.8	703.1	88	481.4	700.4
6	73.8	61.4	48	486.8	700.2	90	481.4	700.4
8	110.9	101	50	482.9	700.4	92	481.2	700.4
10	143	137.8	52	479.2	701.3	94	480.9	700.2
12	185.8	187.5	54	478.2	700.1	96	480.9	700.2
14	279.6	220.8	56	480.2	700	98	480.7	700.2
16	314	271.8	58	480.9	700.4	100	480.4	700.4
18	372.9	298.9	60	482.5	702.8	102	480.7	700
20	392.8	376.8	62	483.9	699.5	104	480.4	700.2
22	400.2	423.6	64	483.2	701	106	480.2	700.4
24	419.8	491.3	66	482.1	703.1	108	480	700.2
26	429.3	559.2	68	482.2	700.7	110	479.9	700
28	448.1	615.8	70	482.7	702.6	112	479.4	700.4
30	445.1	649.2	72	482.4	701.9	114	477.5	700.2
32	447.3	689.2	74	482.4	700.8	116	476.2	700
34	457.2	698.1	76	482.7	700.4	118	474	700
36	460.2	702.2	78	482.4	700.4	120	473.8	700.2
38	466.3	704.9	80	482.1	700.2	122	472.9	700
40	472.4	704.8	82	481.9	700	124	472.2	700

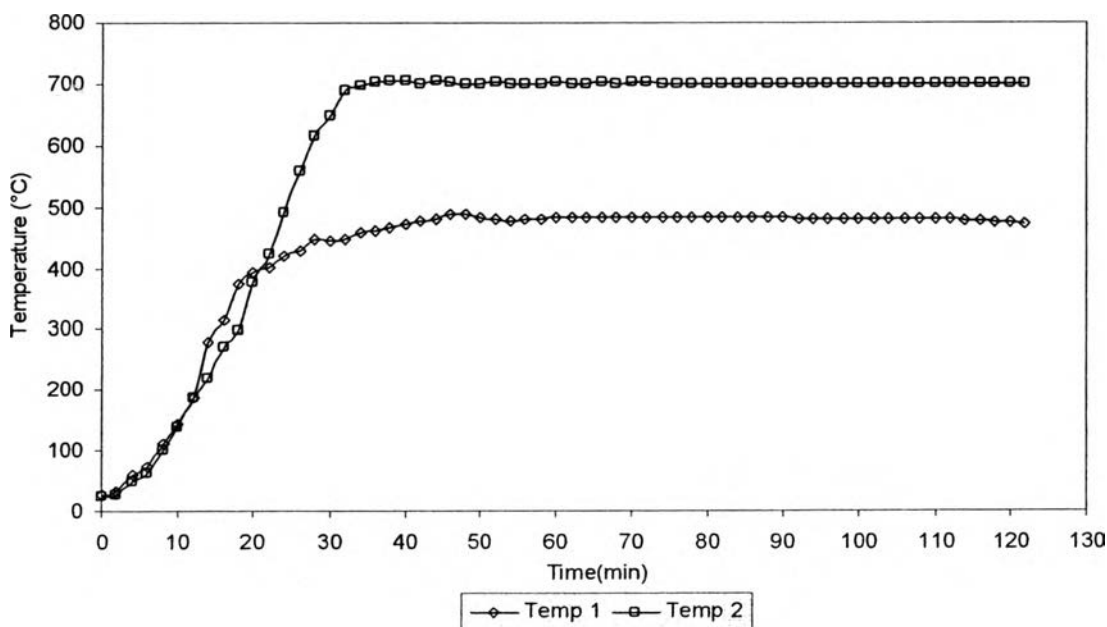
**Figure A8** Operating temperature of 700°C 75 min residence time.

Table A9 Non-catalytic pyrolysis 600°C 25 min residence time

1. Sample = 30.05 g
2. Carbon black = 13.98 g
3. Pyrolysis oils = 12.66 g
4. Pyrolysis gas = 3.41 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.7	21.2	42	385	606.2	84	356.1	601
2	41.7	32.2	44	386.2	604.2	86	356.7	600.7
4	61.1	51.2	46	387.7	599.7	88	356.8	601.2
6	92.7	82.2	48	381.2	598.6	90	355.7	600.2
8	131.3	124.5	50	372.4	600	92	354.2	600.7
10	181.8	179.2	52	373	597.6	94	352.7	600.2
12	223.4	230.1	54	375.2	602.2	96	351.2	599.7
14	272.0	280.1	56	375.2	598	98	350.2	600.2
16	314.8	349.1	58	372	592.7	100	349.1	600
18	339.1	441.2	60	368.2	597.2	102	347	600.2
20	369.2	444.7	62	369.7	601.3	104	344.2	600.2
22	384.2	497.1	64	366.1	599.6	106	346.4	600.2
24	392.2	500.2	66	363.4	600.2	108	343.7	601.8
26	394.2	543.7	68	362.7	599.2	110	340.2	600
28	392.2	587.6	70	360.1	601.7	112	337.2	600.8
30	394.2	608.7	72	359.9	600.2	114	337.8	600.2
32	393.2	603.1	74	358.4	599.4	116	338.2	602.4
34	397.0	606.4	76	360.2	600.5	118	335.7	599.7
36	392.0	592.5	78	360.4	600.7	120	335.2	600
38	390.0	577.7	80	361	602.3			
40	386.2	597.2	82	358.7	601.2			

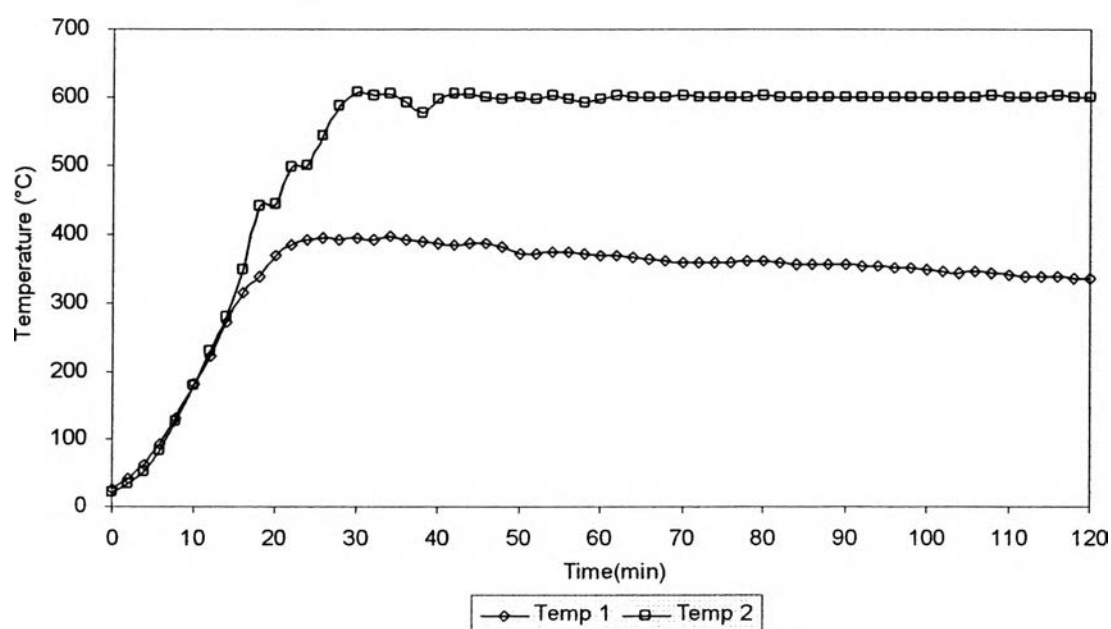
**Figure A9** Operating temperature of 600°C 25 min residence time.

Table A10 Non-catalytic pyrolysis 600°C 75 min residence time

1. Sample = 30.02 g
2. Carbon black = 13.91 g
3. Pyrolysis oils = 12.13 g
4. Pyrolysis gas = 3.98 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	24.3	25.2	42	408.3	560.7	84	408.6	599
2	48.2	39.1	44	405.7	562.7	86	409.7	600.4
4	68.9	53.9	46	409.5	597.4	88	412	599.9
6	98.2	87.9	48	410.2	616.7	90	408.5	600.2
8	136.7	110	50	413.7	632.3	92	408.2	599.6
10	177.2	151.3	52	412.3	630.2	94	407.8	599.7
12	242.2	221.7	54	409.2	608.2	96	410.6	600.4
14	282.2	267	56	408.2	594.6	98	408.2	600.9
16	317.9	287.5	58	409.6	607	100	407.7	599.3
18	327.2	323.6	60	412.2	612.2	102	407.5	600.1
20	354.7	349.3	62	415.5	625	104	407	601
22	378.8	467.3	64	412.2	621.6	106	407.6	600.2
24	386.7	527	66	418.2	628.2	108	408.6	599.9
26	395.1	563.7	68	419.9	620.8	110	408.3	599.5
28	407.1	598.2	70	413.5	605.2	112	411.1	600.9
30	400.0	633.2	72	414.2	599.7	114	408.7	600.1
32	400.7	629.3	74	411.2	596.3	116	407.7	600.2
34	398.2	630.3	76	414.2	599.4	118	406.2	600.2
36	404.2	616.7	78	411.2	592.6	120	405	600.5
38	407.3	592.6	80	413.4	598.1			
40	408.2	575.6	82	411.9	599.1			

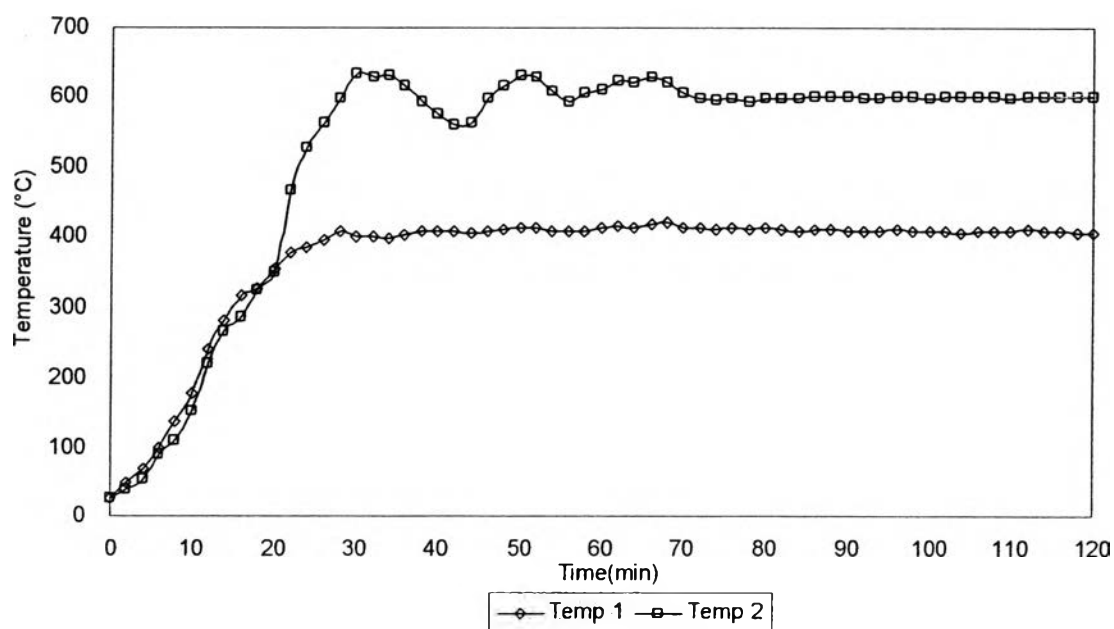
**Figure A10** Operating temperature of 600°C 75 min residence time.

Table A11 HMOR 500°C (Effect of amount of metal loading)

1. Sample = 30 g
2. Carbon black = 14.67 g
3. Pyrolysis oils = 10.4 g
4. Pyrolysis gas = 4.93 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.0	24	40	389	498	80	370	507
2	27.0	29	42	390	505	82	368	501
4	30.0	45	44	390	496	84	367	507
6	38.0	71	46	390	507	86	365	500
8	51.0	109	48	390	502	88	363	494
10	71.0	158	50	389	502	90	362	508
12	100.0	223	52	388	501	92	361	501
14	123.0	280	54	387	494	94	360	506
16	150.0	338	56	386	507	96	358	502
18	188.0	406	58	385	500	98	356	495
20	242.0	444	60	384	507	100	355	507
22	315.0	497	62	382	498	102	354	501
24	352.0	515	64	381	505	104	353	507
26	367.0	507	66	380	501	106	352	502
28	373.0	497	68	378	505	108	350	495
30	378.0	508	70	377	496	110	349	506
32	383.0	502	72	376	507	112	348	506
34	385.0	493	74	374	500	114	347	504
36	387.0	505	76	372	505	116	346	502
38	389.0	504	78	371	500	118	345	496

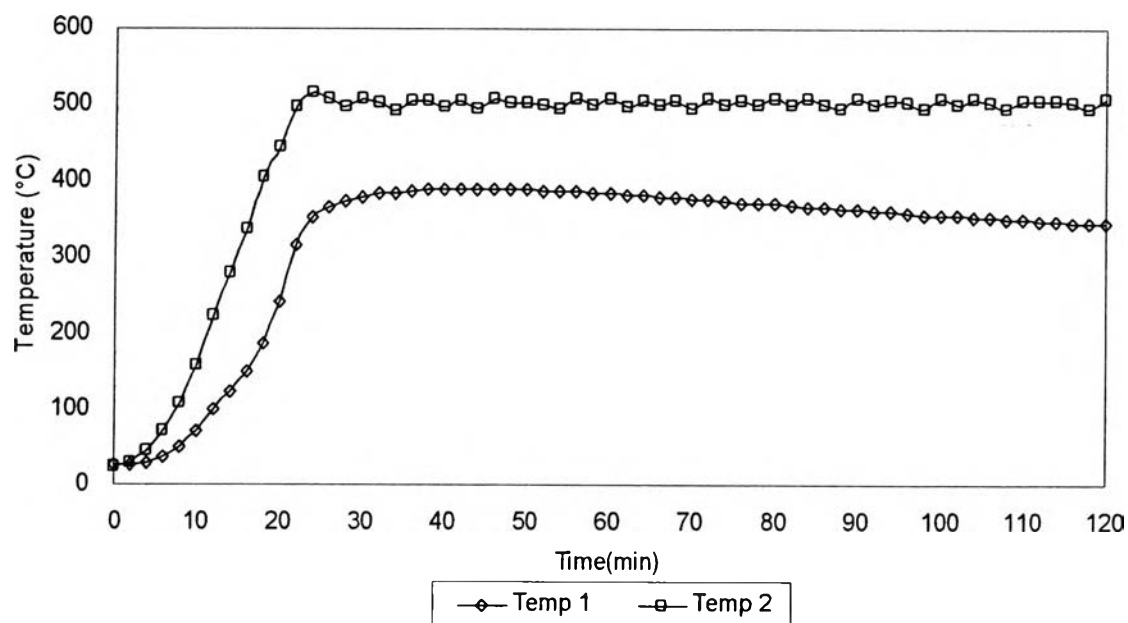
**Figure A11** Catalytic pyrolysis: HMOR temperature of 500°C.

Table A12 1.0%Ru/HMOR 500°C (Effect of catalyst supports)

1. Sample = 30.13 g
2. Carbon black = 14.12 g
3. Pyrolysis oils = 9.83 g
4. Pyrolysis gas = 6.18 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	24.2	22.2	40	349.7	503.3	80	334.9	500
2	25.3	24.9	42	345.2	490.8	82	336.6	500
4	28.9	34.3	44	343.8	497.7	84	350.2	500
6	38.6	55.9	46	342.6	505	86	350.2	500.3
8	58.6	92.9	48	343.7	497.7	88	359.9	500.4
10	82.0	130.6	50	344.3	503.8	90	354.4	499.8
12	114.7	180.2	52	346	495.3	92	349.9	500.2
14	154.7	244.5	54	346.5	499.8	94	340.7	500.8
16	185.0	292.4	56	347.4	500.1	96	337.9	499.4
18	231.2	364.3	58	347.8	498.7	98	336.9	500.8
20	290.6	433.4	60	348.2	499.7	100	335	499.8
22	325.1	485.6	62	349	499.7	102	334.8	500.4
24	326.1	514.2	64	349.1	499.8	104	336.2	500.3
26	325.4	505.8	66	349.3	499.7	106	337.2	500
28	337.8	496.4	68	349.1	499.9	108	336.4	500.4
30	345.8	505.8	70	348.7	500.1	110	337.7	499.7
32	354.0	496.8	72	346.2	500.9	112	338.9	499
34	355.7	490.9	74	345.9	501.2	114	338.2	501.3
36	355.1	503.2	76	342.3	499.7			
38	352.7	500	78	339.9	499.9			

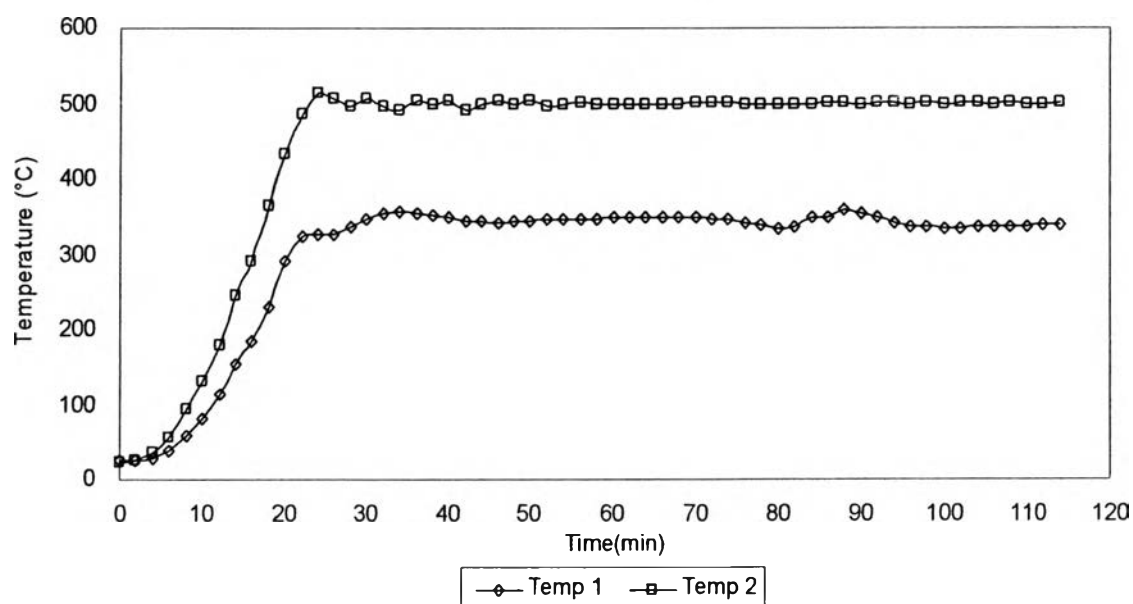
**Figure A12** 1.0%Ru/HMOR temperature of 500°C (Effect of catalyst supports).

Table A13 1.0%Ru/HMOR 500°C (Effect of amount of metal loading)

1. Sample = 30.01 g
2. Carbon black = 14.9 g
3. Pyrolysis oils = 9.22 g
4. Pyrolysis gas = 5.89 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.1	23.3	40	374.7	502.1	80	344	502.2
2	27.8	28.9	42	352.1	503.9	82	344.2	501.8
4	33.4	42.9	44	348.1	499.4	84	344.6	499.9
6	45.3	68.4	46	349.3	506	86	349.7	500.2
8	65.9	118.6	48	349.6	501.2	88	355	501.1
10	89.8	145.1	50	349.9	499.7	90	355.2	499.1
12	120.3	192.7	52	350.5	495.8	92	355.7	498.9
14	149.3	247.6	54	352.3	494.1	94	356.9	498
16	178.3	308.4	56	353.7	500.7	96	355.9	498.6
18	210.5	377.6	58	354.3	499.1	98	352.3	500.2
20	258.6	434.8	60	354.5	499.5	100	343.5	500.7
22	306.1	453.4	62	354.3	499.1	102	345.7	500.1
24	343.2	512.2	64	354.8	499.6	104	349.6	501.2
26	340.9	502.4	66	356.9	499.9	106	351.6	500.4
28	342.3	501.4	68	359.4	499.7	108	349.6	499.5
30	357.5	505	70	363.1	499.4	110	348.2	499.7
32	360.4	499.5	72	362	501.2	112	347.7	499.7
34	345.6	490	74	357	499.3	114	344.1	499.6
36	347.7	503.7	76	351.2	501			
38	351.5	503.2	78	347.4	498.1			

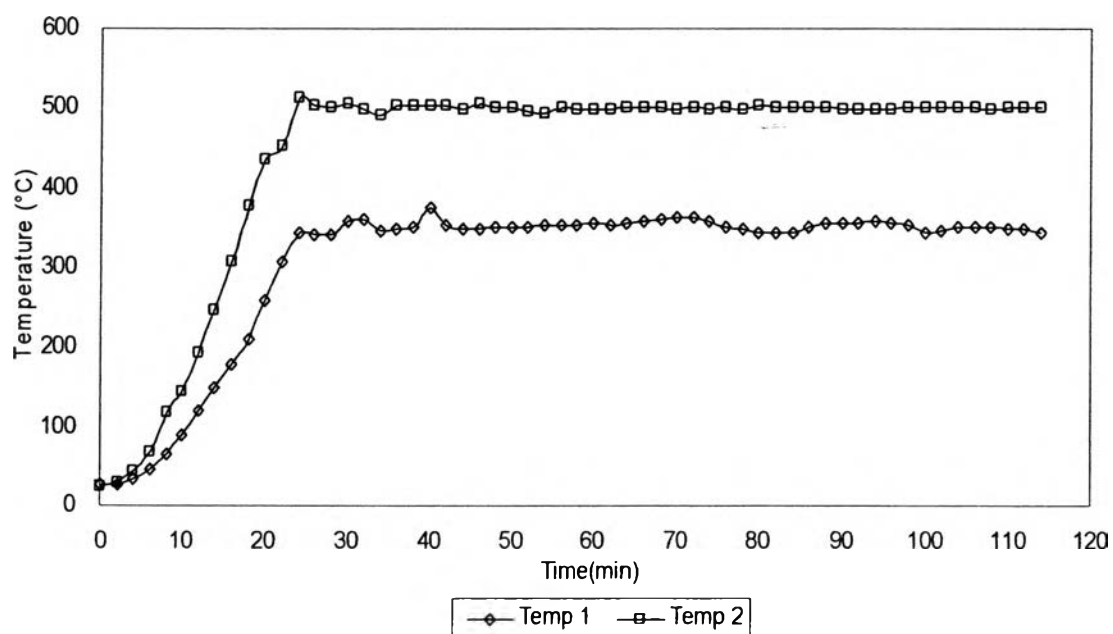
**Figure A13** 1.0%Ru/HMOR temperature of 500°C.

Table A14 0.3%Ru/HMOR 500°C (Effect of amount of metal loading)

1. Sample = 30.05 g
2. Carbon black = 14.37 g
3. Pyrolysis oils = 9.77 g
4. Pyrolysis gas = 5.91 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	27.2	28.3	40	378.8	500	80	349.9	500.9
2	28.5	30.7	42	378.4	504.6	82	351.5	500.7
4	34.1	41.1	44	376.5	492.4	84	352.8	498.3
6	47.2	63.7	46	373.5	499.5	86	348.1	500.4
8	67.1	94.1	48	362.7	502.1	88	344	503.2
10	94.7	135.4	50	351.9	503.7	90	345.5	499
12	126.7	184.9	52	351.7	499.6	92	358.1	501.4
14	163.6	246	54	347	502.8	94	361.1	500.2
16	211.2	325.6	56	343.5	497.7	96	361.1	500
18	247.2	382	58	343.5	500	98	361	499.9
20	309.1	447.8	60	344.7	498.8	100	361.4	499.7
22	334.2	481.7	62	345.8	500.3	102	360.7	501
24	335.7	511.4	64	346.6	499.1	104	359.5	499.2
26	338.1	504.3	66	347	499.4	106	358.7	500.1
28	339.2	500.4	68	347.5	501.2	108	358.1	500.2
30	340.8	508.6	70	347.5	499.4	110	357.1	499.6
32	353.1	507.8	72	348.1	500.7	112	356.4	500.3
34	351.5	504.3	74	347.8	499.5	114	355.7	500
36	361.9	498.8	76	347.6	499.6			
38	373.8	505.5	78	347.4	501.2			

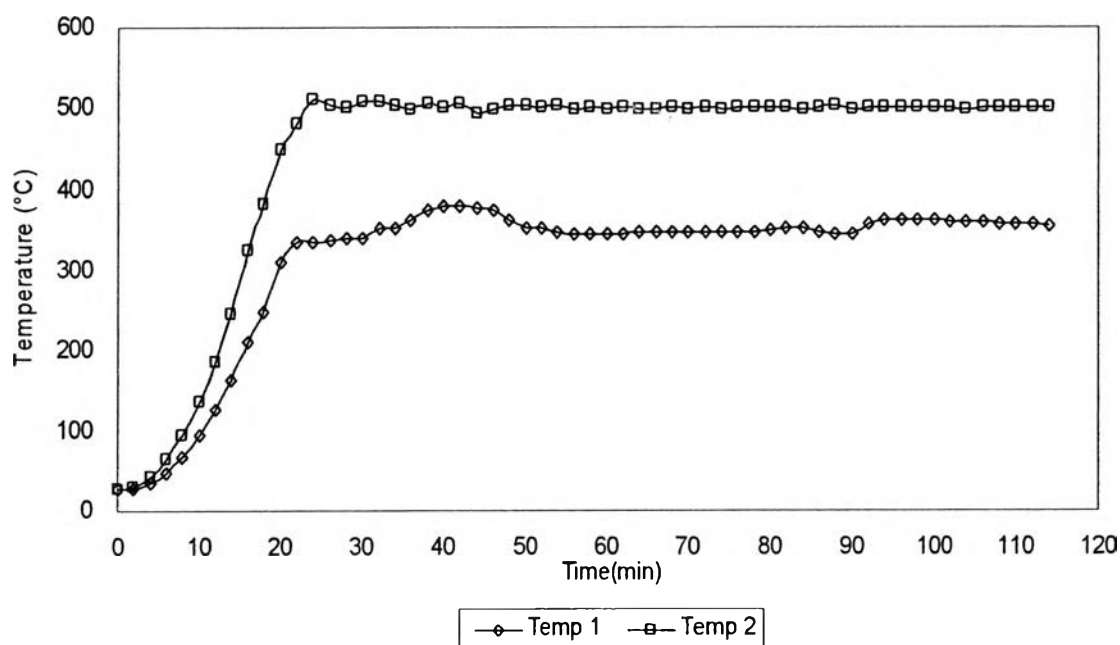
**Figure A14** 0.3%Ru/HMOR temperature of 500°C.

