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APPENDICES

Appendix A Operating Temperatures

Table A1 Operating temperatures, non catalytic pyrolysis (Catalytic temp. 400°C): 02/06/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 13.9669 g
3. Pyrolysis oils = 14.1789 g
4. Pyrolysis Gas = 1.857 g.

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	33.4	43.9	32	380.2	500	62	365.9	505.1	92	343.1	506.7
4	48.9	66.4	34	382.2	502.7	64	365.2	504.5	94	338.9	496.9
6	87.1	98.9	36	382.3	498.6	66	360.7	494.1	96	337.6	505
8	128	142.3	38	381.1	499.5	68	361.1	495.6	98	336.7	510.7
10	155.9	194.7	40	381.1	505.1	70	358.2	501.2	100	336.7	501.8
12	198.9	250.3	42	380.1	502.1	72	356	499.8	102	335.9	503.8
14	242.7	314.7	44	380.5	506.2	74	353.5	499.4	104	335.7	499.5
16	286.9	377.7	46	372.2	496.7	76	352.7	501.4	106	335.7	499.3
18	310.7	432.4	48	376.3	503.1	78	350.7	501.1	108	334.7	503.4
20	356.7	441.5	50	375.6	502.9	80	351	498.7	110	334.2	502.1
22	367.5	455.4	52	374.9	500.6	82	348.4	503.1	112	332.7	503.6
24	376.5	515.9	54	371.1	503.4	84	347.5	507.3	114	330.8	494.1
26	384.7	510.1	56	371.1	500.2	86	343.6	497.2	116	328.4	492.1
28	385.7	510.4	58	370.2	507.6	88	344.1	506.8	118	327.4	498.5
30	386.5	504.9	60	368.4	502.1	90	344.7	506.7	120	327.5	484

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