Table A15 1.2%Ru/HMOR 500°C (Effect of amount of metal loading)

1. Sample = 30.09 g
2. Carbon black = 14.4 g
3. Pyrolysis oils = 10.2 g
4. Pyrolysis gas = 5.49 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.4	22.7	40	379.5	503.8	80	343.7	499.2
2	27.3	26.6	42	385.2	504	82	343.2	499.7
4	31.3	38.8	44	392.5	498.1	84	342.5	500.2
6	42.2	62.1	46	386.6	483.1	86	342	499.2
8	61.5	99.1	48	381	474.9	88	341.5	499.5
10	96.0	157.1	50	372.2	498.1	90	340.9	499.7
12	124.1	203.1	52	364.7	497.8	92	340.2	501.9
14	157.0	265.1	54	354.2	502.3	94	341.5	500
16	190.5	330.4	56	344.5	502.2	96	350.6	499.9
18	231.4	406.7	58	338.1	504.4	98	353.2	501.9
20	257.6	458	60	335.2	496.4	100	353.6	501.4
22	274.5	499.5	62	348.7	493.7	102	352.4	499.7
24	281.2	509.5	64	359.6	498.2	104	352.9	500.5
26	321.2	505	66	361.2	498.8	106	355.1	499.9
28	338.1	501	68	358.5	498.3	108	355.4	497.9
30	346.5	498.9	70	354.8	498.9	110	353.6	499.9
32	348.0	506.2	72	349.3	501.7	112	351.8	501.3
34	370.7	499.6	74	346.5	502.9	114	350.9	500.2
36	345.4	490.7	76	345.3	500.2			
38	345.4	499.8	78	344.3	498.2			

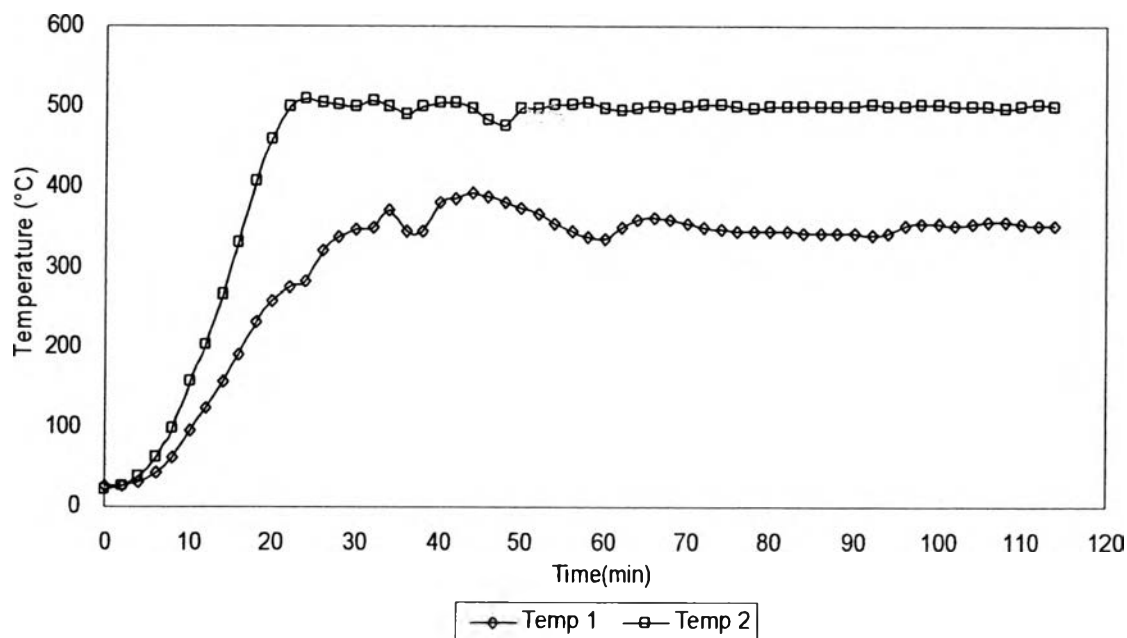
**Figure A15** 1.2%Ru/HMOR temperature of 500°C.

Table A16 0.7%Ru/HMOR 500°C (Effect of amount of metal loading)

1. Sample = 30.02 g
2. Carbon black = 14.35 g
3. Pyrolysis oils = 8.91 g
4. Pyrolysis gas = 6.76 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	26.0	23	40	362	503.7	80	340.1	499.7
2	27.2	25.4	42	359.2	500.2	82	347	501.4
4	32.2	35.7	44	357.4	498.6	84	348.9	501.8
6	45.2	57.7	46	350.8	505.1	86	348.1	498.2
8	64.4	87.5	48	345.7	500	88	347.6	497
10	92.3	128.1	50	343.5	492.2	90	346	498.8
12	129.2	178.2	52	343.5	497.5	92	345.7	501.3
14	163.9	245.8	54	343.2	487.8	94	344.4	501.4
16	193.0	307.9	56	343	493.2	96	344	500.4
18	230.6	381.3	58	342.9	496.6	98	342.8	500.7
20	302.1	452.4	60	342.1	499.1	100	342.5	500.8
22	338.0	492.1	62	342.3	501.8	102	342.4	500.1
24	322.4	511.2	64	341.9	503.1	104	341.9	500.2
26	328.1	504	66	341.5	502.3	106	341	500.1
28	339.9	501.9	68	340.8	501.8	108	340.2	500.1
30	349.4	502.7	70	341	500.2	110	339.3	499.7
32	355.1	495.8	72	339.9	500.7	112	338.3	501.1
34	359.5	506.3	74	340.1	499.7	114	338.1	499.7
36	364.8	503.1	76	339.3	499.6			
38	359.4	499.5	78	338.4	500.7			

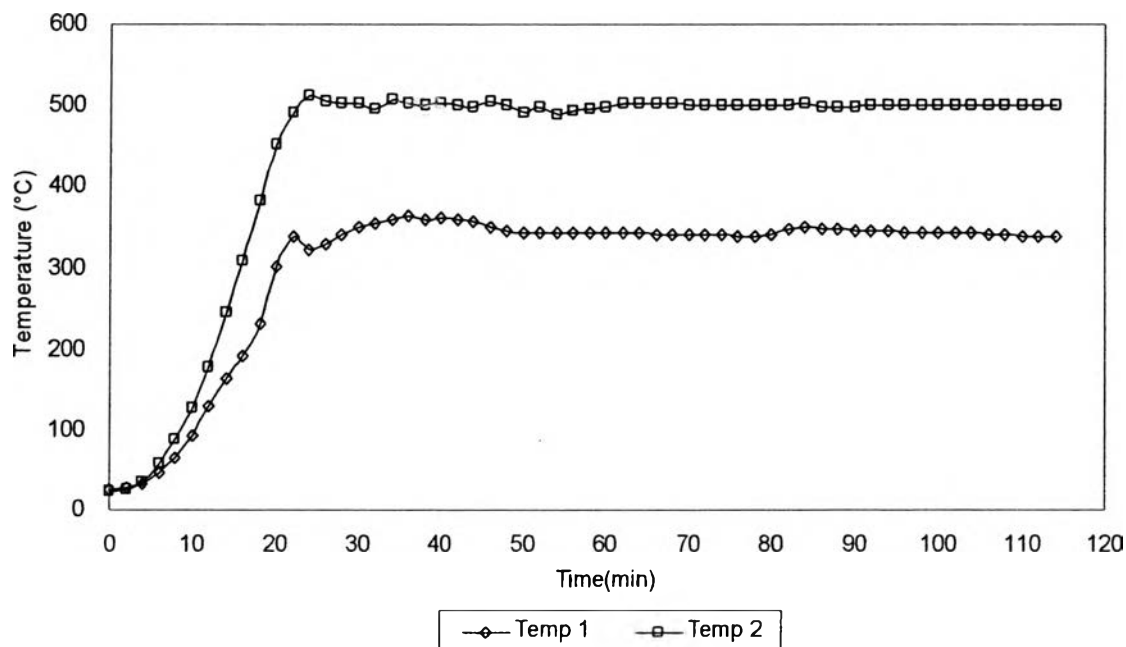
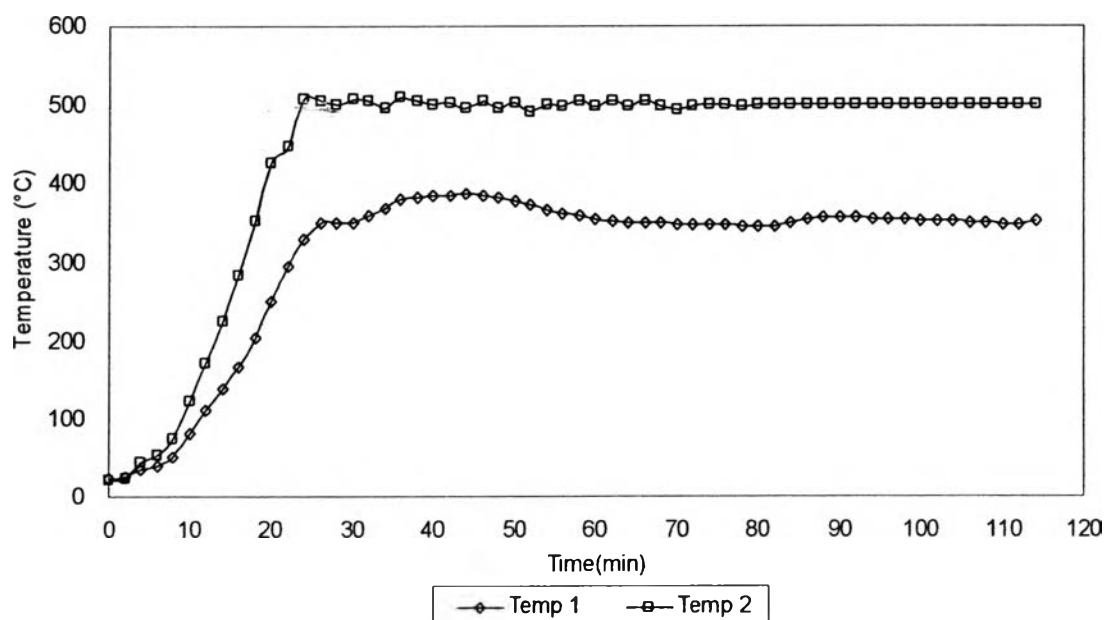
**Figure A16** 0.7%Ru/HMOR temperature of 500°C.

Table A17 1.0%Ru/HZSM5 500°C (Effect of catalyst supports)

1. Sample = 30.07 g
2. Carbon black = 15.22 g
3. Pyrolysis oils = 8.65 g
4. Pyrolysis gas = 6.2 g

Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2	Time (min)	Temp 1	Temp 2
0	23.5	20.5	40	384	499.4	80	345.6	500.4
2	25.2	24.3	42	385.7	503.7	82	344.4	500
4	35.5	43.6	44	385.9	496.7	84	348.7	499.9
6	40.2	54	46	383.4	505.1	86	354.7	501.5
8	51.8	73.5	48	381.5	495.5	88	356.1	499.8
10	81.4	122.8	50	378.2	503.1	90	355.8	500
12	110.7	171	52	373.8	491.7	92	356	500.8
14	138.3	223.9	54	366.8	500.5	94	355.4	499.7
16	167.6	282.3	56	362.2	498.7	96	354.7	499.7
18	202.9	353.2	58	358	505.2	98	353.8	500.2
20	250.3	426.3	60	354.3	498	100	352.8	500
22	295.3	448.2	62	352.5	506	102	352.3	499.3
24	330.1	507.7	64	350.1	497.2	104	351.5	500.7
26	349.4	504.5	66	350.5	506	106	349.9	499.9
28	348.8	500.2	68	349.4	499.2	108	349.2	499.8
30	350.0	506.5	70	348.6	493.2	110	347.8	499.8
32	359.4	503.9	72	347.8	498.7	112	347.3	500.6
34	368.1	496.6	74	348.1	500.7	114	352.7	500.7
36	380.1	508.6	76	347.1	499.7			
38	383.0	504.8	78	346.2	499			

**Figure A17** 1.0%Ru/HZSM5 temperature of 500°C (Effect of catalyst supports).

Appendix B Products Distribution

Table B1 Yields of pyrolysis products at various temperatures and residence time

Temperature	Gas yield (%wt)	Liquid yield (%wt)	Char yield (%wt)	G/L ratio
25 min residence time				
500°C	11.10	41.20	47.70	0.269
600°C	11.35	42.13	46.52	0.269
700°C	11.48	42.38	46.14	0.271
50 min residence time				
400°C	10.83	28.05	61.13	0.386
500°C	12.48	40.27	47.25	0.310
600°C	12.37	41.30	46.33	0.300
700°C	11.83	42.15	46.02	0.281
75 min residence time				
500°C	13.80	40.09	46.11	0.344
600°C	13.26	40.41	46.34	0.328
700°C	12.43	42.02	45.55	0.296

Table B2 Yields of pyrolysis products at different amounts of metal loading

Metal loading	Gas yield (%wt)	Liquid yield (%wt)	Char yield (%wt)	G/L ratio
Effects of Catalyst Supports				
1.0% Ru/MOR	20.51	32.63	46.86	0.629
1.0% Ru/ZSM5	20.62	28.77	50.62	0.717
Effects of Amount of Metal Loading				
HMOR	16.43	34.67	48.90	0.474
0.3% Ru/MOR	19.67	32.51	47.82	0.605
0.7% Ru/MOR	22.52	29.68	47.80	0.759
1.0% Ru/MOR	19.63	30.72	49.65	0.639
1.2% Ru/MOR	18.25	33.90	47.86	0.538

Table B3 Product distribution (Non-catalytic pyrolysis), g/100 g of tires

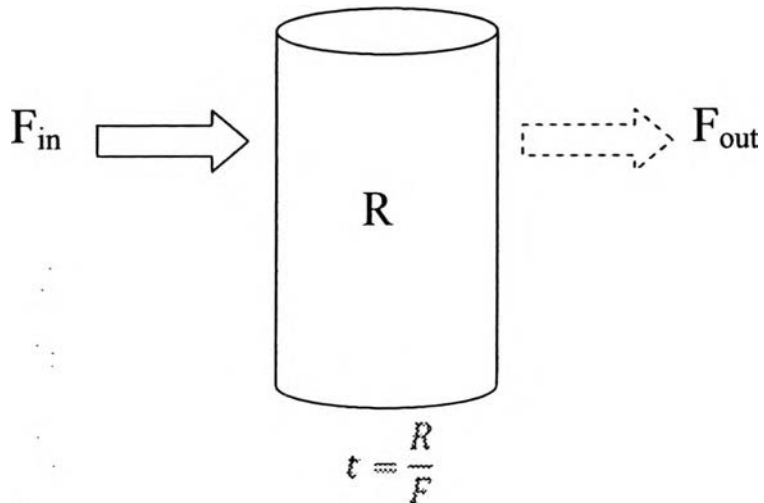
Products distribution, %wt	400°C 50min	500°C 25min	500°C 50min	500°C 75min	600°C 25min	600°C 50min	600°C 75min	700°C 25min	700°C 50min	700°C 75min
Light gas products										
Methane	1.24	1.80	2.40	2.46	2.40	2.60	2.95	2.64	2.83	3.00
Ethane	1.47	1.61	1.98	2.22	1.69	1.94	2.01	1.45	1.61	1.94
Ethylene	0.64	0.88	1.12	1.31	1.23	1.41	1.45	1.14	1.23	1.43
Propylene	0.85	1.06	1.23	1.41	1.28	1.43	1.50	1.08	1.24	1.45
Cooking gas	4.32	3.26	3.64	4.20	2.74	3.42	3.21	2.77	2.96	3.22
Mixed-C5	1.32	1.56	1.29	1.45	1.20	1.02	1.37	1.24	1.15	0.89
C6-C8	0.97	0.93	0.83	0.74	0.81	0.55	0.77	1.14	0.81	0.50
Total	10.83	11.10	12.48	13.80	11.35	12.37	13.26	11.48	11.83	12.43
Petroleum products										
Gasoline	2.06	4.23	2.76	1.85	2.55	2.42	2.48	4.09	2.65	1.51
Kerosene	11.89	14.02	12.88	11.81	13.31	10.26	11.83	14.35	12.03	9.55
Gas oil	9.53	14.19	14.04	14.21	14.81	15.13	14.21	15.64	15.36	14.98
Light vacuum gas oil	1.51	2.65	2.90	3.14	3.09	3.50	3.10	2.88	3.29	3.74
Heavy vacuum gas oil	3.01	6.03	7.62	9.00	8.23	9.85	8.62	5.39	8.75	12.12
Total	28.02	41.12	40.19	40.01	41.99	41.17	40.25	42.35	42.08	41.91
Residual										
Asphaltene	0.0320	0.0848	0.0744	0.0863	0.1424	0.1383	0.1569	0.0321	0.0776	0.1141
Carbon black	61.13	47.70	47.25	46.14	46.52	46.33	46.34	46.14	46.02	45.55
Total	61.16	47.78	47.33	46.23	46.66	46.47	46.49	46.17	46.10	45.66

Table B4 Product distribution (Catalytic pyrolysis), g/100 g of tires

Products distribution, %wt	HMOR	0.3%Ru/MOR	0.7%Ru/MOR	1.0%Ru/MOR	1.2%Ru/MOR	Ru/MOR*	Ru/ZSM5*
Light gas products							
Methane	2.48	3.23	3.88	3.70	2.71	3.48	3.27
Ethane	2.31	2.93	3.37	3.16	2.48	3.38	2.84
Ethylene	0.68	0.98	1.03	1.01	0.88	1.15	1.11
Propylene	1.07	1.57	1.67	1.56	1.36	1.68	1.61
Cooking gas	6.14	6.69	7.76	6.38	5.07	7.39	8.95
Mixed-C5	2.50	2.34	2.63	2.15	2.47	2.03	1.70
C6-C8	1.24	1.93	2.19	1.68	3.28	1.39	1.14
Total	16.43	19.67	22.52	19.63	18.25	20.51	20.62
Petroleum products							
Gasoline	6.89	3.15	3.07	3.44	3.75	3.56	2.94
Kerosene	16.25	16.55	16.70	16.94	14.60	15.90	16.39
Gas oil	10.09	10.79	7.98	8.92	12.84	11.92	8.13
Light vacuum gas oil	0.77	0.95	0.82	0.70	1.33	0.74	0.63
Heavy vacuum gas oil	0.65	1.05	1.10	0.72	1.37	0.51	0.66
Total	34.65	32.50	29.67	30.72	33.89	32.62	28.76
Residual							
Asphaltene	0.0187	0.0132	0.0064	0.0031	0.0059	0.0006	0.0068
Carbon black	48.90	47.82	47.80	49.65	47.86	46.86	50.62
Total	48.92	47.83	47.81	49.65	47.86	46.86	50.62

Appendix C Residence time calculations

The calculation of residence time used in this thesis is show in following figure.



Assumption

$$F_{in} = F_{out}$$

R = constant (steady state)

Reactor volume = 750 ml

Carrier gas flow rate = 10, 15, 30 ml/min

Residence time (t) = 75, 50, 25 min

Sample of calculation

For carrier gas flow rate = 15 ml/min

Residence time = $750/15$ (ml/ml·min⁻¹)

= 50 min

Appendix D Correlation Factor of Light Hydrocarbons using GC/FID

Components	Factor
Methane	1
Ethylene	0.946536
Ethane	1.009963
Propylene	0.973512
Propane	0.989204
C4	0.982421
C5	0.984112
C6	0.939427
C7	0.918044
C8	0.968731

$$\% \text{wt of Gas}_i = \frac{\text{Area of Gas}_i \text{ (from GC)} \times \text{Factor}_i}{\sum (\text{Area} \times \text{Factor})} \times 100$$

Appendix E Pyrolysis Gas Compositions

Table E1 Effect of residence time at 500°C

residence time (min)	25	50	75
Composition (%wt)			
Methane	16.173	19.205	17.850
Ethylene	7.940	8.937	9.487
Ethane	14.537	15.864	16.103
Propylene	9.539	9.888	10.239
Propane	8.117	8.083	8.192
C4	21.219	21.093	22.255
C5	14.076	10.303	10.491
C6	6.628	5.221	4.589
C7	0.995	0.722	0.452
C8	0.776	0.683	0.342

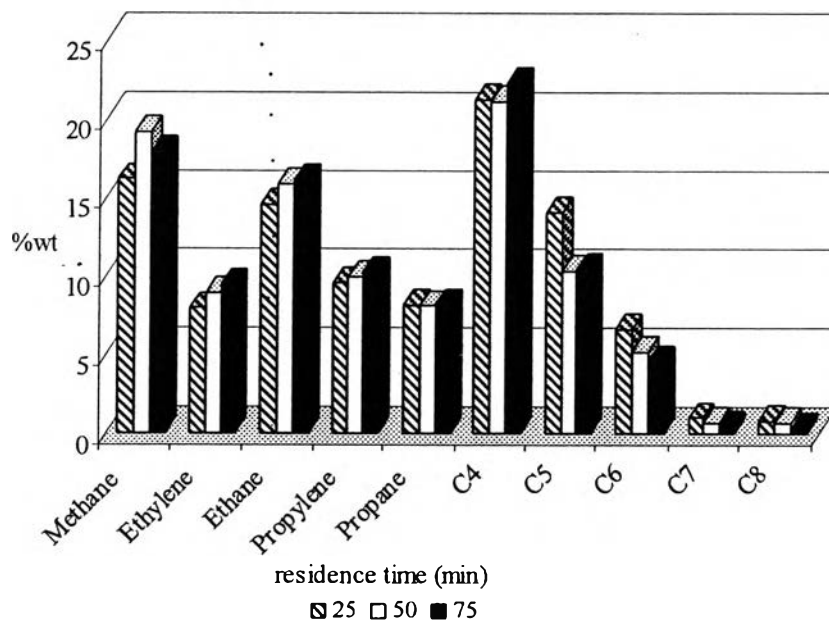


Figure E1 Pyrolysis gas composition obtained at 500°C for various residence time.

Table E2 Effect of residence time at 600°C

residence time (min)	25	50	75
Composition (%wt)			
Methane	21.180	20.995	22.269
Ethylene	10.796	11.366	10.911
Ethane	14.902	15.715	15.178
Propylene	11.256	11.561	11.313
Propane	6.498	6.947	6.571
C4	17.620	20.702	17.641
C5	10.608	8.238	10.308
C6	5.181	3.638	4.266
C7	0.668	0.383	0.501
C8	1.290	0.456	1.041

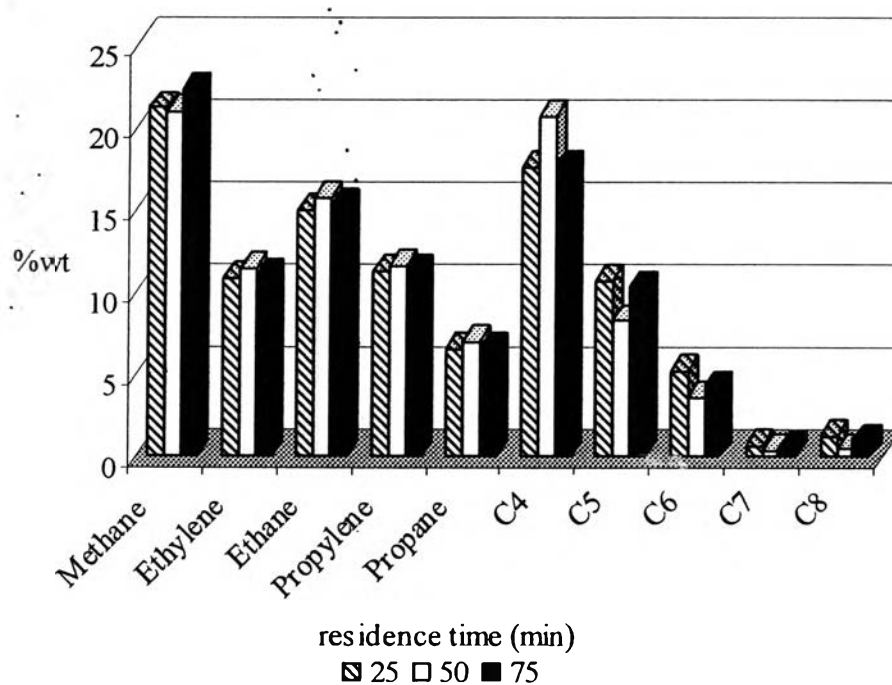
**Figure E2** Pyrolysis gas composition obtained at 600°C for various residence time.

Table E3 Effect of residence time at 700°C

residence time (min)	25	50	75
Composition (%wt)			
Methane	23.041	23.957	24.153
Ethylene	9.975	10.379	11.511
Ethane	12.675	13.571	15.631
Propylene	9.435	10.506	11.669
Propane	5.873	5.804	6.670
C4	18.282	19.252	19.218
C5	10.804	9.699	7.139
C6	7.334	5.375	3.073
C7	1.117	0.653	0.373
C8	1.463	0.805	0.563

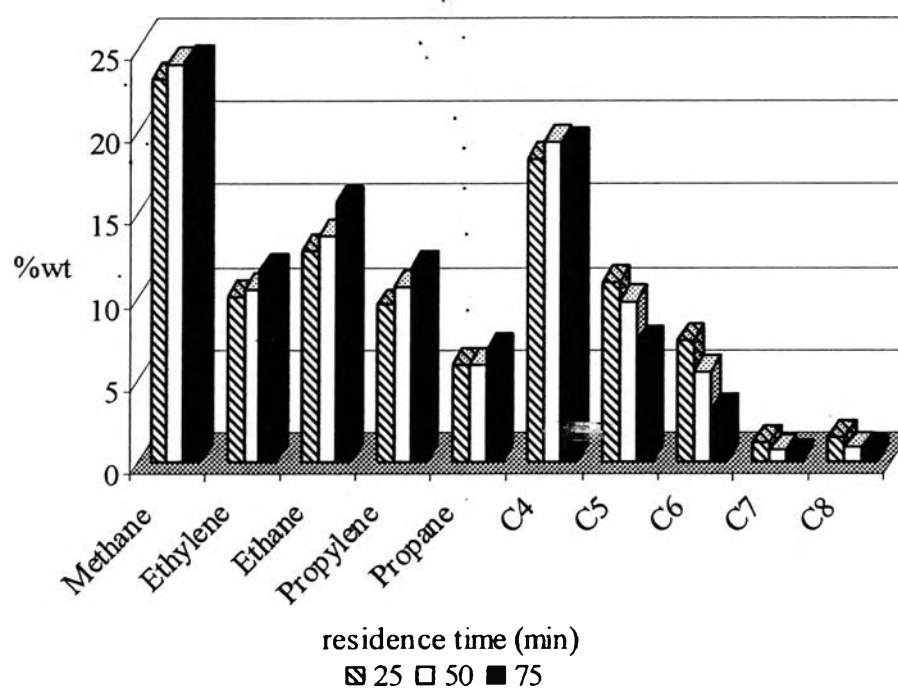
**Figure E3** Pyrolysis gas composition obtained at 700°C for various residence time.

Table E4 Effect of pyrolysis temperature at 25 min residence time

Temperature (°C)	500	600	700
Composition (%wt)			
Methane	23.754	21.180	23.041
Ethylene	9.026	10.796	9.975
Ethane	17.414	14.902	12.675
Propylene	10.345	11.256	9.435
Propane	7.870	6.498	5.873
C4	13.835	17.620	18.282
C5	10.713	10.608	10.804
C6	5.519	5.181	7.334
C7	0.646	0.668	1.117
C8	0.879	1.290	1.463

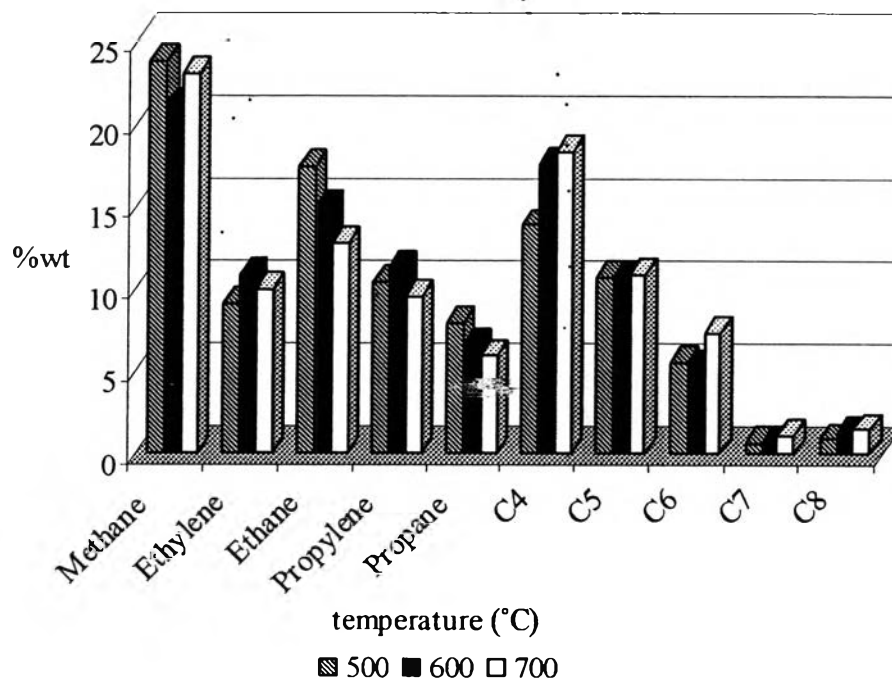
**Figure E4** Pyrolysis gas composition obtained at 25 min residence time for various temperatures.

Table E5 Effect of pyrolysis temperature at 50 min residence time

Temperature (°C)	400	500	600	700
Composition (%wt)				
Methane	11.463	19.205	20.995	23.957
Ethylene	5.921	8.937	11.366	10.379
Ethane	13.616	15.864	15.715	13.571
Propylene	7.879	9.888	11.561	10.506
Propane	9.010	8.083	6.947	5.804
C4	30.912	21.093	20.702	19.252
C5	12.193	10.303	8.238	9.699
C6	7.866	5.221	3.638	5.375
C7	0.534	0.722	0.383	0.653
C8	0.605	0.683	0.456	0.805

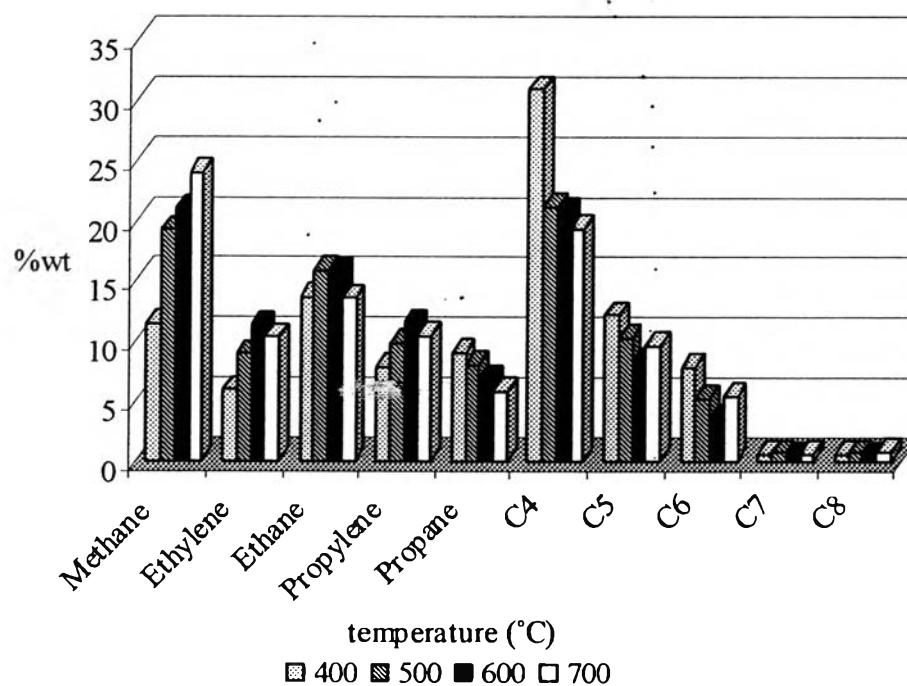
**Figure E5** Pyrolysis gas composition obtained at 50 min residence time for various temperatures.

Table E6 Effect of pyrolysis temperature at 75 min residence time

Temperature (°C)	500	600	700
Composition (%wt)			
Methane	17.850	22.269	24.153
Ethylene	9.487	10.911	11.511
Ethane	16.103	15.178	15.631
Propylene	10.239	11.313	11.669
Propane	8.192	6.571	6.670
C4	22.255	17.641	19.218
C5	10.491	10.308	7.139
C6	4.589	4.266	3.073
C7	0.452	0.501	0.373
C8	0.342	1.041	0.563

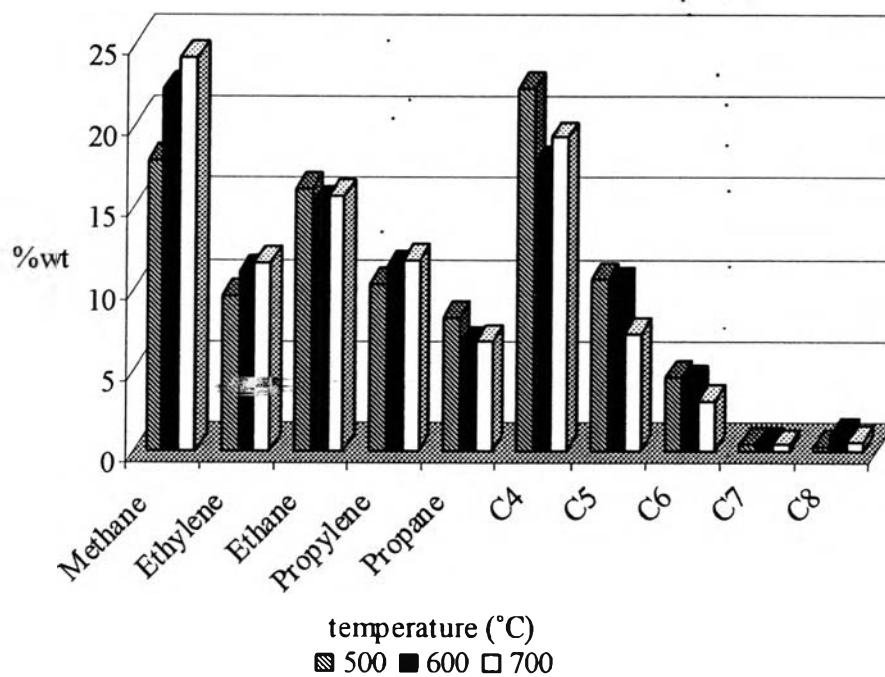
**Figure E6** Pyrolysis gas composition obtained at 75 min residence time for various temperatures.

Table E7 Effect of catalyst supports

Catalyst	Non-cat	Ru/MOR	Ru/ZSM5
Composition (%wt)			
Methane	17.850	16.975	15.838
Ethylene	9.487	5.604	5.366
Ethane	16.103	16.492	13.797
Propylene	10.239	8.213	7.831
Propane	8.192	14.706	23.579
C4	22.255	21.339	19.810
C5	10.491	9.880	8.249
C6	4.589	5.180	4.215
C7	0.452	0.985	0.463
C8	0.342	0.626	0.851

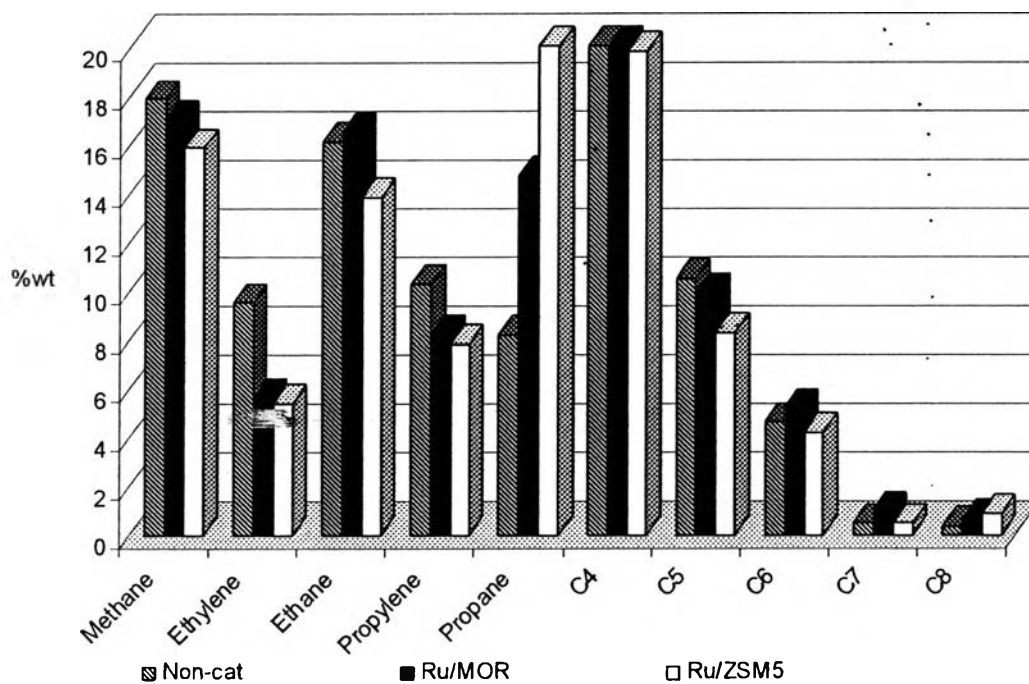
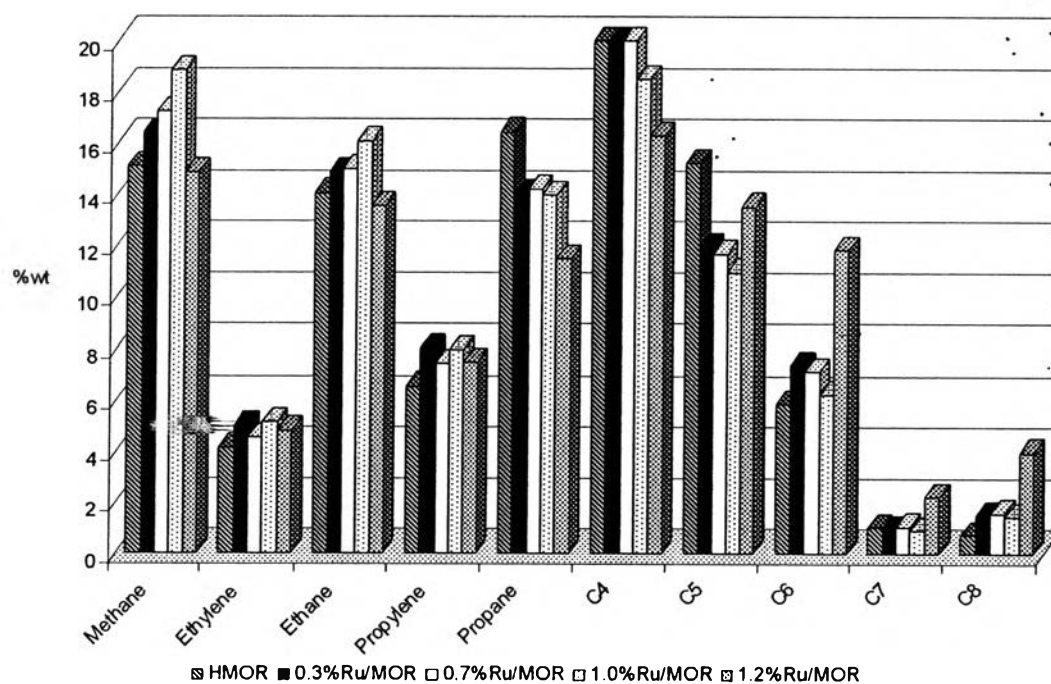
**Figure E7** Pyrolysis gas composition obtained from different bifunctional catalysts.

Table E8 Effect of amount of metal loading

Catalyst	HMOR	0.3%Ru/MOR	0.7%Ru/MOR	1.0%Ru/MOR	1.2%Ru/MOR
Composition (%wt)					
Methane	15.110	16.428	17.245	18.862	14.868
Ethylene	4.148	4.981	4.559	5.130	4.800
Ethane	14.061	14.876	14.965	16.096	13.576
Propylene	6.537	7.996	7.403	7.931	7.470
Propane	16.452	14.006	14.227	13.997	11.459
C4	20.898	19.991	20.212	18.488	16.305
C5	15.229	11.915	11.671	10.953	13.527
C6	5.860	7.345	7.095	6.210	11.832
C7	1.008	0.972	1.042	0.915	2.196
C8	0.697	1.491	1.580	1.419	3.967

**Figure E8** Pyrolysis gas composition obtained from different amounts of ruthenium loading.

Appendix F Lower Heating Value (LHV) of Gaseous Products

Table F1 Heating value of Gaseous products

Component	MW	Heating Value LHV (kcal/kg mole)
H2	2.02	57,798
C1	16.04	191,759
C2	30.07	341,261
C2 =	28.04	316,195
C3	44.1	488,527
C3 =	42.06	460,428
C4 averaged	57.45	624,395
C5 averaged	71.47	772,137
C6	86.18	928,930
C7	100.2	1,075,850
C8	114.22	1,222,770

LHV = Average LHV (kcal/kg mole) / 22.414

Average LHV (kcal/kg mole) = $LHV_1 \times Y_1 + LHV_2 \times Y_2 + LHV_3 \times Y_3 + \dots + LHV_n \times Y_n$

Y_i = Gas composition

Note: PERRY's table 3-207, page 3-155

Table F2 Heating Value (non-catalytic), LHV (Kcal/Nm³)

Temperature(°C)	Residence time (min)	Heating Value, LHV (Kcal/Nm³)
400	50	19142
500	25	15316
	50	16377
	75	16559
600	25	15877
	50	15663
	75	15573
700	25	15875
	50	15445
	75	15015

Table F3 Heating Value (catalytic), LHV (Kcal/Nm³)

Catalysts	Heating Value, LHV (Kcal/Nm³)
HMOR	18065
0.3% Ru/MOR	17584
0.7% Ru/MOR	17418
1.0% Ru/MOR	16796
1.2% Ru/MOR	18665

Appendix G True Boiling Point Distillation (°C)

Table G1 Non-catalytic pyrolysis at 500°C 25 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.7	22.9	22.2	22.2	22.2	20.5
5	148.2	156.7	86	70.1	73.2	21.6
10	156.8	170.3	213.3	80.1	73.6	22.7
15	167.3	178.6	253.7	252.4	74	23.7
20	172.1	189.9	267.6	294.2	74.4	24.8
25	187.1	200	274	306.7	74.8	25.8
30	202.2	208.3	282	315.3	75.1	26.9
35	213.8	214.8	288.8	321.9	75.5	28
40	225.6	222.3	295.2	329.3	76.6	30.5
45	237.8	229	302.3	336.6	168.3	38.8
50	252.9	236.8	308.4	346	320.3	172.7
55	268.6	246.5	317.1	354.4	350.4	187.6
60	282.6	256.8	326.3	364.1	366.4	257
65	298.3	268	333.6	374.3	379.6	323.6
70	316.4	279.2	344.7	385.5	392.4	363.9
75	335.2	292.8	359.5	398	404.8	399.7
80	358.5	312.4	375.2	409.3	416.6	411.3
85	382.8	337.8	394.2	422.9	431.1	422.2
90	408.6	375.1	414.3	440.6	449.5	447.2
95	439.7	414.8	442.6	466.7	476.2	482.3
100	506.7	487.1	509.2	521.5	526.4	522.7

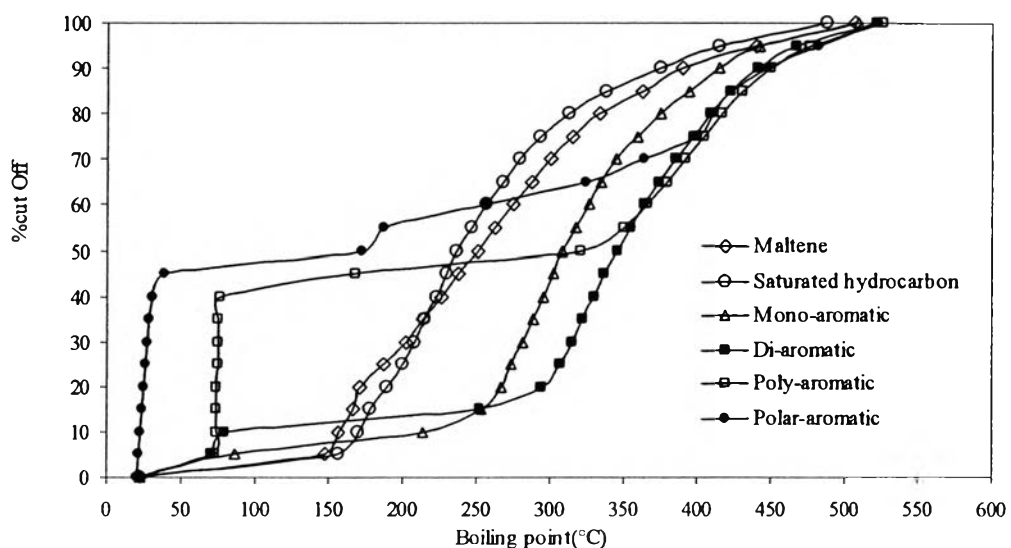


Figure G1 True boiling point distillation (°C) for pyrolysis at 500°C and 25 min residence time.

Table G2 Non-catalytic pyrolysis at 500°C 50 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	24.9	24.8	24.2	23.5	23.7	21.4
5	153.88	77.3	75.4	73	72.6	23.1
10	163.9	155.6	80.2	74.1	73.1	25.4
15	176.8	170	167.7	76.4	73.7	28.6
20	187	180.5	195.7	80.8	74.5	39.2
25	199.2	190.7	251.5	237	244.1	203.7
30	211.9	202.3	270.1	300.3	324	243.8
35	222.2	210.3	277.2	315	343.7	269.4
40	234.8	219.1	288.5	324.2	357.5	292.3
45	247.4	226.1	298.9	333	368.1	317.2
50	262.1	236.2	308.1	344	377.6	336.3
55	272.8	248.4	319	353.4	386.6	355
60	286.6	261.4	328.2	363.5	395.1	373.6
65	300.5	274.5	336.1	373.1	403.8	387.6
70	315.2	287.4	347.7	383.2	412	401.7
75	331.1	303.9	361.8	394.3	420.8	411
80	348.7	324.4	374.4	405.6	430.9	423.8
85	372.9	349.1	389.8	416.8	442.9	441.9
90	400.1	379.5	408.5	432.9	458.3	462.6
95	437.4	413.5	432	455.6	480.3	487.9
100	501.9	472.7	484.9	504.8	523.9	523.1

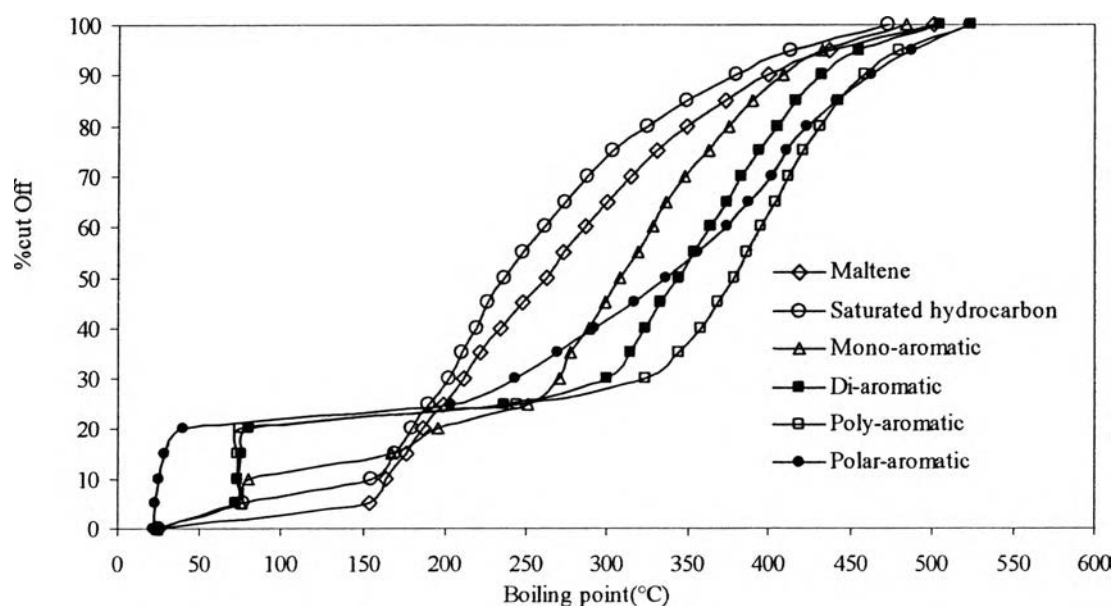
**Figure G2** True boiling point distillation (°C) for pyrolysis at 500°C and 50 min residence time.

Table G3 Non-catalytic pyrolysis at 500°C 75 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	26.7	38.8	22.5	20.8	21.8	20.8
5	156.4	181.6	247.4	22.5	246.1	23.3
10	170.6	194.4	265.3	24.8	309.3	27.1
15	185.7	206.2	273.6	28.2	331	71.6
20	200.3	214.2	282.9	69.9	344.1	172.9
25	210.6	221.9	291	73.5	353.7	220.5
30	220.7	229.6	300.5	220.7	363	245.4
35	230.1	238.7	307.5	277.5	370.4	265.2
40	242.5	249	317.3	306.9	377.9	284.2
45	256.1	259.5	325.9	325	385.2	302
50	270.9	270.9	333.1	337.7	392.2	324.2
55	282.7	280.4	342.7	351.2	399.1	345.7
60	296.8	291.7	354.4	364.3	406.3	366.7
65	312.4	305.5	366.4	377.4	413	386.3
70	328.1	322.3	376.7	390.8	420.6	402.2
75	345.7	340.8	389.1	404.3	428.9	419.8
80	365.1	365.3	402.8	417	438.3	437
85	384.9	388.4	415.8	432.3	449.8	454.4
90	407.3	411.1	432.1	450	464.9	474.7
95	435	437.6	455	475.1	486.7	499.3
100	498.2	499.6	507	517.8	528.5	535

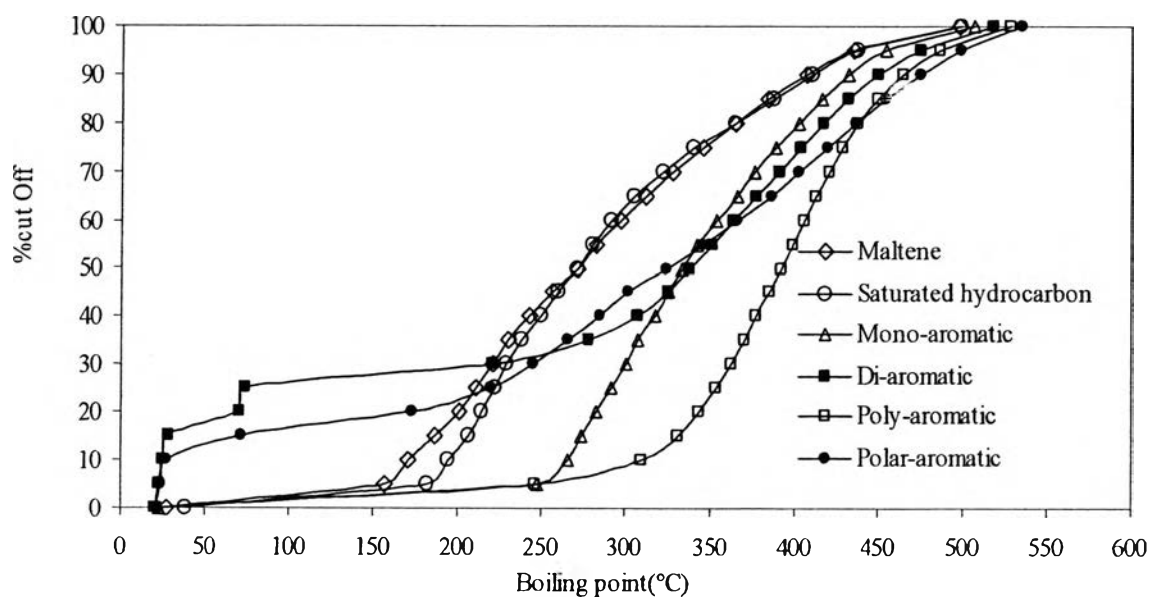
**Figure G3** True boiling point distillation (°C) for pyrolysis at 500°C and 75 min residence time.

Table G4 Non-catalytic pyrolysis at 600°C 25 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	23.7	23.9	22.5	23.1	22.2	22.7
5	155.8	75.3	75.7	73.3	71	70
10	167.7	82.8	179.9	79.4	71.3	70.4
15	173.3	171.8	188.6	184.1	71.7	70.7
20	191.1	184.9	197	195.6	72.1	71.1
25	204.1	191.9	203.3	203	72.5	71.5
30	214.1	200.8	219.3	239.1	72.9	71.9
35	224.6	207.2	244.9	272	73.2	72.3
40	234.9	213.7	256	284.3	73.6	72.6
45	247.7	221.7	270.2	293.6	74.1	73
50	261	229.5	277.7	302.1	196.9	77.5
55	273.5	238.7	288.7	312.7	313.9	160.1
60	286	250.3	299.1	320.9	337.7	181.8
65	299.7	262.2	310.7	330.1	353	209.3
70	315.9	274.4	323.4	339.7	367	241.6
75	332	287.4	336.5	354.3	380.2	274.3
80	352	304.3	354.2	370.6	394	307.6
85	374.2	327.4	373.1	388.9	407.9	345.4
90	399.4	360.2	395.6	408.6	424.7	391.5
95	427.2	401.9	422.2	433.6	450.8	501.5
100	489.8	469.7	486.1	491.2	505.7	574.3

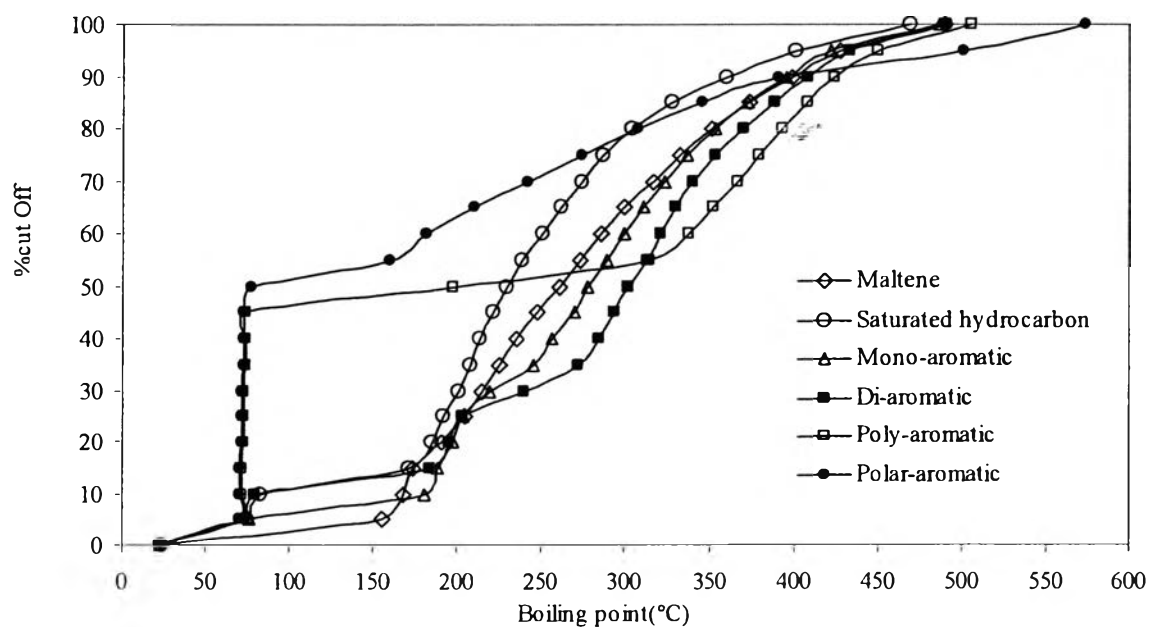
**Figure G4** True boiling point distillation (°C) for pyrolysis at 600°C and 25 min residence time.

Table G5 Non-catalytic pyrolysis at 600°C 50 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	25.6	28.8	22.5	22.7	21.6	21.6
5	157.4	170.9	77	325.3	29.5	24.4
10	170.9	189.3	279.4	346.5	254.5	28.8
15	189.1	202.1	294.4	355.1	310.8	75.1
20	204	211.7	305	363.1	339.7	201.6
25	215.1	220	313.5	368.5	364.1	241.4
30	227.2	227.4	320.3	374.8	381.1	263.8
35	239.6	236.3	327.1	379.8	389.7	284.5
40	254.2	246.8	333	385.5	399.2	304.6
45	269	257.4	340.5	390.9	407.2	325.7
50	279.8	269	348.5	396.6	413.8	345.4
55	292.6	277.1	356.4	402.6	420.6	363.6
60	307	287.4	364.9	407.8	427.5	381.2
65	322.6	299	373.4	413.7	434.7	392
70	337.2	313.5	382.4	420.9	442.5	407.7
75	355	329.4	393.2	429.1	451.2	423.2
80	373.3	349	405.2	438.2	461.2	439
85	392.7	373.1	418.6	448.9	473	455.8
90	413.4	399.5	435.7	463.2	487.6	475.8
95	440.9	429	461.6	483.5	506.4	501
100	501.9	500.4	523	524.5	549.7	543

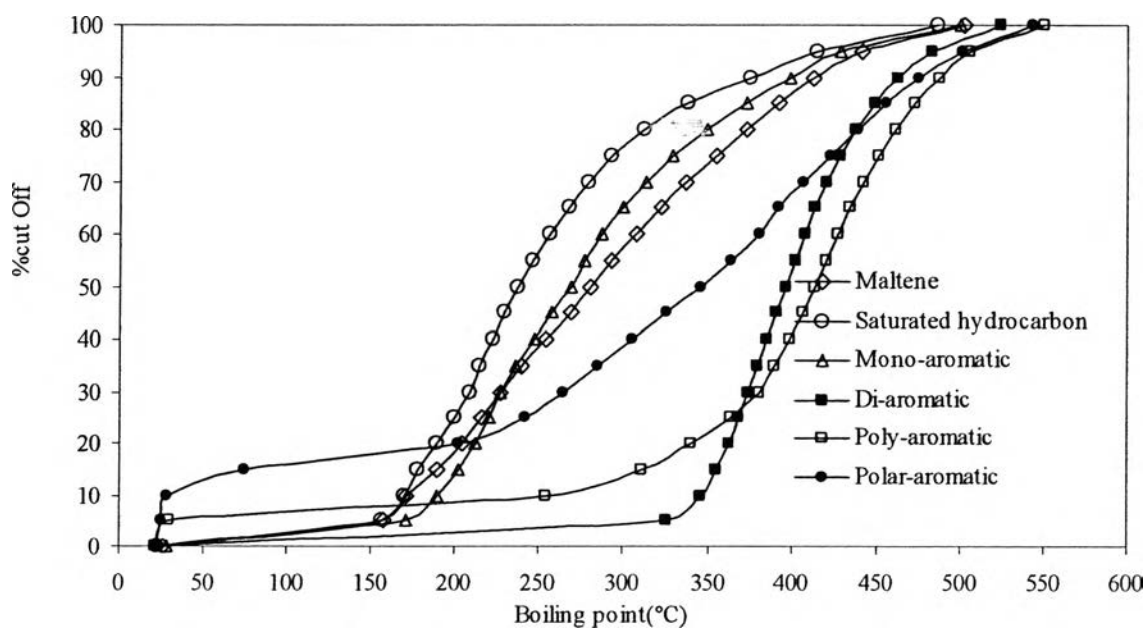
**Figure G5** True boiling point distillation (°C) for pyrolysis at 600°C and 50 min residence time.

Table G6 Non-catalytic pyrolysis at 600°C 75 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	24.2	24.4	23.7	23.1	23.8	21.4
5	155.8	74.1	81.8	51.8	25.5	24.4
10	168.1	76.4	245.1	70.5	27.8	29.7
15	177.5	79	255	71.7	31.2	133.8
20	192.7	103.6	267.9	72.3	71.9	177.9
25	207.4	169.9	273.3	72.9	76.5	207.4
30	218.2	183	278.3	73.5	223.7	234.9
35	228.4	192.8	287.3	74.5	280.5	256.7
40	240.3	205.3	293.5	75.6	309.9	278.9
45	254.4	213.9	302	76.9	328	298.8
50	269	222.8	309.3	79	340.7	321
55	280	231.9	318.9	94.7	354.2	341.3
60	293.1	242.9	328.1	302.5	367.3	361
65	308.1	255.6	335.6	317.6	380.4	381
70	324.2	270.2	347.4	330.8	393.8	392.9
75	340.9	283.6	361.9	347.7	407.3	407.4
80	361.2	300.1	375.2	364.3	420	421.5
85	381.8	324.9	391.8	383.1	435.3	441.3
90	405.5	359.6	410.7	405.3	453	464.1
95	433.2	403.8	435.4	433.1	478.1	492.6
100	497.3	472.5	491.6	494.5	520.8	531

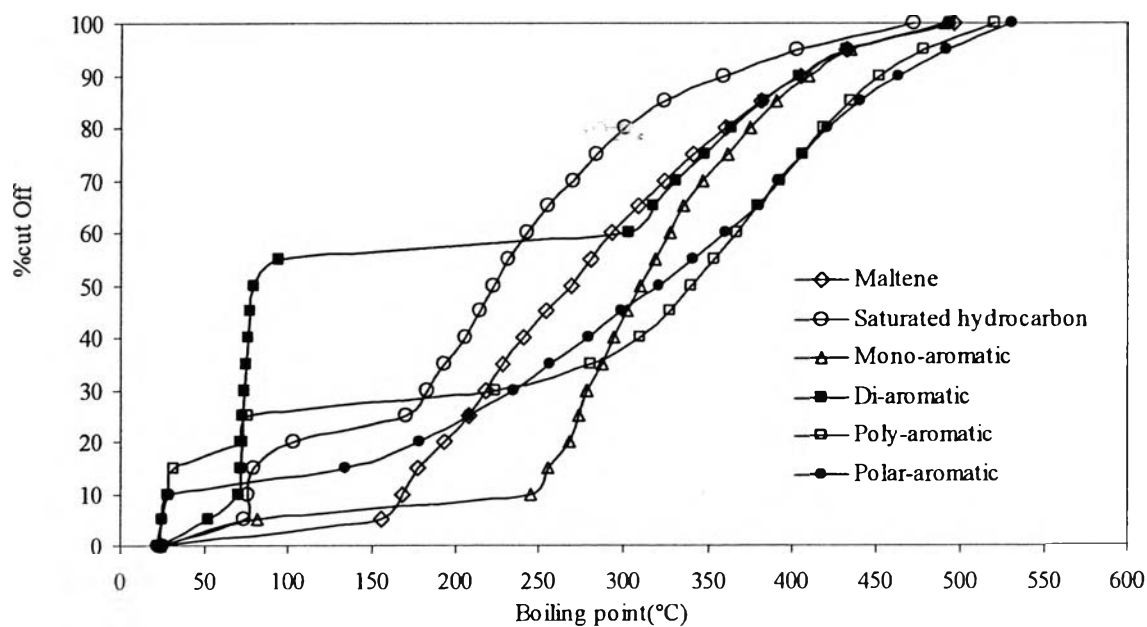
**Figure G6** True boiling point distillation (°C) for pyrolysis at 600°C and 75 min residence time.

Table G7 Non-catalytic pyrolysis at 700°C 25 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.8	24.2	22.9	25.6	64.9	22
5	154.6	71.6	49.8	66.4	66	29.9
10	157.9	74.4	69.6	67.5	67	74
15	170.6	76.2	73.3	68.5	68.1	77.3
20	184.9	78.3	74.4	69.2	69.1	81.5
25	193.3	85	75.4	69.6	69.4	218.7
30	207.7	168.2	76.4	70	69.8	267.2
35	214.8	184.9	77.4	70.4	70.2	299.4
40	226.6	198.4	78.6	70.7	70.6	330.5
45	236.5	212.4	80.5	71.1	71	356.6
50	250.8	223.5	101.7	71.5	71.3	377.1
55	265.3	235.8	383	71.9	71.7	391.4
60	277.5	252.7	413.9	72.4	72.1	402.8
65	291.8	270.6	431	73.2	72.5	412.3
70	307.4	285.5	445.8	74.6	72.9	421.8
75	325	303.4	460.3	78	73.2	432.7
80	345.5	325.1	473.3	80.5	73.6	444.2
85	369.3	351.8	485.1	84.3	74	459.2
90	396	383.1	497	155.6	74.6	476.5
95	427.5	419.1	510.3	199.8	106.7	498.2
100	498.1	492.5	548.4	442.3	411.7	534.7

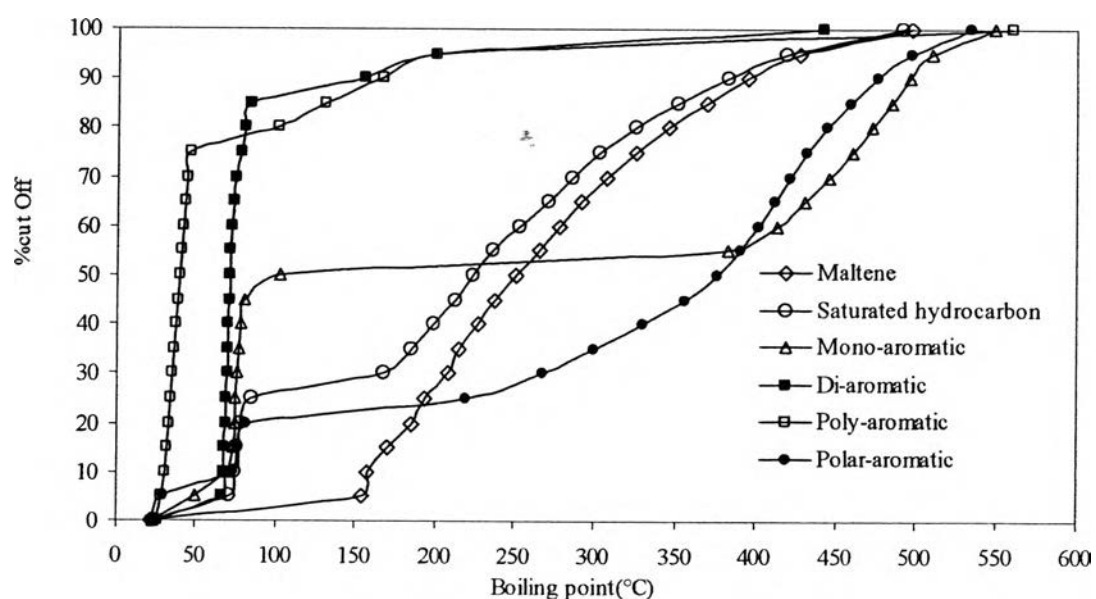
**Figure G7** True boiling point distillation (°C) for pyrolysis at 700°C and 25 min residence time.

Table G8 Non-catalytic pyrolysis at 700°C 50 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.2	23.3	23.5	21.8	26.3	21.6
5	155.3	73.7	73.9	74.3	69.1	71.3
10	168.2	78.1	79.4	187	69.4	71.6
15	181	167.5	186	199.8	69.8	72
20	193.6	177.7	197	211.9	70.2	72.4
25	209.3	187.1	207.1	252.6	70.6	72.8
30	220.3	193.2	215	269.2	71	73.2
35	230.8	202	229.1	277.7	71.3	73.5
40	243.5	208.5	239.3	290	71.7	75.7
45	256.1	215.8	248.4	301	72.5	157.4
50	270.3	223.8	260.3	310.9	74.7	167.6
55	281	234	271.9	321.9	272.9	171.6
60	293.3	246	279.3	331.9	304.7	207.6
65	307.6	260	290.9	342.6	323.9	243.5
70	323.6	273.2	304.1	357	342.7	292.6
75	340	286.4	320.6	372.5	360.5	342.4
80	361.1	302.6	336.7	388.3	376.9	384.6
85	382.6	325.4	360.8	405.4	394.4	407.2
90	406.2	358.8	385.2	422.2	413.2	433.3
95	433.6	403.2	417.7	446.6	440.2	468.6
100	495.1	472.4	481.5	499.9	501.7	524.5

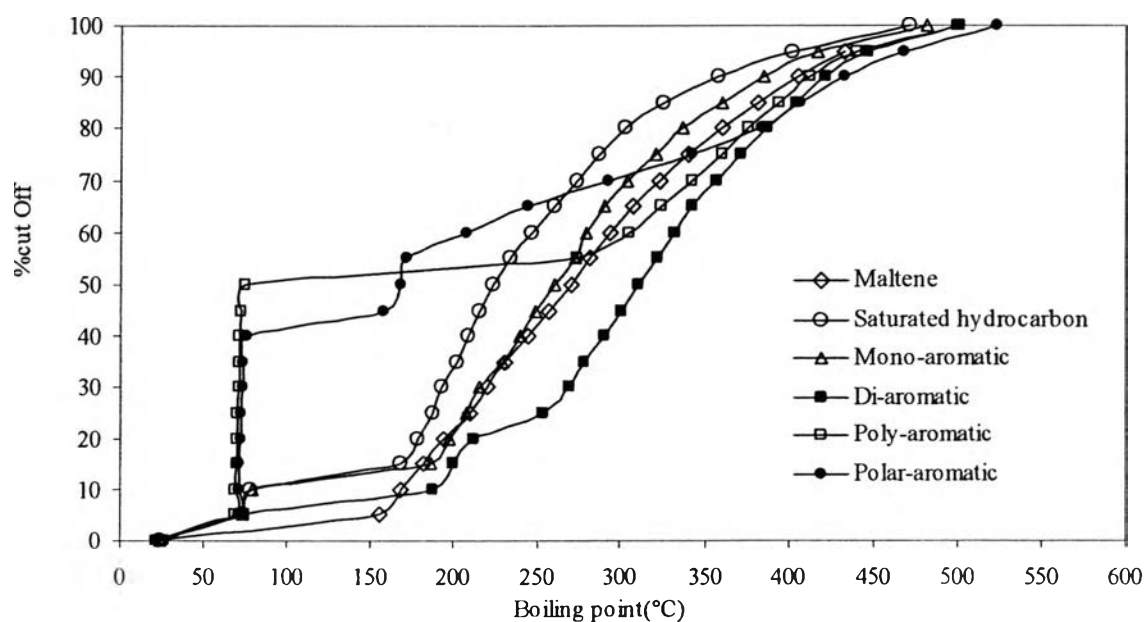
**Figure G8** True boiling point distillation (°C) for pyrolysis at 700°C and 50 min residence time.

Table G9 Non-catalytic pyrolysis at 700°C 75 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	26.3	27.3	24.2	22.9	22	21.8
5	168.7	167.6	265.7	304.2	33.1	27.3
10	185.3	183.2	274.9	315.7	338.2	200.6
15	199.5	192.5	286	327.2	354.7	229.9
20	212.4	204.1	293.5	336.4	366.3	252.6
25	223.9	212.9	302.2	346.2	375.3	274.6
30	236.2	221.2	309.3	353.1	383.1	293
35	251.8	228.7	317.5	361.5	390.1	313.5
40	267	237	324.5	368.7	397.1	331.9
45	278.8	247.8	331.2	376.5	403.8	349
50	292	258.9	338.5	384.2	409.8	365.2
55	306.6	270.6	348.1	392.2	415.5	380.6
60	322.2	280.2	359.2	400.3	422.1	389.4
65	336.2	291.9	369.8	407.3	428.9	402.7
70	352.9	306.8	379.8	414.8	436.3	413.6
75	370.1	324.6	392.3	424.3	444.6	426.8
80	387.2	345.6	405.5	434.7	454	440.8
85	405.4	371.6	418.3	446.2	465.3	456
90	424.1	399.1	434.5	461.5	479	473.8
95	450.2	427.9	456.8	482.4	497.8	496.1
100	504.9	486.5	506.6	523.4	532	529.2

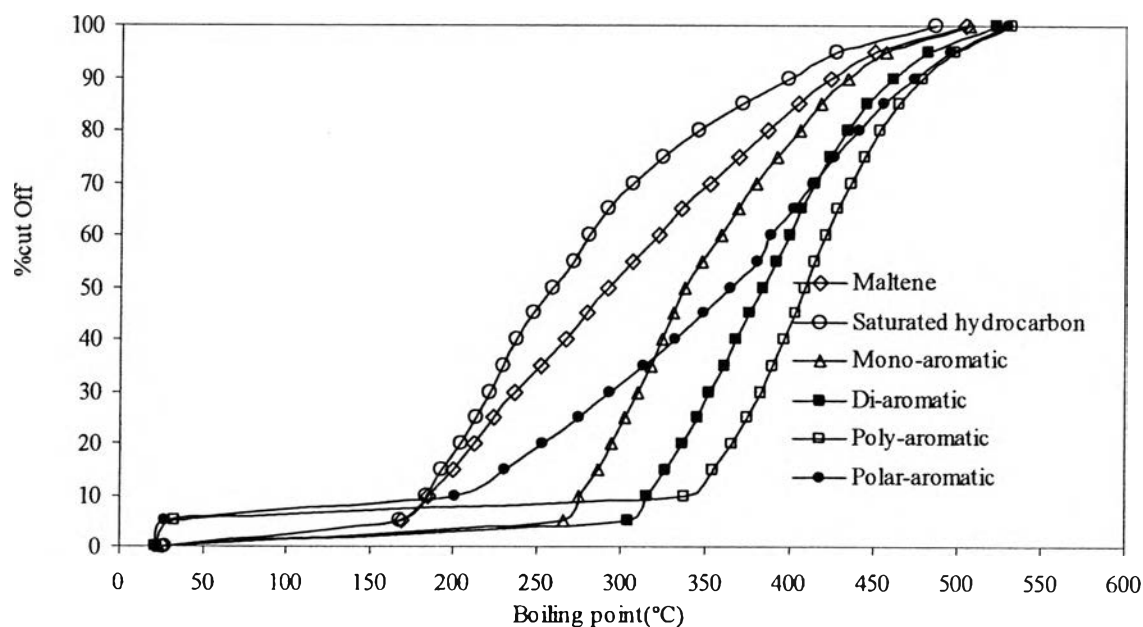
**Figure G9** True boiling point distillation (°C) for pyrolysis at 700°C and 75 min residence time.

Table G10 Catalytic pyrolysis with HMOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	43.7	40.1	26.9	27.5	22.2	20.5
5	101.9	123	32.6	32.6	33.9	21.6
10	110	155.6	34.6	33.7	35	22.7
15	137.9	165.7	35.6	34.8	41.6	29.9
20	157	171	36.7	35.8	42.6	44.3
25	166.1	176.6	37.7	36.9	43.7	48.4
30	171.8	185.6	38.8	38	44.7	154.5
35	179.3	191.4	39.9	39	45.8	178.9
40	188.8	197.6	40.9	40.1	46.9	194.1
45	194.7	205.8	42	41.1	47.9	212.5
50	204.6	212	43.1	42.2	49	228.3
55	212.5	220.5	45.2	43.3	50.1	243.8
60	223.3	228.8	67	44.3	51.1	259.7
65	234	237.6	170.7	45.4	52.2	274.5
70	243.9	245.1	259.7	46.4	53.2	289.8
75	255	254.5	277.2	58.6	54.3	306.1
80	265.9	263	283	104.8	55.4	328.5
85	279.4	274.3	294.2	154.8	56.4	356.5
90	294.7	289.3	304.2	195.8	90.8	378.2
95	315.2	311.4	319.7	309.2	216.2	492
100	515.7	517.1	531.8	394.6	529.7	573.4

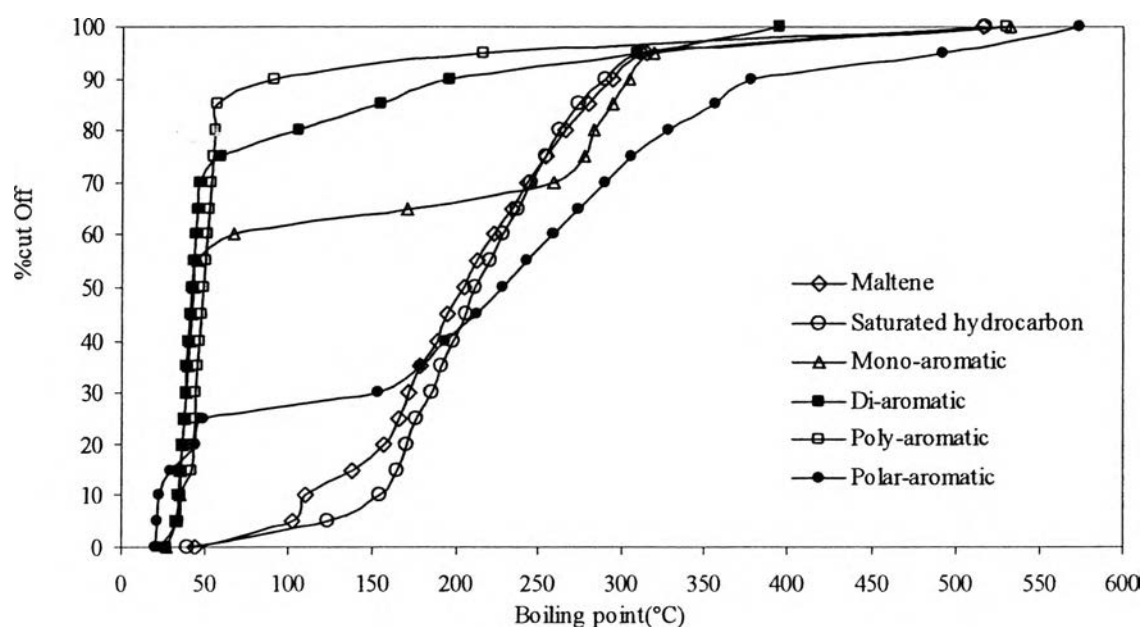
**Figure G11** True boiling point distillation (°C) for pyrolysis with HMOR.

Table G11 Catalytic pyrolysis with 0.3% Ru/MOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.6	23.1	23.9	21.4	22.5	26.1
5	113.3	74.6	173.7	52.4	72.3	176.3
10	156	80.6	200.7	69.1	72.6	193.7
15	161.9	158.3	211.7	69.9	73	199.7
20	170.8	171.3	219.2	70.7	73.4	209.2
25	180.8	184.4	226.7	71.5	73.8	220.7
30	189.3	191.8	231	72.6	74.2	233.8
35	197	201.7	235.9	74.3	74.5	246
40	205.4	208	244.3	79.1	74.9	260.2
45	212.7	213.8	247.3	231.8	77.3	272.9
50	219.6	220.7	254.2	258.9	270.8	285.3
55	225.8	226.7	260.1	271.6	291	298.9
60	233.2	233.4	265.7	280.1	301.9	314.1
65	242	241.5	272.6	291.2	310.7	328.4
70	252.5	251.2	277.8	301.5	320.3	344.5
75	263.9	261.2	285.8	311.5	332.3	362.4
80	276.2	272.8	293.6	323.7	346.5	379.5
85	292.2	286.2	305.6	335.2	362.8	386.9
90	316.7	306.6	324.9	355.2	384.8	412.4
95	362	344.9	357.3	388.2	415.5	446.6
100	462.4	447.1	447.1	468.3	491.4	509.4

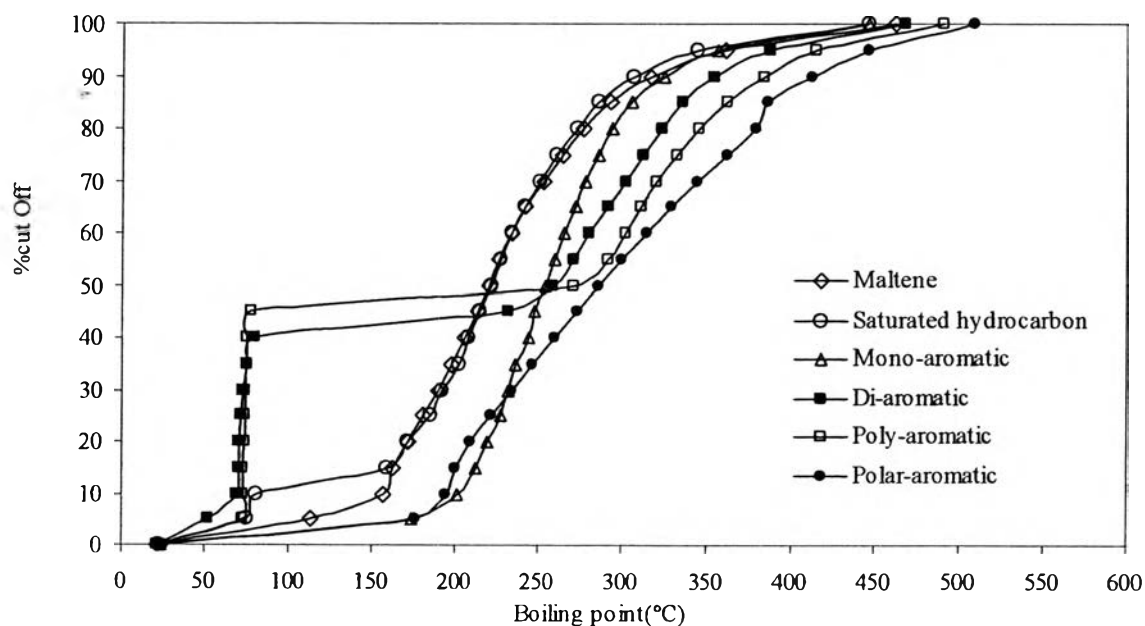
**Figure G11** True boiling point distillation (°C) for pyrolysis with 0.3% Ru/MOR.

Table G12 Catalytic pyrolysis with 0.7% Ru/MOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.2	22.9	22.9	22.9	23.3	24.2
5	86.5	75.7	73.8	74.2	71.9	185.3
10	155	82	77.2	80.1	72.3	201.3
15	156.4	157.5	81.5	170.2	72.7	213.4
20	161.8	170.2	211.2	221.3	73.1	227.5
25	170.3	175.1	227.5	237.9	73.5	240.3
30	173.7	185.9	232.8	249.4	73.8	253
35	185.4	191.9	244.4	260	74.2	265.2
40	192.1	199.8	248.7	271.7	74.7	277.2
45	201.4	205.2	255.6	281.9	76.7	289.2
50	207.6	211	264.7	289	158.1	302.2
55	214.1	215.7	272.4	295.7	235.7	315.8
60	221.6	221.7	276.1	303.6	278.6	327.6
65	228.9	226.9	283.9	312.4	296.9	341.8
70	237.7	234.3	290.8	319	308.4	356.3
75	250.6	242.8	299.1	326.5	323.7	370.1
80	266.3	255	309.4	336.2	334.4	385.2
85	284.3	270.2	323	349.6	347.4	393.5
90	310.5	288	339.1	368.2	361.2	416.9
95	354	323.9	369.9	399.1	393.4	448
100	453.3	431.7	455.8	472.3	486.7	511.1

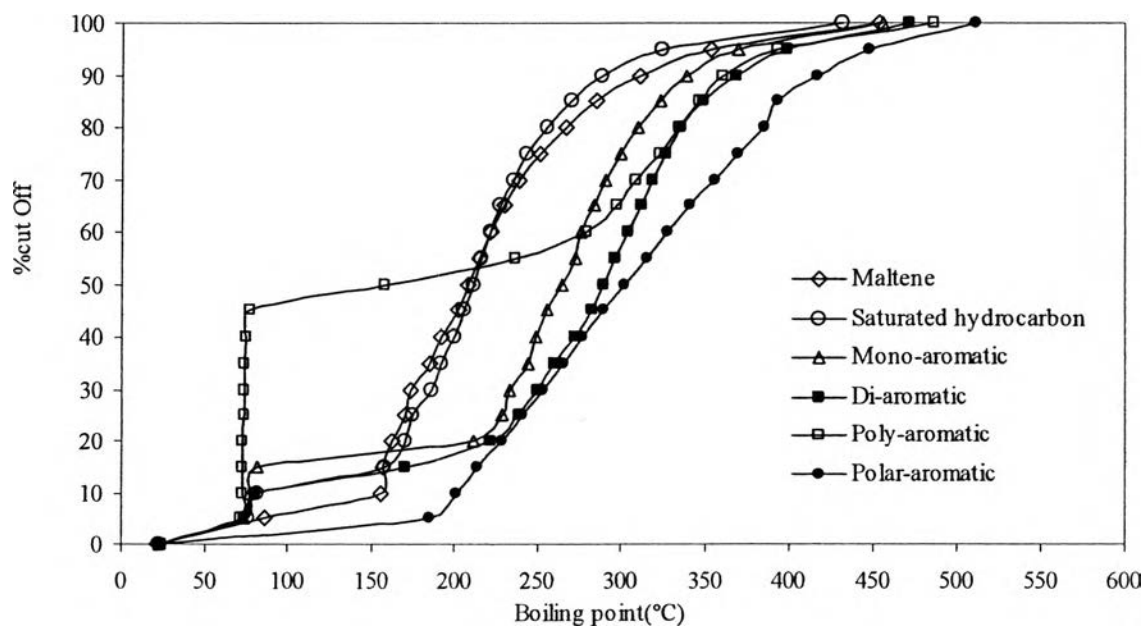
**Figure G12** True boiling point distillation (°C) for pyrolysis with 0.7% Ru/MOR

Table G13 Catalytic pyrolysis with 1.0% Ru/MOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.6	23.1	23.5	22.7	22.3	23.5
5	113.6	74.3	73.9	36.5	60.9	179.5
10	155.5	79.2	77.6	52	61.9	195.4
15	158	155.5	82.1	67.2	63	208.6
20	168.1	168.7	253.3	98.1	64.1	217.5
25	171.4	175.4	272.7	172.9	65.1	230
30	181.4	188.8	281.6	222.5	66.2	242.5
35	189.4	198.6	289.4	251.2	67.3	255.1
40	196.2	207.7	294.5	264	116.8	267.4
45	204.9	214.8	301.8	273.9	143.6	278.9
50	212.1	222.7	306.5	278	161.5	290.8
55	218.5	230.3	312.7	284.5	170.4	303.9
60	224.6	238.6	317.7	290.3	177.7	317.8
65	232.1	248.1	323.7	298.5	181	330.9
70	240.1	258.6	329.6	303.2	185.5	345.5
75	251.4	270.3	335.1	307.8	192.7	362.2
80	264.5	281.1	343.7	314.3	204.5	377.6
85	278.7	295.5	354.5	321.8	221.2	386.7
90	299.2	318.4	368.8	333.6	243.6	408.3
95	336.4	362.9	392.4	374	336.1	441.9
100	447.9	482.9	472.5	459.5	452.7	511.5

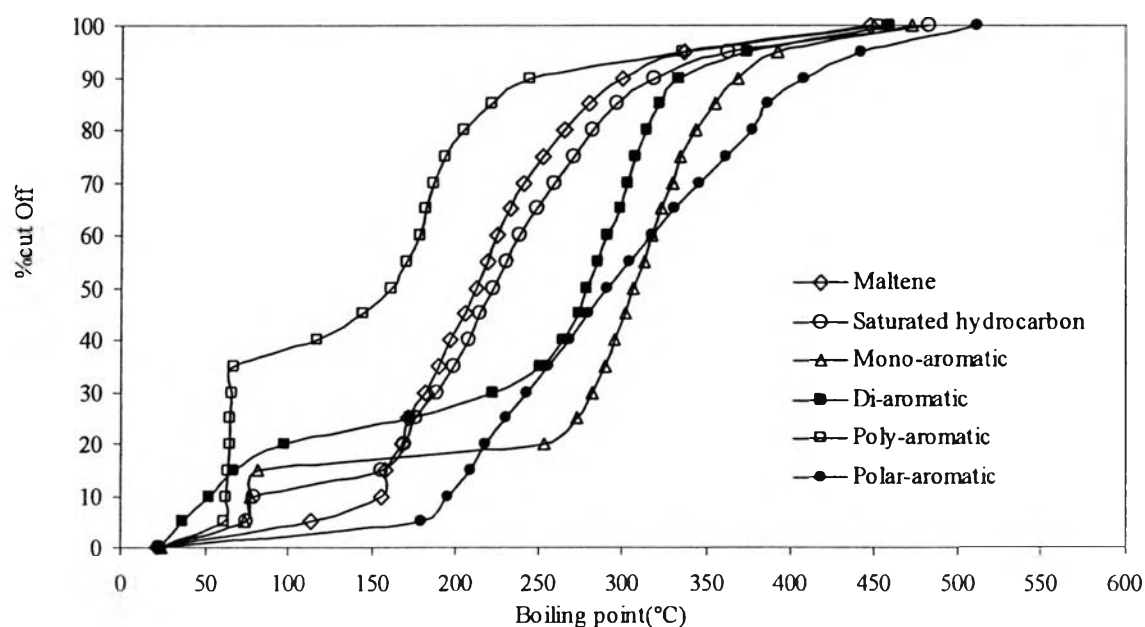
**Figure G13** True boiling point distillation (°C) for pyrolysis with 1.0% Ru/MOR

Table G14 Catalytic pyrolysis with 1.2% Ru/MOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21	23.1	23.2	23.1	23.3	25.8
5	111.7	77.6	226.2	157.1	71.9	185.2
10	155.6	169	236.1	182.5	72.3	201.5
15	159.7	184.1	246.7	205.4	72.7	215.4
20	170.7	192.5	254.2	253.4	73.1	232.6
25	182.1	203.4	260.4	275	73.5	247.7
30	191.7	210.2	266.4	284.8	73.9	262.6
35	203.5	215.2	272.3	291.7	75.1	275.6
40	212.1	222.1	275.2	294.3	159.8	287
45	220.2	228	279.7	301.5	191.1	298.5
50	227.9	234.3	285.2	304.8	231.8	310.6
55	235.9	242	289.9	309.3	295.6	321.5
60	246.2	250	293.8	315.7	317.2	334.1
65	256.1	258.7	300.5	318.9	330	346.7
70	267.5	268.1	306	324.9	342.5	361.7
75	277.8	277.4	314.1	331.3	353	376.1
80	290.5	288.7	322.4	339.4	364.2	385.9
85	306	302.2	332.4	351.2	376.3	402.3
90	329.1	326	347	367.7	392.4	425.9
95	371	371.4	375.2	397.6	417.7	460.2
100	475	499.5	461.2	473.8	486.2	529.5

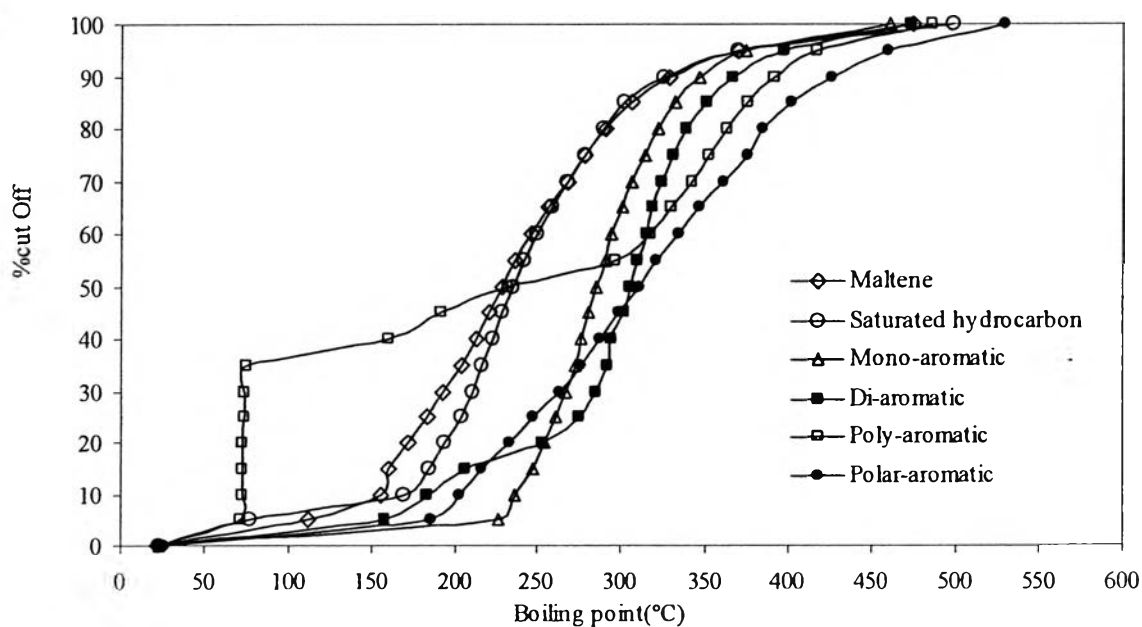
**Figure G14** True boiling point distillation (°C) for pyrolysis with 1.2% Ru/MOR

Table G15 Catalytic pyrolysis with Ru/MOR

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.4	23.1	23.5	21.6	22	21.4
5	115.3	79.8	210.6	24.8	72.9	23.1
10	156	167.9	226.5	30.5	74.4	25.8
15	161.4	172.8	229.8	74.7	75.1	29.2
20	170.7	186	234.9	76.8	157.9	74.4
25	180.6	192.9	244.3	115.9	191.5	181.2
30	190.1	203	246.1	171.7	212	221.8
35	199.9	208.2	250.8	183.8	238.8	238.2
40	207.7	214.1	255	195.2	269.5	252.5
45	214.5	220.1	260.3	207.8	276.2	266.3
50	222	224.5	264.6	230.3	287.3	279.5
55	228.5	230.9	269.4	257.4	293.4	292.4
60	235.5	236.9	272.9	272.2	301.2	307.4
65	244.1	243.9	276.6	281	308.5	323.9
70	253.1	252.4	282.3	292.9	316.1	340.8
75	262.5	260.8	288	306.5	325.2	359.3
80	272.9	270.8	293.5	323.3	338	379.1
85	284.4	280.9	304	342.6	353.3	398.8
90	300.8	294.9	319.6	367.4	376.5	417.1
95	335.2	321.4	343.8	408.3	412.8	447.1
100	446.4	422.1	439.3	472.5	487.9	497.5

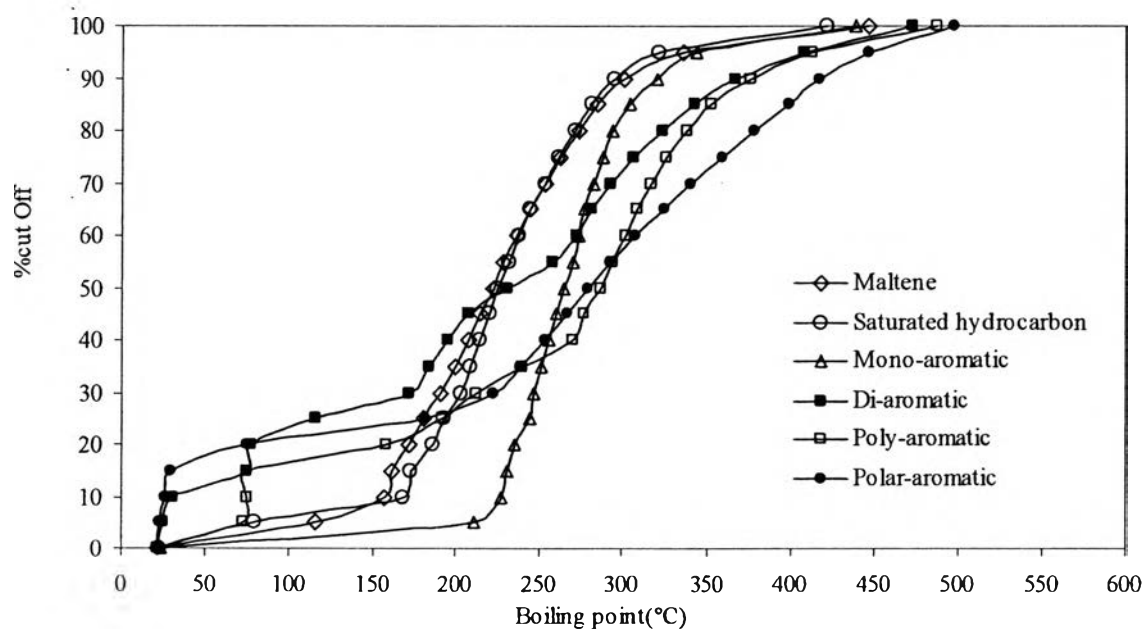
**Figure G15** True boiling point distillation (°C) for pyrolysis with Ru/MOR.

Table G16 Catalytic pyrolysis with Ru/ZSM5

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.6	23.9	22.9	23.1	30.3	22.2
5	113.9	75.8	173.7	155.5	71.4	169.7
10	155.8	80.5	215.3	158.7	71.9	191.7
15	158.2	156.3	249.5	169.9	72.6	202.2
20	168.8	168.1	266.2	171.1	73.4	213
25	171.7	171.7	272.9	173.3	74.7	226
30	182.7	183.3	276.9	183.1	154.4	237.3
35	190.5	190.6	285.5	186.4	157.3	249.9
40	194.9	195.1	290.5	191.3	168.5	263
45	204.4	204.1	296.4	193.8	171.2	275.3
50	211.8	211.3	302.2	201.6	180.2	286.2
55	215.3	214.7	307.4	206	189.7	298.3
60	223	222.1	314.5	212.4	195.1	311.3
65	230.4	229.1	319.8	217.5	210.2	323.4
70	237.7	236	326.1	224.9	222.5	337.8
75	249.4	246.7	332.1	236.6	242.7	353.2
80	263.5	260.1	340.5	264.7	285.3	370.8
85	279.1	275.7	352.8	323.7	328.8	387.3
90	299.8	296.1	370	356.2	369.6	414.4
95	336.6	339.7	400.4	393.6	398	451.5
100	442.4	471.1	484.6	477.5	495.2	521.1

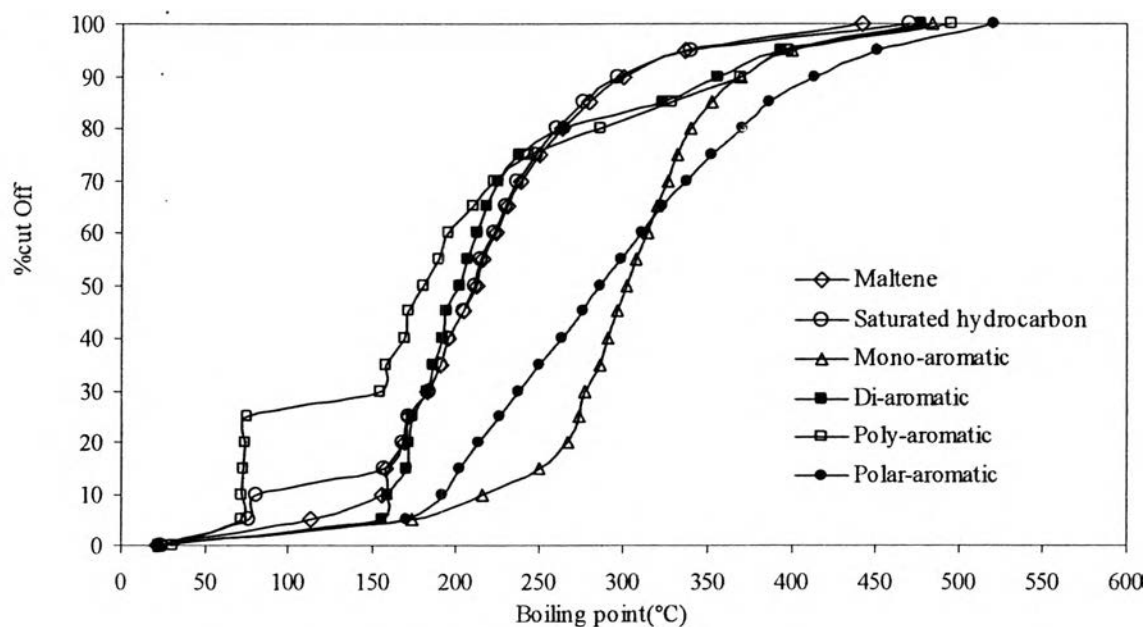
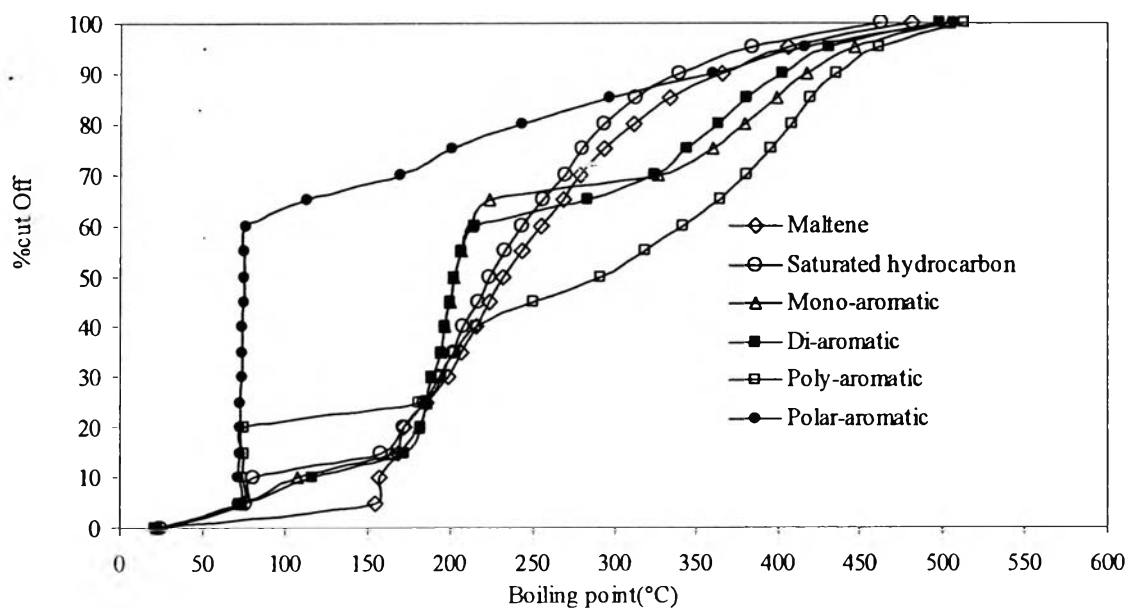
**Figure G16** True boiling point distillation (°C) for pyrolysis with Ru/ZSM5.

Table G17 Non-catalytic pyrolysis at 400°C 50 min residence time

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.9	24.8	22.7	23.1	22	22.9
5	154.8	76.2	73.8	74.4	73.4	71.6
10	157.6	81.4	107.7	117.2	74.1	72
15	168.1	158.7	165	172	74.6	72.4
20	172.4	172.4	181.4	181.9	75.4	72.8
25	186	184.7	185.1	185.4	181.4	73.2
30	199.1	193	189.3	189.1	194.9	73.5
35	207.6	202.2	194.3	194.7	202.8	73.9
40	216.7	208.4	197.2	197.1	215.8	74.3
45	223.8	217.2	199.9	200.3	250.2	74.7
50	232.8	224	202.5	202.9	291.3	75.1
55	243.2	233.1	207	207.2	319.2	75.4
60	255.4	243.9	212.5	215	341.4	75.8
65	269.1	255.8	223.9	283.1	363.9	114.4
70	279.5	269.5	326.2	324.9	380.6	169.1
75	293.7	279.8	360	344.3	394.9	201.7
80	312.1	293.9	378.8	362.8	407.1	243.2
85	334	312.9	399	379.7	418.5	297.1
90	365.1	338.8	416.6	402.3	435.4	359.8
95	405.2	383.8	446.5	430.3	461.6	415.2
100	480.9	461.7	503.4	497.6	512.2	506.8

**Figure G17** True boiling point distillation (°C) for pyrolysis at 400°C and 50 min residence time.

Appendix H Asphaltene in Pyrolytic Oils (%wt)

Table H1 Asphaltene in pyrolytic oils for non-catalytic pyrolysis

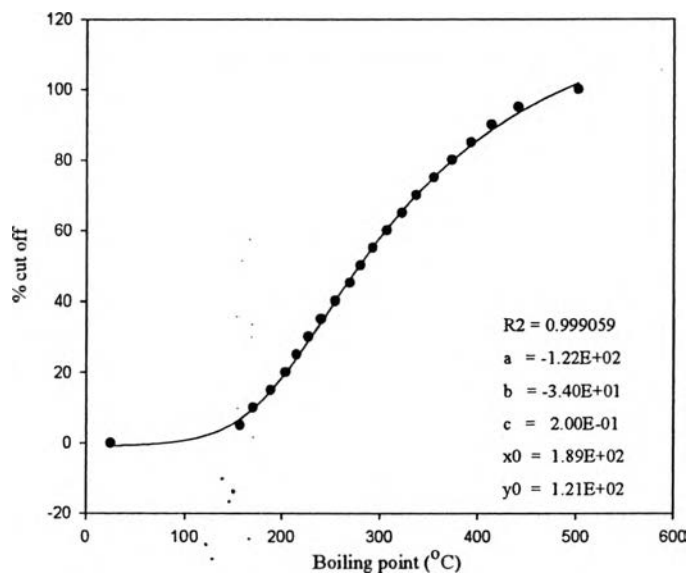
Temperature(°C)	Residence time (min)	Asphaltene(%wt)
400	50	0.032
500	25	0.085
	50	0.074
	75	0.086
600	25	0.142
	50	0.138
	75	0.157
700	25	0.032
	50	0.078
	75	0.114

Table H2 Asphaltene in pyrolytic oils for catalytic pyrolysis

Catalysts	Asphaltene(%wt)
HMOR	0.003
0.3% Ru/MOR	0.013
0.7% Ru/MOR	0.006
1.0% Ru/MOR	0.003
1.2% Ru/MOR	0.006
Ru/MOR	0.001
Ru/ZSM5	0.007

Appendix I Calculation of Carbon number Distribution

Example: True Boiling Point (TBP) Curve from Sigma Plot



The equation is

$$y = y_0 + \frac{a}{\left[\left(1 + e^{-\left(\frac{x-x_0}{b} \right)} \right) \right]^c}$$

Calibration curve

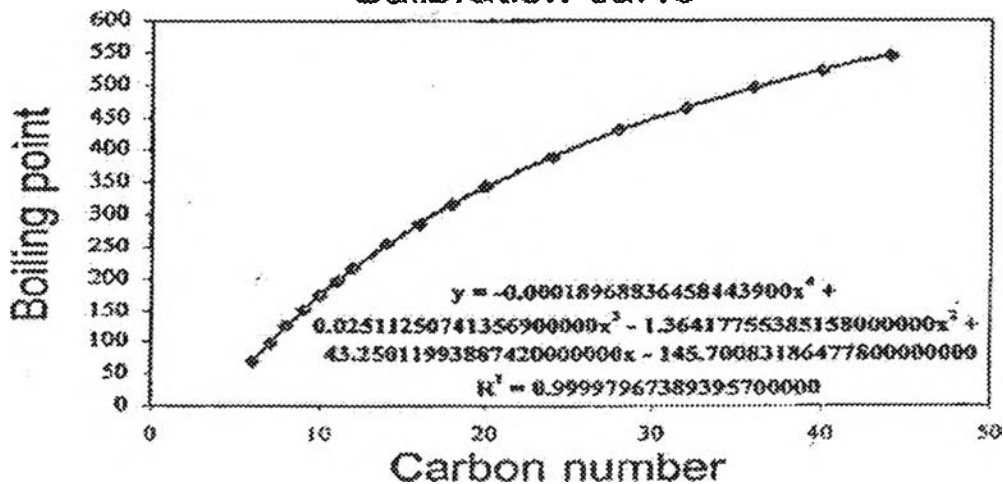


Figure 11 GC Calibration Curve of ASTM D2887

The Carbon number Distribution

No. carbon.	B.P.	% Accumulate	% Yield
5	38	9.352	0.009
6	69	9.389	0.037
7	97	9.519	0.130
8	124	9.934	0.415
9	150	11.122	1.188
10	173	14.046	2.924
11	196	19.819	5.773
12	216	28.450	8.631
13	236	38.370	9.920
14	254	47.896	9.526
15	271	56.229	8.333

Note:

1. **B.P.** = GC Calibration Curve of ASTM D2887

2. **% Accumulate** come from

$$y = y_0 + \frac{a}{\left[\left(1 + e^{-\left(\frac{x-x_0}{b} \right)} \right) \right]^c}$$

3. **% Yield** = % Accumulate_n - % Accumulate_{n-1}

Table II Carbon number distributions of Non-catalytic pyrolysis at 500°C and 25 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0935	0.0027	0.0001	0.0018	0.0000	0.2829
5	38	0.2522	0.0138	0.0003	0.0048	0.0003	0.3749
6	69	0.6272	0.0629	0.0013	0.0120	0.0010	0.4859
7	97	1.4232	0.2582	0.0051	0.0283	0.0025	0.6166
8	124	2.8796	0.9420	0.0187	0.0630	0.0063	0.7673
9	150	5.0214	2.9277	0.0625	0.1324	0.0146	0.9376
10	173	7.3185	7.0327	0.1919	0.2635	0.0319	1.1268
11	196	8.8757	11.6831	0.5410	0.4976	0.0660	1.3335
12	216	9.2359	13.4330	1.3848	0.8908	0.1298	1.5562
13	236	8.6570	12.1619	3.1313	1.5083	0.2425	1.7930
14	254	7.6389	9.8958	5.9601	2.4039	0.4314	2.0421
15	271	6.5400	7.7781	9.0869	3.5809	0.7312	2.3018
16	288	5.5299	6.0829	10.9773	4.9463	1.1800	2.5705
17	303	4.6628	4.7846	10.9930	6.2946	1.8110	2.8469
18	317	3.9404	3.7989	9.7872	7.3639	2.6380	3.1295
19	331	3.3458	3.0478	8.2066	7.9507	3.6387	3.4168
20	344	2.8581	2.4707	6.7111	8.0007	4.7423	3.7069
21	357	2.4573	2.0231	5.4499	7.6053	5.8319	3.9967
22	368	2.1268	1.6724	4.4326	6.9272	6.7669	4.2815
23	380	1.8527	1.3949	3.6248	6.1237	7.4204	4.5537
24	391	1.6241	1.1732	2.9849	5.3085	7.7160	4.8021
25	401	1.4322	0.9944	2.4761	4.5475	7.6453	5.0111
26	411	1.2699	0.8489	2.0691	3.8706	7.2609	5.1600
27	421	1.1318	0.7294	1.7408	3.2854	6.6518	5.2244
28	430	1.0134	0.6303	1.4740	2.7875	5.9151	5.1797
29	439	0.9110	0.5476	1.2552	2.3675	5.1353	5.0068
30	448	0.8219	0.4779	1.0744	2.0145	4.3751	4.6998
31	457	0.7438	0.4188	0.9237	1.7179	3.6735	4.2715
32	465	0.6746	0.3682	0.7972	1.4682	3.0506	3.7543
33	473	0.6130	0.3245	0.6901	1.2575	2.5127	3.1933
34	481	0.5577	0.2866	0.5990	1.0790	2.0573	2.6356
35	489	0.5076	0.2535	0.5208	0.9272	1.6773	2.1193
36	496	0.4618	0.2243	0.4533	0.7976	1.3634	1.6684
37	504	0.4198	0.1985	0.3948	0.6864	1.1059	1.2922
38	510	0.3809	0.1755	0.3437	0.5905	0.8957	0.9892
39	517	0.3445	0.1548	0.2989	0.5076	0.7247	0.7512
40	523	0.3103	0.1362	0.2593	0.4355	0.5856	0.5677
41	529	0.2780	0.1193	0.2241	0.3724	0.4725	0.4278
42	535	0.2470	0.1038	0.1926	0.3169	0.3802	0.3219
43	540	0.2171	0.0895	0.1642	0.2676	0.3047	0.2418
44	544	0.1881	0.0762	0.1382	0.2234	0.2424	0.1811
45	548	0.1594	0.0636	0.1143	0.1834	0.1905	0.1347
46	552	0.1309	0.0515	0.0918	0.1463	0.1464	0.0987
47	554	0.1020	0.0397	0.0703	0.1115	0.1080	0.0700
48	556	0.0724	0.0279	0.0492	0.0777	0.0735	0.0462
49	557	0.0414	0.0159	0.0279	0.0439	0.0408	0.0251
50	558	0.0083	0.0032	0.0056	0.0088	0.0081	0.0049
SUM		100	100	100	100	100	100

Table I2 Carbon number distributions of Non-catalytic pyrolysis at 500°C and 50 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0000	0.0000	0.0001	0.0003	0.0532
5	38	0.0885	0.0293	0.6690	0.0020	0.0031	0.4661
6	69	0.2720	0.1220	0.9156	0.0053	0.0068	0.6290
7	97	0.7578	0.4554	1.2227	0.0129	0.0142	0.8271
8	124	1.8668	1.4894	1.5955	0.0297	0.0280	1.0612
9	150	3.8758	3.9912	2.0373	0.0643	0.0527	1.3299
10	173	6.4186	7.8810	2.5488	0.1321	0.0948	1.6298
11	196	8.3373	10.8461	3.1270	0.2574	0.1637	1.9553
12	216	8.8940	11.2180	3.7635	0.4770	0.2720	2.2988
13	236	8.3979	9.9542	4.4429	0.8408	0.4359	2.6511
14	254	7.4576	8.3118	5.1393	1.4078	0.6750	3.0020
15	271	6.4530	6.8189	5.8137	2.2310	1.0116	3.3411
16	288	5.5378	5.5902	6.4125	3.3273	1.4688	3.6580
17	303	4.7522	4.6084	6.8696	4.6381	2.0659	3.9434
18	317	4.0932	3.8284	7.1166	6.0027	2.8121	4.1892
19	331	3.5444	3.2070	7.0999	7.1839	3.6978	4.3889
20	344	3.0878	2.7089	6.8009	7.9554	4.6841	4.5378
21	357	2.7066	2.3066	6.2488	8.2006	5.6969	4.6331
22	368	2.3871	1.9793	5.5158	7.9507	6.6290	4.6733
23	380	2.1178	1.7109	4.6956	7.3414	7.3578	4.6587
24	391	1.8897	1.4890	3.8767	6.5369	7.7758	4.5907
25	401	1.6951	1.3042	3.1238	5.6741	7.8242	4.4721
26	411	1.5282	1.1491	2.4718	4.8430	7.5112	4.3063
27	421	1.3840	1.0179	1.9314	4.0910	6.9064	4.0979
28	430	1.2586	0.9060	1.4969	3.4357	6.1147	3.8523
29	439	1.1487	0.8100	1.1549	2.8775	5.2442	3.5757
30	448	1.0517	0.7268	0.8892	2.4082	4.3833	3.2750
31	457	0.9654	0.6542	0.6845	2.0166	3.5908	2.9578
32	465	0.8880	0.5904	0.5274	1.6907	2.8973	2.6322
33	473	0.8179	0.5339	0.4072	1.4196	2.3119	2.3064
34	481	0.7539	0.4833	0.3151	1.1938	1.8305	1.9885
35	489	0.6950	0.4379	0.2445	1.0055	1.4418	1.6859
36	496	0.6402	0.3966	0.1903	0.8478	1.1320	1.4049
37	504	0.5890	0.3590	0.1485	0.7155	0.8871	1.1506
38	510	0.5406	0.3243	0.1161	0.6039	0.6947	0.9260
39	517	0.4944	0.2922	0.0911	0.5096	0.5440	0.7326
40	523	0.4501	0.2622	0.0715	0.4295	0.4261	0.5701
41	529	0.4071	0.2340	0.0563	0.3612	0.3337	0.4368
42	535	0.3652	0.2072	0.0443	0.3025	0.2612	0.3298
43	540	0.3238	0.1816	0.0348	0.2517	0.2040	0.2457
44	544	0.2827	0.1568	0.0272	0.2074	0.1586	0.1806
45	548	0.2413	0.1326	0.0210	0.1682	0.1220	0.1309
46	552	0.1993	0.1086	0.0159	0.1328	0.0921	0.0930
47	554	0.1562	0.0845	0.0116	0.1003	0.0670	0.0640
48	556	0.1112	0.0599	0.0078	0.0694	0.0450	0.0411
49	557	0.0637	0.0342	0.0043	0.0390	0.0248	0.0219
50	558	0.0128	0.0069	0.0009	0.0078	0.0049	0.0043
SUM		100	100	100	100	100	100

Table I3 Carbon number distributions of Non-catalytic pyrolysis at 500°C and 75 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0960	0.0000	0.0000	0.0003	0.0955
5	38	0.0368	0.0001	0.0002	0.0824	0.0032	0.8347
6	69	0.1304	0.0008	0.0009	0.1362	0.0072	1.1158
7	97	0.4178	0.0075	0.0036	0.2171	0.0151	1.4404
8	124	1.1863	0.0603	0.0128	0.3340	0.0300	1.7980
9	150	2.8414	0.4124	0.0414	0.4973	0.0569	2.1732
10	173	5.3396	2.2034	0.1241	0.7174	0.1033	2.5479
11	196	7.5665	7.0078	0.3421	1.0043	0.1797	2.9030
12	216	8.4512	10.9836	0.8622	1.3658	0.3005	3.2212
13	236	8.1607	10.9070	1.9447	1.8054	0.4842	3.4891
14	254	7.3510	9.3567	3.7777	2.3201	0.7528	3.6981
15	271	6.4420	7.8103	6.0558	2.8983	1.1311	3.8447
16	288	5.5995	6.5255	7.8849	3.5181	1.6427	3.9303
17	303	4.8679	5.4893	8.6012	4.1469	2.3048	3.9597
18	317	4.2474	4.6542	8.3316	4.7439	3.1199	3.9402
19	331	3.7249	3.9774	7.5573	5.2644	4.0650	3.8803
20	344	3.2851	3.4249	6.6451	5.6665	5.0828	3.7886
21	357	2.9139	2.9706	5.7727	5.9185	6.0797	3.6734
22	368	2.5994	2.5945	5.0020	6.0044	6.9363	3.5418
23	380	2.3317	2.2809	4.3429	5.9260	7.5341	3.3997
24	391	2.1026	2.0175	3.7861	5.7018	7.7884	3.2519
25	401	1.9054	1.7949	3.3169	5.3615	7.6749	3.1020
26	411	1.7347	1.6054	2.9208	4.9403	7.2344	2.9527
27	421	1.5860	1.4429	2.5848	4.4730	6.5549	2.8058
28	430	1.4555	1.3025	2.2981	3.9901	5.7422	2.6622
29	439	1.3404	1.1803	2.0518	3.5152	4.8925	2.5226
30	448	1.2378	1.0732	1.8386	3.0651	4.0776	2.3872
31	457	1.1458	0.9785	1.6528	2.6503	3.3412	2.2559
32	465	1.0625	0.8942	1.4895	2.2760	2.7033	2.1285
33	473	0.9864	0.8184	1.3450	1.9437	2.1673	2.0047
34	481	0.9163	0.7497	1.2161	1.6526	1.7264	1.8840
35	489	0.8510	0.6870	1.1002	1.3998	1.3695	1.7660
36	496	0.7897	0.6293	0.9954	1.1821	1.0835	1.6505
37	504	0.7316	0.5756	0.8997	0.9956	0.8560	1.5369
38	510	0.6760	0.5255	0.8119	0.8364	0.6758	1.4250
39	517	0.6223	0.4781	0.7306	0.7010	0.5335	1.3144
40	523	0.5701	0.4331	0.6549	0.5858	0.4212	1.2049
41	529	0.5187	0.3900	0.5839	0.4879	0.3324	1.0960
42	535	0.4678	0.3483	0.5166	0.4045	0.2621	0.9873
43	540	0.4169	0.3076	0.4523	0.3332	0.2061	0.8783
44	544	0.3656	0.2675	0.3903	0.2718	0.1612	0.7686
45	548	0.3134	0.2276	0.3298	0.2183	0.1247	0.6573
46	552	0.2598	0.1875	0.2700	0.1710	0.0946	0.5435
47	554	0.2041	0.1465	0.2100	0.1282	0.0691	0.4261
48	556	0.1457	0.1041	0.1487	0.0882	0.0466	0.3035
49	557	0.0836	0.0596	0.0849	0.0494	0.0258	0.1739
50	558	0.0168	0.0120	0.0170	0.0098	0.0051	0.0350
SUM		100	100	100	100	100	100

Table I4 Carbon number distributions of Non-catalytic pyrolysis at 600°C and 25 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0000	0.0000	0.1472	0.0019	0.0000
5	38	0.0653	0.0021	0.5158	1.2342	0.0201	0.9382
6	69	0.2120	0.0152	0.8797	1.5533	0.0377	1.6791
7	97	0.6229	0.0944	1.4202	1.9178	0.0678	2.7515
8	124	1.6196	0.5113	2.1659	2.3256	0.1167	4.0724
9	150	3.5471	2.2940	3.1116	2.7732	0.1934	5.3946
10	173	6.1481	7.2383	4.2003	3.2553	0.3089	6.4038
11	196	8.2258	13.0688	5.3180	3.7642	0.4770	6.9043
12	216	8.8964	14.2103	6.3143	4.2898	0.7135	6.9056
13	236	8.4402	12.0477	7.0450	4.8179	1.0363	6.5518
14	254	7.5074	9.4923	7.4181	5.3290	1.4630	6.0088
15	271	6.5034	7.3963	7.4177	5.7961	2.0097	5.4011
16	288	5.5882	5.7982	7.0970	6.1845	2.6863	4.8033
17	303	4.8029	4.5925	6.5488	6.4518	3.4912	4.2520
18	317	4.1440	3.6781	5.8733	6.5541	4.4030	3.7609
19	331	3.5949	2.9778	5.1556	6.4557	5.3730	3.3318
20	344	3.1374	2.4360	4.4559	6.1425	6.3195	2.9605
21	357	2.7551	2.0123	3.8105	5.6325	7.1328	2.6407
22	368	2.4341	1.6777	3.2368	4.9767	7.6942	2.3657
23	380	2.1633	1.4108	2.7391	4.2461	7.9089	2.1288
24	391	1.9334	1.1959	2.3145	3.5130	7.7389	1.9244
25	401	1.7372	1.0213	1.9557	2.8337	7.2194	1.7473
26	411	1.5685	0.8782	1.6545	2.2415	6.4455	1.5933
27	421	1.4227	0.7599	1.4023	1.7482	5.5386	1.4585
28	430	1.2957	0.6612	1.1912	1.3507	4.6110	1.3400
29	439	1.1843	0.5783	1.0143	1.0376	3.7441	1.2350
30	448	1.0857	0.5079	0.8659	0.7949	2.9835	1.1414
31	457	0.9980	0.4478	0.7408	0.6085	2.3453	1.0572
32	465	0.9191	0.3961	0.6352	0.4662	1.8265	0.9809
33	473	0.8476	0.3512	0.5455	0.3577	1.4140	0.9111
34	481	0.7823	0.3119	0.4692	0.2751	1.0909	0.8467
35	489	0.7220	0.2774	0.4040	0.2121	0.8402	0.7867
36	496	0.6659	0.2468	0.3480	0.1640	0.6470	0.7303
37	504	0.6133	0.2195	0.2998	0.1272	0.4985	0.6767
38	510	0.5635	0.1950	0.2581	0.0989	0.3847	0.6255
39	517	0.5159	0.1729	0.2220	0.0771	0.2973	0.5760
40	523	0.4701	0.1528	0.1904	0.0603	0.2301	0.5277
41	529	0.4257	0.1344	0.1628	0.0471	0.1783	0.4802
42	535	0.3821	0.1175	0.1385	0.0369	0.1383	0.4332
43	540	0.3391	0.1017	0.1169	0.0288	0.1071	0.3862
44	544	0.2963	0.0868	0.0976	0.0224	0.0827	0.3387
45	548	0.2531	0.0727	0.0800	0.0173	0.0632	0.2904
46	552	0.2092	0.0590	0.0638	0.0131	0.0475	0.2407
47	554	0.1639	0.0456	0.0486	0.0095	0.0344	0.1892
48	556	0.1168	0.0321	0.0338	0.0064	0.0230	0.1350
49	557	0.0669	0.0183	0.0191	0.0035	0.0127	0.0775
50	558	0.0135	0.0037	0.0038	0.0007	0.0025	0.0156
SUM		100	100	100	100	100	100

Table 15 Carbon number distributions of Non-catalytic pyrolysis at 600°C and 50 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0004	0.0000	0.0000	0.0018	0.0871
5	38	0.1611	0.0076	0.0000	0.0000	0.0188	0.7398
6	69	0.3783	0.0323	0.0000	0.0000	0.0323	0.9491
7	97	0.8218	0.1250	0.0000	0.0000	0.0534	1.1893
8	124	1.6311	0.4359	0.0000	0.0001	0.0851	1.4571
9	150	2.8983	1.3437	0.0000	0.0004	0.1310	1.7473
10	173	4.5045	3.4691	0.0000	0.0012	0.1954	2.0528
11	196	6.0399	6.8635	0.0020	0.0035	0.2831	2.3651
12	216	7.0407	9.8211	0.0352	0.0099	0.3994	2.6751
13	236	7.3359	10.6577	0.2731	0.0260	0.5497	2.9734
14	254	7.0755	9.8130	1.1314	0.0644	0.7397	3.2511
15	271	6.5119	8.3975	2.9126	0.1500	0.9752	3.5003
16	288	5.8417	7.0058	5.2918	0.3303	1.2614	3.7148
17	303	5.1766	5.8164	7.4964	0.6878	1.6037	3.8900
18	317	4.5666	4.8449	8.9203	1.3487	2.0061	4.0231
19	331	4.0284	4.0617	9.4096	2.4665	2.4715	4.1132
20	344	3.5622	3.4306	9.1402	4.1386	2.9999	4.1606
21	357	3.1618	2.9199	8.3964	6.2397	3.5869	4.1671
22	368	2.8190	2.5041	7.4302	8.2987	4.2209	4.1353
23	380	2.5253	2.1630	6.4155	9.6789	4.8803	4.0683
24	391	2.2730	1.8812	5.4527	10.0177	5.5299	3.9697
25	401	2.0556	1.6466	4.5897	9.4375	6.1200	3.8429
26	411	1.8672	1.4498	3.8419	8.3298	6.5885	3.6915
27	421	1.7032	1.2834	3.2072	7.0600	6.8696	3.5192
28	430	1.5594	1.1417	2.6750	5.8485	6.9099	3.3293
29	439	1.4326	1.0200	2.2319	4.7894	6.6855	3.1252
30	448	1.3199	0.9147	1.8641	3.9036	6.2143	2.9101
31	457	1.2189	0.8229	1.5592	3.1790	5.5544	2.6875
32	465	1.1277	0.7422	1.3062	2.5920	4.7876	2.4607
33	473	1.0446	0.6707	1.0960	2.1181	3.9971	2.2330
34	481	0.9681	0.6069	0.9209	1.7352	3.2495	2.0077
35	489	0.8972	0.5496	0.7748	1.4251	2.5866	1.7880
36	496	0.8308	0.4975	0.6524	1.1731	2.0262	1.5768
37	504	0.7681	0.4501	0.5497	0.9675	1.5690	1.3768
38	510	0.7083	0.4064	0.4631	0.7991	1.2056	1.1901
39	517	0.6508	0.3660	0.3900	0.6605	0.9218	1.0184
40	523	0.5951	0.3283	0.3280	0.5459	0.7029	0.8625
41	529	0.5405	0.2928	0.2751	0.4507	0.5351	0.7229
42	535	0.4867	0.2592	0.2299	0.3711	0.4071	0.5993
43	540	0.4331	0.2271	0.1909	0.3040	0.3092	0.4909
44	544	0.3793	0.1961	0.1569	0.2469	0.2340	0.3966
45	548	0.3248	0.1658	0.1270	0.1977	0.1758	0.3146
46	552	0.2689	0.1358	0.1001	0.1545	0.1299	0.2430
47	554	0.2111	0.1056	0.0755	0.1156	0.0928	0.1797
48	556	0.1505	0.0748	0.0522	0.0795	0.0616	0.1223
49	557	0.0863	0.0427	0.0293	0.0445	0.0336	0.0679
50	558	0.0174	0.0086	0.0058	0.0089	0.0066	0.0135
SUM		100	100	100	100	100	100

Table I6 Carbon number distributions of Non-catalytic pyrolysis at 600°C and 75 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	38	0.0914	0.0021	0.0000	0.0000	0.0782	1.6524
6	69	0.2668	0.0137	0.0002	0.0000	0.1293	1.8976
7	97	0.7094	0.0800	0.0011	0.0000	0.2060	2.1492
8	124	1.6812	0.4100	0.0055	0.0001	0.3170	2.4024
9	150	3.4101	1.7751	0.0245	0.0004	0.4721	2.6523
10	173	5.6474	5.7091	0.0977	0.0021	0.6812	2.8935
11	196	7.4948	11.2446	0.3522	0.0091	0.9542	3.1212
12	216	8.2447	13.4172	1.1299	0.0362	1.2986	3.3301
13	236	8.0132	12.0268	3.0728	0.1314	1.7184	3.5159
14	254	7.2835	9.7608	6.4739	0.4337	2.2116	3.6742
15	271	6.4181	7.7505	9.8045	1.2769	2.7685	3.8017
16	288	5.5890	6.1658	11.0073	3.1858	3.3697	3.8956
17	303	4.8553	4.9467	10.2673	6.2023	3.9857	3.9544
18	317	4.2270	4.0085	8.8059	8.9256	4.5790	3.9774
19	331	3.6956	3.2811	7.3340	9.8978	5.1072	3.9649
20	344	3.2479	2.7120	6.0714	9.3703	5.5293	3.9186
21	357	2.8704	2.2624	5.0414	8.2488	5.8124	3.8409
22	368	2.5511	1.9039	4.2127	7.0703	5.9376	3.7349
23	380	2.2799	1.6154	3.5463	6.0209	5.9021	3.6043
24	391	2.0484	1.3811	3.0076	5.1355	5.7198	3.4533
25	401	1.8498	1.1892	2.5691	4.4005	5.4165	3.2859
26	411	1.6783	1.0307	2.2093	3.7918	5.0246	3.1064
27	421	1.5293	0.8987	1.9116	3.2857	4.5780	2.9185
28	430	1.3990	0.7877	1.6633	2.8624	4.1073	2.7260
29	439	1.2842	0.6938	1.4546	2.5058	3.6372	2.5319
30	448	1.1823	0.6137	1.2776	2.2030	3.1861	2.3390
31	457	1.0912	0.5447	1.1264	1.9440	2.7660	2.1496
32	465	1.0089	0.4849	0.9962	1.7208	2.3837	1.9657
33	473	0.9340	0.4327	0.8832	1.5269	2.0420	1.7888
34	481	0.8652	0.3868	0.7845	1.3573	1.7406	1.6201
35	489	0.8015	0.3460	0.6976	1.2080	1.4777	1.4603
36	496	0.7418	0.3097	0.6206	1.0755	1.2502	1.3102
37	504	0.6855	0.2770	0.5520	0.9573	1.0546	1.1698
38	510	0.6319	0.2474	0.4904	0.8511	0.8872	1.0393
39	517	0.5804	0.2205	0.4348	0.7551	0.7444	0.9185
40	523	0.5304	0.1959	0.3842	0.6677	0.6227	0.8070
41	529	0.4816	0.1731	0.3380	0.5877	0.5191	0.7043
42	535	0.4335	0.1519	0.2953	0.5137	0.4306	0.6097
43	540	0.3857	0.1320	0.2556	0.4449	0.3549	0.5224
44	544	0.3377	0.1131	0.2182	0.3800	0.2896	0.4414
45	548	0.2891	0.0950	0.1827	0.3183	0.2327	0.3658
46	552	0.2393	0.0774	0.1483	0.2585	0.1823	0.2942
47	554	0.1878	0.0599	0.1146	0.1998	0.1367	0.2254
48	556	0.1339	0.0423	0.0807	0.1408	0.0941	0.1577
49	557	0.0768	0.0241	0.0459	0.0801	0.0527	0.0893
50	558	0.0154	0.0048	0.0092	0.0161	0.0105	0.0179
SUM		100	100	100	100	100	100

Table I7 Carbon number distributions of Non-catalytic pyrolysis at 700°C and 25 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0002	0.1857	0.0022	0.4851	3.8317	0.1725
5	38	0.0146	0.7714	0.0041	1.1988	5.7685	0.2396
6	69	0.2036	2.0512	0.0075	2.7170	8.2483	0.3245
7	97	1.0690	3.9020	0.0130	5.5337	11.0139	0.4292
8	124	2.9631	5.8112	0.0217	9.7758	13.3685	0.5551
9	150	5.4088	7.2627	0.0350	14.3068	14.2822	0.7033
10	173	7.5135	8.0203	0.0544	16.7158	13.1221	0.8743
11	196	8.7276	8.1245	0.0821	15.5550	10.3876	1.0680
12	216	9.0159	7.7544	0.1203	11.9892	7.2931	1.2839
13	236	8.6251	7.1074	0.1715	8.1345	4.7344	1.5209
14	254	7.8488	6.3408	0.2387	5.1426	2.9518	1.7779
15	271	6.9169	5.5588	0.3248	3.1548	1.8159	2.0535
16	288	5.9752	4.8213	0.4332	1.9250	1.1206	2.3461
17	303	5.1015	4.1570	0.5673	1.1842	0.7000	2.6542
18	317	4.3289	3.5752	0.7308	0.7396	0.4447	2.9758
19	331	3.6650	3.0745	0.9279	0.4703	0.2878	3.3087
20	344	3.1039	2.6481	1.1627	0.3049	0.1898	3.6495
21	357	2.6343	2.2871	1.4399	0.2014	0.1275	3.9934
22	368	2.2430	1.9822	1.7642	0.1355	0.0872	4.3333
23	380	1.9175	1.7247	2.1402	0.0927	0.0606	4.6584
24	391	1.6465	1.5070	2.5718	0.0645	0.0428	4.9540
25	401	1.4202	1.3224	3.0609	0.0455	0.0307	5.2002
26	411	1.2305	1.1653	3.6060	0.0326	0.0223	5.3730
27	421	1.0709	1.0310	4.1993	0.0236	0.0164	5.4464
28	430	0.9358	0.9155	4.8238	0.0173	0.0122	5.3966
29	439	0.8208	0.8158	5.4491	0.0128	0.0091	5.2089
30	448	0.7224	0.7291	6.0291	0.0096	0.0069	4.8839
31	457	0.6376	0.6532	6.5026	0.0072	0.0053	4.4408
32	465	0.5642	0.5865	6.8007	0.0055	0.0040	3.9152
33	473	0.5001	0.5274	6.8623	0.0042	0.0031	3.3519
34	481	0.4440	0.4746	6.6542	0.0032	0.0024	2.7944
35	489	0.3944	0.4274	6.1876	0.0025	0.0019	2.2771
36	496	0.3504	0.3847	5.5193	0.0019	0.0015	1.8214
37	504	0.3112	0.3459	4.7358	0.0015	0.0012	1.4360
38	510	0.2759	0.3105	3.9274	0.0012	0.0009	1.1200
39	517	0.2442	0.2780	3.1664	0.0009	0.0007	0.8670
40	523	0.2153	0.2479	2.4969	0.0007	0.0006	0.6678
41	529	0.1890	0.2198	1.9364	0.0006	0.0005	0.5126
42	535	0.1648	0.1936	1.4834	0.0005	0.0004	0.3925
43	540	0.1423	0.1687	1.1258	0.0004	0.0003	0.2997
44	544	0.1213	0.1449	0.8471	0.0003	0.0002	0.2279
45	548	0.1013	0.1220	0.6306	0.0002	0.0002	0.1717
46	552	0.0822	0.0995	0.4614	0.0002	0.0001	0.1273
47	554	0.0634	0.0772	0.3264	0.0001	0.0001	0.0911
48	556	0.0446	0.0545	0.2148	0.0001	0.0001	0.0605
49	557	0.0254	0.0311	0.1167	0.0000	0.0000	0.0331
50	558	0.0051	0.0062	0.0229	0.0000	0.0000	0.0065
SUM		100	100	100	100	100	100

Table 18 Carbon number distributions of Non-catalytic pyrolysis at 700°C and 50 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0000	0.0000	0.0000	0.0015	0.0000
5	38	0.1259	0.0000	0.0100	0.0004	0.0170	0.0000
6	69	0.3308	0.0003	0.0388	0.0018	0.0357	0.0000
7	97	0.7976	0.0049	0.1366	0.0064	0.0710	0.2889
8	124	1.7351	0.0783	0.4373	0.0213	0.1343	6.0225
9	150	3.3059	0.9862	1.2523	0.0648	0.2422	6.5065
10	173	5.3274	6.9353	3.0814	0.1823	0.4171	5.9612
11	196	7.1302	15.1289	6.0831	0.4730	0.6867	5.4716
12	216	8.0644	14.5192	9.0942	1.1205	1.0814	5.0321
13	236	8.0608	11.4641	10.4531	2.3674	1.6279	4.6377
14	254	7.4703	8.9289	10.0380	4.2980	2.3400	4.2835
15	271	6.6508	7.0209	8.7805	6.4741	3.2060	3.9657
16	288	5.8128	5.5855	7.3875	8.0462	4.1786	3.6805
17	303	5.0471	4.4945	6.1410	8.5409	5.1724	3.4247
18	317	4.3808	3.6559	5.1037	8.1680	6.0759	3.1954
19	331	3.8134	3.0043	4.2621	7.3718	6.7759	2.9900
20	344	3.3345	2.4928	3.5834	6.4709	7.1885	2.8061
21	357	2.9311	2.0873	3.0354	5.6182	7.2807	2.6415
22	368	2.5907	1.7628	2.5905	4.8667	7.0739	2.4942
23	380	2.3027	1.5008	2.2271	4.2242	6.6301	2.3624
24	391	2.0577	1.2873	1.9280	3.6813	6.0298	2.2444
25	401	1.8483	1.1120	1.6799	3.2238	5.3513	2.1385
26	411	1.6683	0.9667	1.4727	2.8374	4.6582	2.0433
27	421	1.5126	0.8453	1.2982	2.5097	3.9951	1.9573
28	430	1.3769	0.7431	1.1501	2.2301	3.3883	1.8793
29	439	1.2580	0.6563	1.0235	1.9899	2.8503	1.8079
30	448	1.1528	0.5820	0.9143	1.7822	2.3837	1.7420
31	457	1.0591	0.5180	0.8195	1.6012	1.9853	1.6804
32	465	0.9749	0.4623	0.7364	1.4422	1.6490	1.6220
33	473	0.8987	0.4135	0.6631	1.3016	1.3671	1.5658
34	481	0.8291	0.3705	0.5980	1.1762	1.1322	1.5107
35	489	0.7648	0.3322	0.5396	1.0636	0.9370	1.4557
36	496	0.7051	0.2980	0.4870	0.9617	0.7751	1.3999
37	504	0.6491	0.2671	0.4391	0.8689	0.6409	1.3424
38	510	0.5962	0.2391	0.3953	0.7837	0.5298	1.2823
39	517	0.5456	0.2135	0.3550	0.7050	0.4376	1.2187
40	523	0.4970	0.1900	0.3175	0.6317	0.3611	1.1507
41	529	0.4499	0.1682	0.2825	0.5629	0.2973	1.0775
42	535	0.4037	0.1479	0.2495	0.4978	0.2441	0.9982
43	540	0.3582	0.1287	0.2181	0.4357	0.1993	0.9120
44	544	0.3128	0.1105	0.1879	0.3759	0.1613	0.8181
45	548	0.2672	0.0929	0.1586	0.3175	0.1287	0.7156
46	552	0.2207	0.0757	0.1296	0.2599	0.1002	0.6035
47	554	0.1730	0.0587	0.1007	0.2021	0.0748	0.4810
48	556	0.1232	0.0414	0.0713	0.1431	0.0513	0.3470
49	557	0.0706	0.0236	0.0407	0.0817	0.0287	0.2006
50	558	0.0142	0.0047	0.0082	0.0164	0.0057	0.0405
SUM		100	100	100	100	100	100

Table 19 Carbon number distributions of Non-catalytic pyrolysis at 700°C and 75 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0005	0.0000	0.0000	0.0000	0.0613
5	38	0.0000	0.0027	0.0000	0.0000	0.0000	0.5331
6	69	0.1516	0.0158	0.0001	0.0000	0.0001	0.7100
7	97	0.4040	0.0820	0.0004	0.0000	0.0002	0.9217
8	124	0.9746	0.3765	0.0018	0.0001	0.0006	1.1677
9	150	2.0690	1.4774	0.0074	0.0007	0.0018	1.4454
10	173	3.7113	4.4582	0.0278	0.0033	0.0045	1.7498
11	196	5.4560	8.8341	0.0959	0.0140	0.0107	2.0737
12	216	6.6315	11.2045	0.3022	0.0502	0.0241	2.4085
13	236	6.9858	10.7387	0.8618	0.1548	0.0514	2.7441
14	254	6.7435	9.2011	2.1577	0.4076	0.1042	3.0700
15	271	6.2186	7.6379	4.4735	0.9176	0.2018	3.3760
16	288	5.6150	6.3164	7.2236	1.7737	0.3736	3.6526
17	303	5.0291	5.2494	9.0184	2.9707	0.6618	3.8922
18	317	4.4975	4.3956	9.2791	4.3678	1.1213	4.0885
19	331	4.0291	3.7106	8.5562	5.7286	1.8116	4.2375
20	344	3.6216	3.1577	7.5046	6.8194	2.7763	4.3371
21	357	3.2688	2.7081	6.4610	7.4952	4.0058	4.3871
22	368	2.9636	2.3398	5.5395	7.7269	5.3963	4.3888
23	380	2.6991	2.0358	4.7595	7.5752	6.7392	4.3445
24	391	2.4692	1.7830	4.1082	7.1442	7.7772	4.2576
25	401	2.2686	1.5712	3.5656	6.5427	8.3150	4.1322
26	411	2.0927	1.3924	3.1122	5.8614	8.3040	3.9726
27	421	1.9377	1.2404	2.7311	5.1663	7.8395	3.7836
28	430	1.8003	1.1102	2.4087	4.4997	7.0882	3.5701
29	439	1.6775	0.9978	2.1340	3.8855	6.2120	3.3370
30	448	1.5671	0.8999	1.8981	3.3343	5.3289	3.0893
31	457	1.4668	0.8141	1.6940	2.8487	4.5080	2.8321
32	465	1.3750	0.7383	1.5160	2.4262	3.7806	2.5704
33	473	1.2900	0.6707	1.3592	2.0616	3.1544	2.3091
34	481	1.2106	0.6101	1.2212	1.7489	2.6247	2.0528
35	489	1.1356	0.5551	1.0979	1.4817	2.1812	1.8058
36	496	1.0640	0.5050	0.9871	1.2539	1.8118	1.5716
37	504	0.9949	0.4590	0.8869	1.0599	1.5048	1.3533
38	510	0.9276	0.4163	0.7957	0.8949	1.2498	1.1531
39	517	0.8613	0.3766	0.7122	0.7543	1.0376	0.9723
40	523	0.7954	0.3392	0.6350	0.6344	0.8608	0.8115
41	529	0.7294	0.3037	0.5633	0.5320	0.7128	0.6704
42	535	0.6626	0.2698	0.4961	0.4441	0.5884	0.5481
43	540	0.5945	0.2372	0.4325	0.3683	0.4831	0.4432
44	544	0.5245	0.2054	0.3717	0.3023	0.3931	0.3537
45	548	0.4521	0.1741	0.3130	0.2443	0.3152	0.2775
46	552	0.3765	0.1429	0.2555	0.1923	0.2466	0.2124
47	554	0.2969	0.1114	0.1982	0.1448	0.1848	0.1558
48	556	0.2125	0.0790	0.1401	0.1000	0.1271	0.1054
49	557	0.1222	0.0452	0.0799	0.0562	0.0712	0.0583
50	558	0.0246	0.0091	0.0160	0.0112	0.0142	0.0115
SUM		100	100	100	100	100	100

Table I10 Carbon number distributions of Non-catalytic pyrolysis at 400°C and 50 min residence time

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0000	0.0000	0.0000	0.0986	0.0000
5	38	0.0000	0.0000	0.0000	0.0505	0.8115	5.3606
6	69	0.0000	0.0371	0.0002	0.0890	0.9921	6.0017
7	97	0.2891	0.1789	0.0040	0.1505	1.1920	6.3358
8	124	2.0648	0.7597	0.0704	0.2451	1.4094	6.3763
9	150	5.0085	2.7182	1.0098	0.3850	1.6420	6.1867
10	173	9.0214	7.2554	9.7517	0.5851	1.8869	5.8458
11	196	11.6504	12.4907	31.0923	0.8617	2.1414	5.4238
12	216	11.6454	14.0520	27.3226	1.2319	2.4026	4.9725
13	236	10.1334	12.3145	14.5223	1.7117	2.6682	4.5258
14	254	8.3309	9.8073	7.3684	2.3130	2.9358	4.1030
15	271	6.7334	7.6223	3.8480	3.0385	3.2037	3.7141
16	288	5.4394	5.9275	2.0813	3.8762	3.4706	3.3626
17	303	4.4199	4.6488	1.1641	4.7914	3.7356	3.0486
18	317	3.6211	3.6850	0.6717	5.7214	3.9980	2.7699
19	331	2.9931	2.9534	0.3988	6.5755	4.2565	2.5239
20	344	2.4961	2.3924	0.2432	7.2460	4.5095	2.3070
21	357	2.0997	1.9579	0.1519	7.6326	4.7529	2.1161
22	368	1.7809	1.6177	0.0971	7.6725	4.9797	1.9481
23	380	1.5223	1.3488	0.0633	7.3636	5.1772	1.8000
24	391	1.3108	1.1340	0.0421	6.7654	5.3250	1.6693
25	401	1.1363	0.9608	0.0284	5.9777	5.3934	1.5536
26	411	0.9913	0.8199	0.0195	5.1092	5.3444	1.4508
27	421	0.8698	0.7042	0.0136	4.2510	5.1388	1.3590
28	430	0.7671	0.6084	0.0096	3.4639	4.7519	1.2767
29	439	0.6796	0.5284	0.0068	2.7792	4.1922	1.2024
30	448	0.6046	0.4610	0.0049	2.2055	3.5121	1.1348
31	457	0.5396	0.4039	0.0036	1.7374	2.7948	1.0726
32	465	0.4830	0.3549	0.0026	1.3623	2.1236	1.0151
33	473	0.4333	0.3128	0.0019	1.0655	1.5542	0.9611
34	481	0.3892	0.2762	0.0014	0.8324	1.1066	0.9099
35	489	0.3499	0.2442	0.0011	0.6504	0.7736	0.8608
36	496	0.3147	0.2160	0.0008	0.5085	0.5351	0.8132
37	504	0.2828	0.1911	0.0006	0.3981	0.3684	0.7664
38	510	0.2538	0.1689	0.0005	0.3121	0.2535	0.7200
39	517	0.2271	0.1490	0.0004	0.2450	0.1749	0.6733
40	523	0.2026	0.1311	0.0003	0.1926	0.1212	0.6261
41	529	0.1797	0.1148	0.0002	0.1515	0.0845	0.5779
42	535	0.1583	0.0998	0.0002	0.1192	0.0593	0.5281
43	540	0.1380	0.0861	0.0001	0.0935	0.0419	0.4765
44	544	0.1186	0.0732	0.0001	0.0730	0.0297	0.4226
45	548	0.0999	0.0611	0.0001	0.0565	0.0210	0.3659
46	552	0.0815	0.0495	0.0001	0.0428	0.0148	0.3058
47	554	0.0633	0.0381	0.0000	0.0312	0.0102	0.2420
48	556	0.0447	0.0268	0.0000	0.0211	0.0065	0.1736
49	557	0.0255	0.0152	0.0000	0.0116	0.0035	0.1000
50	558	0.0051	0.0031	0.0000	0.0023	0.0007	0.0201
SUM		100	100	100	100	100	100

Table III Carbon number distributions of catalytic pyrolysis with HMOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0000	0.0005	0.0000	0.0000	0.0051	0.0288
5	38	0.3033	0.0006	0.0018	13.0055	0.0000	0.0000
6	69	0.7270	0.0078	0.0055	11.2255	0.0000	0.0000
7	97	1.5950	0.0759	0.0159	9.6259	19.3420	0.0000
8	124	3.1624	0.5120	0.0429	8.2276	15.1738	5.4391
9	150	5.5651	2.2589	0.1082	7.0264	11.9063	5.8227
10	173	8.5239	6.3608	0.2558	6.0058	9.3763	6.1667
11	196	11.2014	11.7436	0.5704	5.1444	7.4265	6.4582
12	216	12.6079	15.2860	1.2041	4.4199	5.9239	6.6818
13	236	12.3279	15.3938	2.4151	3.8113	4.7625	6.8195
14	254	10.7513	13.0838	4.6075	3.3002	3.8605	6.8520
15	271	8.6256	10.0381	8.3111	2.8703	3.1557	6.7614
16	288	6.5511	7.2790	13.7989	2.5081	2.6015	6.5354
17	303	4.8184	5.1367	19.5819	2.2022	2.1624	6.1730
18	317	3.4886	3.5909	20.8395	1.9432	1.8123	5.6882
19	331	2.5137	2.5127	15.0206	1.7233	1.5309	5.1102
20	344	1.8152	1.7704	7.7024	1.5358	1.3032	4.4793
21	357	1.3193	1.2601	3.2811	1.3756	1.1177	3.8388
22	368	0.9673	0.9074	1.3176	1.2382	0.9655	3.2263
23	380	0.7164	0.6615	0.5305	1.1199	0.8398	2.6690
24	391	0.5362	0.4882	0.2190	1.0176	0.7352	2.1815
25	401	0.4056	0.3646	0.0934	0.9289	0.6476	1.7680
26	411	0.3099	0.2754	0.0411	0.8515	0.5737	1.4250
27	421	0.2392	0.2102	0.0187	0.7837	0.5110	1.1452
28	430	0.1862	0.1620	0.0087	0.7240	0.4574	0.9195
29	439	0.1462	0.1260	0.0042	0.6711	0.4112	0.7385
30	448	0.1157	0.0988	0.0020	0.6238	0.3711	0.5939
31	457	0.0922	0.0780	0.0010	0.5813	0.3361	0.4786
32	465	0.0739	0.0620	0.0005	0.5428	0.3053	0.3866
33	473	0.0596	0.0496	0.0003	0.5075	0.2779	0.3130
34	481	0.0482	0.0399	0.0001	0.4749	0.2533	0.2541
35	489	0.0392	0.0322	0.0001	0.4446	0.2312	0.2067
36	496	0.0320	0.0261	0.0000	0.4160	0.2111	0.1686
37	504	0.0262	0.0212	0.0000	0.3887	0.1926	0.1377
38	510	0.0215	0.0173	0.0000	0.3626	0.1756	0.1127
39	517	0.0177	0.0141	0.0000	0.3372	0.1598	0.0923
40	523	0.0146	0.0116	0.0000	0.3123	0.1449	0.0757
41	529	0.0120	0.0095	0.0000	0.2878	0.1308	0.0620
42	535	0.0099	0.0077	0.0000	0.2633	0.1174	0.0508
43	540	0.0081	0.0063	0.0000	0.2386	0.1046	0.0415
44	544	0.0066	0.0051	0.0000	0.2137	0.0921	0.0338
45	548	0.0054	0.0041	0.0000	0.1882	0.0799	0.0272
46	552	0.0043	0.0033	0.0000	0.1619	0.0679	0.0217
47	554	0.0033	0.0026	0.0000	0.1346	0.0558	0.0168
48	556	0.0025	0.0019	0.0000	0.1061	0.0435	0.0125
49	557	0.0017	0.0013	0.0000	0.0758	0.0309	0.0086
50	558	0.0010	0.0007	0.0000	0.0436	0.0177	0.0048
SUM		100	100	100	100	100	100

Table I12 Carbon number distributions of catalytic pyrolysis with 0.3%Ru/MOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0342	0.0034	0.0011	0.0003	0.0000	0.0008
5	38	0.1154	0.0161	0.0049	0.0012	0.0000	0.0047
6	69	0.3574	0.0688	0.0196	0.0045	0.0000	0.0232
7	97	1.0097	0.2659	0.0721	0.0152	0.0001	0.1027
8	124	2.5602	0.9241	0.2420	0.0472	0.0007	0.4038
9	150	5.6060	2.8175	0.7415	0.1350	0.0032	1.3576
10	173	9.9806	7.0568	2.0521	0.3584	0.0139	3.5471
11	196	13.7030	13.0614	4.9708	0.8806	0.0551	6.4306
12	216	14.5391	16.6859	9.9101	1.9865	0.1990	8.1246
13	236	12.7080	15.5500	15.0818	4.0322	0.6516	8.1837
14	254	9.9254	12.0568	16.9533	7.1210	1.8954	7.4724
15	271	7.3619	8.6562	14.7813	10.5279	4.6345	6.6010
16	288	5.3691	6.0850	10.9965	12.7513	8.7331	5.7853
17	303	3.9170	4.2882	7.5838	12.8379	11.9870	5.0755
18	317	2.8811	3.0566	5.0959	11.2415	12.5144	4.4711
19	331	2.1437	2.2102	3.4196	9.0208	11.0630	3.9592
20	344	1.6152	1.6221	2.3169	6.9135	9.0665	3.5251
21	357	1.2326	1.2080	1.5918	5.1957	7.2368	3.1559
22	368	0.9522	0.9121	1.1104	3.8866	5.7498	2.8405
23	380	0.7442	0.6975	0.7864	2.9166	4.5872	2.5700
24	391	0.5880	0.5399	0.5652	2.2041	3.6865	2.3367
25	401	0.4693	0.4225	0.4117	1.6800	2.9871	2.1345
26	411	0.3780	0.3339	0.3037	1.2922	2.4403	1.9583
27	421	0.3071	0.2664	0.2266	1.0029	2.0090	1.8038
28	430	0.2514	0.2143	0.1708	0.7850	1.6657	1.6674
29	439	0.2072	0.1736	0.1300	0.6192	1.3900	1.5462
30	448	0.1719	0.1416	0.0998	0.4920	1.1666	1.4376
31	457	0.1433	0.1162	0.0772	0.3934	0.9841	1.3395
32	465	0.1200	0.0959	0.0601	0.3164	0.8337	1.2501
33	473	0.1010	0.0794	0.0471	0.2558	0.7089	1.1679
34	481	0.0852	0.0660	0.0371	0.2076	0.6046	1.0914
35	489	0.0721	0.0551	0.0293	0.1692	0.5168	1.0197
36	496	0.0611	0.0460	0.0233	0.1383	0.4425	0.9517
37	504	0.0519	0.0386	0.0186	0.1133	0.3793	0.8865
38	510	0.0441	0.0323	0.0148	0.0931	0.3252	0.8235
39	517	0.0374	0.0271	0.0119	0.0765	0.2787	0.7620
40	523	0.0317	0.0227	0.0095	0.0629	0.2384	0.7013
41	529	0.0269	0.0190	0.0077	0.0517	0.2033	0.6411
42	535	0.0226	0.0159	0.0061	0.0424	0.1726	0.5807
43	540	0.0189	0.0131	0.0049	0.0346	0.1454	0.5196
44	544	0.0157	0.0108	0.0039	0.0280	0.1212	0.4573
45	548	0.0128	0.0087	0.0031	0.0223	0.0993	0.3933
46	552	0.0101	0.0069	0.0024	0.0174	0.0791	0.3269
47	554	0.0077	0.0052	0.0017	0.0130	0.0602	0.2574
48	556	0.0053	0.0036	0.0012	0.0089	0.0419	0.1840
49	557	0.0030	0.0020	0.0007	0.0050	0.0237	0.1057
50	558	0.0006	0.0004	0.0001	0.0010	0.0047	0.0213
SUM		100	100	100	100	100	100

Table I13 Carbon number distributions of catalytic pyrolysis with 0.7%Ru/MOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0042	0.0138	0.0081	0.0415	0.1659	0.0001
5	38	0.0248	0.0552	0.0247	0.0864	0.2648	0.0017
6	69	0.1299	0.2005	0.0695	0.1711	0.4085	0.0228
7	97	0.6012	0.6615	0.1821	0.3226	0.6101	0.1510
8	124	2.3785	1.9646	0.4448	0.5810	0.8842	0.5856
9	150	7.2189	5.0802	1.0117	1.0017	1.2463	1.5098
10	173	14.1024	10.6686	2.1308	1.6549	1.7118	2.8731
11	196	16.8153	16.6169	4.0990	2.6184	2.2954	4.3765
12	216	14.4665	18.3900	7.0369	3.9555	3.0101	5.6735
13	236	10.9002	15.3194	10.4615	5.6688	3.8655	6.5492
14	254	7.9376	10.7598	13.1237	7.6283	4.8640	6.9579
15	271	5.7838	7.0066	13.8015	9.5097	5.9934	6.9682
16	288	4.2617	4.4651	12.4153	10.8309	7.2107	6.6932
17	303	3.1843	2.8556	9.9310	11.1625	8.4156	6.2441
18	317	2.4134	1.8522	7.3654	10.4034	9.4187	5.7090
19	331	1.8545	1.2230	5.2398	8.8550	9.9370	5.1497
20	344	1.4436	0.8228	3.6595	7.0059	9.6841	4.6048
21	357	1.1376	0.5638	2.5453	5.2583	8.5727	4.0959
22	368	0.9067	0.3932	1.7774	3.8146	6.8593	3.6334
23	380	0.7304	0.2786	1.2515	2.7146	5.0138	3.2200
24	391	0.5942	0.2005	0.8905	1.9153	3.4215	2.8545
25	401	0.4878	0.1462	0.6407	1.3493	2.2334	2.5334
26	411	0.4038	0.1080	0.4661	0.9534	1.4232	2.2522
27	421	0.3368	0.0807	0.3428	0.6774	0.8982	2.0062
28	430	0.2828	0.0610	0.2546	0.4845	0.5666	1.7907
29	439	0.2389	0.0465	0.1909	0.3492	0.3591	1.6016
30	448	0.2030	0.0357	0.1443	0.2536	0.2293	1.4350
31	457	0.1732	0.0277	0.1100	0.1855	0.1477	1.2879
32	465	0.1485	0.0216	0.0844	0.1367	0.0960	1.1573
33	473	0.1277	0.0169	0.0652	0.1014	0.0630	1.0408
34	481	0.1101	0.0133	0.0506	0.0756	0.0418	0.9364
35	489	0.0951	0.0106	0.0395	0.0568	0.0279	0.8424
36	496	0.0822	0.0084	0.0310	0.0428	0.0188	0.7573
37	504	0.0712	0.0067	0.0244	0.0325	0.0128	0.6799
38	510	0.0616	0.0054	0.0192	0.0247	0.0088	0.6093
39	517	0.0533	0.0043	0.0152	0.0189	0.0061	0.5443
40	523	0.0460	0.0035	0.0121	0.0145	0.0042	0.4844
41	529	0.0395	0.0028	0.0096	0.0112	0.0030	0.4287
42	535	0.0338	0.0022	0.0076	0.0086	0.0021	0.3766
43	540	0.0287	0.0018	0.0060	0.0066	0.0015	0.3275
44	544	0.0241	0.0014	0.0048	0.0051	0.0011	0.2808
45	548	0.0198	0.0011	0.0037	0.0039	0.0008	0.2359
46	552	0.0159	0.0009	0.0028	0.0029	0.0005	0.1922
47	554	0.0121	0.0006	0.0021	0.0021	0.0004	0.1488
48	556	0.0085	0.0004	0.0014	0.0014	0.0002	0.1050
49	557	0.0048	0.0002	0.0008	0.0008	0.0001	0.0598
50	558	0.0010	0.0000	0.0002	0.0002	0.0000	0.0120
SUM		100	100	100	100	100	100

Table I14 Carbon number distributions of catalytic pyrolysis with 1.0%Ru/MOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0289	0.0001	0.0000	0.0123	0.0008	0.0359
5	38	0.1063	0.0013	0.0000	0.0294	0.0075	0.0911
6	69	0.3570	0.0213	0.0002	0.0664	0.0590	0.2161
7	97	1.0864	0.2082	0.0011	0.1414	0.4042	0.4784
8	124	2.9342	1.1857	0.0044	0.2856	2.3453	0.9832
9	150	6.6846	3.9930	0.0160	0.5494	10.1108	1.8551
10	173	11.8790	8.4720	0.0539	1.0097	23.6358	3.1586
11	196	15.5302	12.4515	0.1670	1.7785	25.3217	4.7607
12	216	15.2874	14.0205	0.4774	3.0102	16.5184	6.2788
13	236	12.4330	13.1982	1.2551	4.9017	9.2303	7.2834
14	254	9.1821	11.0961	2.9908	7.6553	5.0856	7.5960
15	271	6.5386	8.7221	6.2443	11.3092	2.8637	7.3372
16	288	4.6261	6.6057	10.8220	15.2302	1.6597	6.7478
17	303	3.2953	4.9130	14.7615	17.4084	0.9900	6.0323
18	317	2.3762	3.6313	15.6562	15.5021	0.6069	5.3146
19	331	1.7377	2.6866	13.5170	10.4226	0.3816	4.6540
20	344	1.2891	1.9982	10.2292	5.6284	0.2456	4.0713
21	357	0.9697	1.4977	7.2338	2.7028	0.1616	3.5683
22	368	0.7392	1.1327	4.9782	1.2469	0.1084	3.1384
23	380	0.5705	0.8649	3.4073	0.5756	0.0741	2.7723
24	391	0.4454	0.6668	2.3437	0.2705	0.0515	2.4606
25	401	0.3514	0.5189	1.6277	0.1302	0.0363	2.1944
26	411	0.2800	0.4075	1.1433	0.0642	0.0260	1.9662
27	421	0.2251	0.3226	0.8123	0.0325	0.0188	1.7695
28	430	0.1824	0.2575	0.5836	0.0168	0.0138	1.5990
29	439	0.1489	0.2069	0.4237	0.0089	0.0102	1.4502
30	448	0.1223	0.1674	0.3106	0.0048	0.0076	1.3194
31	457	0.1010	0.1362	0.2296	0.0026	0.0058	1.2037
32	465	0.0839	0.1113	0.1711	0.0015	0.0044	1.1004
33	473	0.0699	0.0914	0.1284	0.0008	0.0033	1.0075
34	481	0.0585	0.0754	0.0970	0.0005	0.0026	0.9233
35	489	0.0491	0.0623	0.0737	0.0003	0.0020	0.8463
36	496	0.0413	0.0517	0.0563	0.0002	0.0015	0.7753
37	504	0.0348	0.0429	0.0432	0.0001	0.0012	0.7094
38	510	0.0293	0.0357	0.0333	0.0001	0.0009	0.6477
39	517	0.0247	0.0297	0.0258	0.0000	0.0007	0.5895
40	523	0.0208	0.0247	0.0200	0.0000	0.0006	0.5341
41	529	0.0175	0.0206	0.0156	0.0000	0.0005	0.4810
42	535	0.0147	0.0170	0.0121	0.0000	0.0004	0.4296
43	540	0.0122	0.0140	0.0094	0.0000	0.0003	0.3795
44	544	0.0101	0.0115	0.0073	0.0000	0.0002	0.3301
45	548	0.0082	0.0092	0.0056	0.0000	0.0002	0.2809
46	552	0.0064	0.0072	0.0042	0.0000	0.0001	0.2314
47	554	0.0049	0.0054	0.0031	0.0000	0.0001	0.1809
48	556	0.0034	0.0037	0.0021	0.0000	0.0001	0.1285
49	557	0.0019	0.0021	0.0011	0.0000	0.0000	0.0736
50	558	0.0004	0.0004	0.0002	0.0000	0.0000	0.0148
SUM		100	100	100	100	100	100

Table II5 Carbon number distributions of catalytic pyrolysis with 1.2%Ru/MOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0454	0.0011	0.0000	0.0000	0.5049	0.0516
5	38	0.1653	0.0058	0.0002	0.0000	0.6743	0.1230
6	69	0.5216	0.0279	0.0010	0.0000	0.8801	0.2692
7	97	1.4009	0.1197	0.0046	0.0000	1.1242	0.5405
8	124	3.1410	0.4626	0.0191	0.0002	1.4077	0.9934
9	150	5.7953	1.5849	0.0724	0.0010	1.7303	1.6687
10	173	8.7781	4.5787	0.2500	0.0054	2.0907	2.5628
11	196	11.0600	10.0566	0.7868	0.0270	2.4869	3.6063
12	216	11.9056	15.1325	2.2284	0.1208	2.9161	4.6713
13	236	11.3260	15.8313	5.4708	0.4862	3.3749	5.6083
14	254	9.8495	13.1447	10.8352	1.7428	3.8601	6.2949
15	271	8.0610	9.8561	15.9612	5.2795	4.3684	6.6690
16	288	6.3505	7.1632	17.1115	12.0237	4.8961	6.7342
17	303	4.8952	5.1973	14.3136	18.0859	5.4388	6.5414
18	317	3.7339	3.8059	10.3847	18.0525	5.9885	6.1634
19	331	2.8397	2.8230	7.0837	13.8976	6.5293	5.6735
20	344	2.1637	2.1226	4.7476	9.5836	7.0271	5.1328
21	357	1.6568	1.6175	3.1902	6.4094	7.4144	4.5859
22	368	1.2771	1.2484	2.1674	4.2897	7.5735	4.0618
23	380	0.9921	0.9751	1.4932	2.9041	7.3422	3.5771
24	391	0.7769	0.7701	1.0438	1.9946	6.5882	3.1393
25	401	0.6134	0.6144	0.7400	1.3902	5.3518	2.7501
26	411	0.4882	0.4948	0.5316	0.9825	3.9069	2.4077
27	421	0.3914	0.4019	0.3867	0.7034	2.5958	2.1083
28	430	0.3160	0.3289	0.2844	0.5095	1.6111	1.8475
29	439	0.2569	0.2711	0.2113	0.3730	0.9600	1.6205
30	448	0.2100	0.2248	0.1584	0.2757	0.5610	1.4230
31	457	0.1726	0.1874	0.1198	0.2056	0.3260	1.2509
32	465	0.1425	0.1570	0.0912	0.1545	0.1900	1.1006
33	473	0.1181	0.1320	0.0699	0.1169	0.1115	0.9691
34	481	0.0983	0.1114	0.0539	0.0890	0.0660	0.8535
35	489	0.0820	0.0942	0.0418	0.0682	0.0395	0.7518
36	496	0.0685	0.0799	0.0326	0.0525	0.0239	0.6619
37	504	0.0574	0.0678	0.0255	0.0406	0.0147	0.5822
38	510	0.0481	0.0576	0.0200	0.0315	0.0091	0.5113
39	517	0.0403	0.0489	0.0157	0.0245	0.0057	0.4480
40	523	0.0338	0.0415	0.0124	0.0192	0.0036	0.3912
41	529	0.0283	0.0351	0.0098	0.0150	0.0023	0.3401
42	535	0.0236	0.0296	0.0078	0.0117	0.0015	0.2938
43	540	0.0195	0.0247	0.0061	0.0092	0.0010	0.2515
44	544	0.0160	0.0205	0.0048	0.0072	0.0007	0.2126
45	548	0.0129	0.0167	0.0037	0.0055	0.0005	0.1763
46	552	0.0102	0.0132	0.0028	0.0042	0.0003	0.1420
47	554	0.0077	0.0100	0.0021	0.0030	0.0002	0.1090
48	556	0.0053	0.0070	0.0014	0.0021	0.0001	0.0764
49	557	0.0030	0.0039	0.0008	0.0011	0.0001	0.0433
50	558	0.0006	0.0008	0.0002	0.0002	0.0000	0.0087
SUM		100	100	100	100	100	100

Table I16 Carbon number distributions of catalytic pyrolysis with Ru/MOR

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0732	0.0093	0.0000	1.6731	0.2267	0.0683
5	38	0.2132	0.0357	0.0002	2.1240	0.3648	0.1445
6	69	0.5686	0.1254	0.0012	2.6408	0.5668	0.2888
7	97	1.3785	0.4025	0.0062	3.2178	0.8523	0.5453
8	124	2.9907	1.1767	0.0294	3.8431	1.2431	0.9701
9	150	5.6755	3.0780	0.1259	4.4975	1.7620	1.6187
10	173	9.1764	6.9016	0.4863	5.1519	2.4316	2.5152
11	196	12.3870	12.3648	1.6818	5.7666	3.2713	3.6098
12	216	13.9174	16.5775	5.0224	6.2917	4.2920	4.7547
13	236	13.2626	16.5914	11.8369	6.6718	5.4870	5.7400
14	254	11.1006	13.3315	19.3292	6.8556	6.8126	6.3872
15	271	8.4889	9.4583	20.5805	6.8093	8.1605	6.6288
16	288	6.1401	6.3588	15.6612	6.5290	9.3283	6.5138
17	303	4.3111	4.2136	9.9788	6.0451	10.0254	6.1519
18	317	2.9902	2.8044	5.9640	5.4163	9.9681	5.6566
19	331	2.0716	1.8901	3.5307	4.7135	9.0623	5.1141
20	344	1.4431	1.2939	2.1150	4.0030	7.5209	4.5792
21	357	1.0146	0.9005	1.2914	3.3350	5.7571	4.0810
22	368	0.7212	0.6368	0.8051	2.7392	4.1411	3.6319
23	380	0.5188	0.4573	0.5122	2.2281	2.8573	3.2346
24	391	0.3777	0.3331	0.3322	1.8015	1.9251	2.8869
25	401	0.2781	0.2459	0.2194	1.4521	1.2833	2.5839
26	411	0.2071	0.1837	0.1472	1.1695	0.8538	2.3203
27	421	0.1558	0.1388	0.1003	0.9425	0.5700	2.0907
28	430	0.1184	0.1059	0.0692	0.7610	0.3831	1.8900
29	439	0.0907	0.0816	0.0484	0.6159	0.2595	1.7139
30	448	0.0700	0.0633	0.0342	0.4998	0.1773	1.5585
31	457	0.0545	0.0495	0.0244	0.4069	0.1222	1.4205
32	465	0.0426	0.0390	0.0176	0.3321	0.0849	1.2972
33	473	0.0336	0.0309	0.0127	0.2719	0.0595	1.1861
34	481	0.0266	0.0245	0.0093	0.2231	0.0420	1.0854
35	489	0.0211	0.0196	0.0069	0.1835	0.0299	0.9934
36	496	0.0168	0.0157	0.0051	0.1512	0.0214	0.9088
37	504	0.0135	0.0127	0.0038	0.1247	0.0155	0.8302
38	510	0.0108	0.0102	0.0028	0.1030	0.0112	0.7568
39	517	0.0087	0.0082	0.0021	0.0851	0.0082	0.6877
40	523	0.0070	0.0067	0.0016	0.0703	0.0060	0.6221
41	529	0.0056	0.0054	0.0012	0.0580	0.0044	0.5594
42	535	0.0045	0.0044	0.0009	0.0477	0.0033	0.4990
43	540	0.0036	0.0035	0.0007	0.0391	0.0025	0.4402
44	544	0.0029	0.0028	0.0005	0.0317	0.0018	0.3824
45	548	0.0023	0.0022	0.0004	0.0254	0.0014	0.3251
46	552	0.0018	0.0017	0.0003	0.0198	0.0010	0.2675
47	554	0.0013	0.0013	0.0002	0.0148	0.0007	0.2089
48	556	0.0009	0.0009	0.0001	0.0102	0.0005	0.1484
49	557	0.0005	0.0005	0.0001	0.0057	0.0003	0.0849
50	558	0.0001	0.0001	0.0000	0.0011	0.0000	0.0171
SUM		100	100	100	100	100	100

Table II7 Carbon number distributions of catalytic pyrolysis with Ru/ZSM5

No. carbon.	IBP	Maltene	Saturated hydrocarbon	Mono aromatic	Di aromatic	Poly aromatic	Polar aromatic
4	5	0.0156	0.0017	0.0025	0.0000	0.0000	0.0572
5	38	0.0654	0.0104	0.0073	0.0000	0.0000	0.1364
6	69	0.2485	0.0554	0.0200	0.0009	0.0000	0.3047
7	97	0.8509	0.2627	0.0509	0.0182	0.0000	0.6367
8	124	2.5715	1.1004	0.1216	0.3011	2.0659	1.2382
9	150	6.4722	3.8922	0.2730	3.6898	25.5438	2.2172
10	173	12.2999	10.2932	0.5786	18.8209	18.0154	3.6007
11	196	16.3730	17.3270	1.1584	25.3975	12.8151	5.2198
12	216	15.8178	18.2954	2.1867	17.6906	9.2824	6.6944
13	236	12.5152	14.4169	3.8664	11.1749	6.8388	7.6324
14	254	9.0528	10.1132	6.3174	7.1460	5.1195	7.8805
15	271	6.3678	6.8986	9.3392	4.6760	3.8905	7.5593
16	288	4.4766	4.7253	12.1740	3.1302	2.9985	6.9051
17	303	3.1796	3.2831	13.6934	2.1406	2.3419	6.1243
18	317	2.2904	2.3199	13.2098	1.4933	1.8521	5.3460
19	331	1.6749	1.6672	11.0951	1.0612	1.4820	4.6332
20	344	1.2432	1.2178	8.3677	0.7671	1.1990	4.0083
21	357	0.9359	0.9033	5.8691	0.5635	0.9801	3.4728
22	368	0.7141	0.6795	3.9457	0.4200	0.8090	3.0189
23	380	0.5517	0.5180	2.5988	0.3174	0.6739	2.6358
24	391	0.4312	0.3996	1.7007	0.2429	0.5661	2.3125
25	401	0.3405	0.3118	1.1154	0.1880	0.4792	2.0389
26	411	0.2716	0.2458	0.7365	0.1470	0.4086	1.8065
27	421	0.2186	0.1955	0.4907	0.1161	0.3507	1.6081
28	430	0.1773	0.1569	0.3303	0.0925	0.3028	1.4377
29	439	0.1448	0.1268	0.2247	0.0742	0.2628	1.2904
30	448	0.1191	0.1032	0.1544	0.0600	0.2291	1.1621
31	457	0.0985	0.0845	0.1071	0.0488	0.2005	1.0497
32	465	0.0818	0.0695	0.0749	0.0399	0.1761	0.9503
33	473	0.0683	0.0574	0.0529	0.0328	0.1551	0.8610
34	481	0.0572	0.0477	0.0376	0.0270	0.1369	0.7825
35	489	0.0480	0.0397	0.0270	0.0224	0.1209	0.7109
36	496	0.0404	0.0331	0.0195	0.0186	0.1069	0.6456
37	504	0.0341	0.0277	0.0141	0.0154	0.0945	0.5858
38	510	0.0287	0.0232	0.0103	0.0128	0.0835	0.5305
39	517	0.0242	0.0194	0.0076	0.0107	0.0736	0.4790
40	523	0.0204	0.0162	0.0056	0.0089	0.0647	0.4308
41	529	0.0172	0.0136	0.0042	0.0074	0.0567	0.3852
42	535	0.0144	0.0113	0.0031	0.0061	0.0493	0.3418
43	540	0.0120	0.0093	0.0023	0.0051	0.0425	0.3001
44	544	0.0099	0.0077	0.0017	0.0041	0.0361	0.2596
45	548	0.0080	0.0062	0.0013	0.0033	0.0301	0.2198
46	552	0.0063	0.0049	0.0009	0.0026	0.0244	0.1803
47	554	0.0048	0.0037	0.0007	0.0020	0.0188	0.1404
48	556	0.0033	0.0025	0.0004	0.0014	0.0132	0.0995
49	557	0.0019	0.0014	0.0002	0.0008	0.0075	0.0569
50	558	0.0004	0.0003	0.0000	0.0002	0.0015	0.0114
SUM		100	100	100	100	100	100

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1. Kongkadee, K., Wongkasemjit, S., and Jitkarnka, S. (2007, November 21-24) Effects of Residence time and Pyrolysis Temperature on Waste Tire Pyrolysis for Production of Light Olefins. Poster presented at Eco-Energy and Materials Science and Engineering Symposium 2007, Pattaya, Thailand.

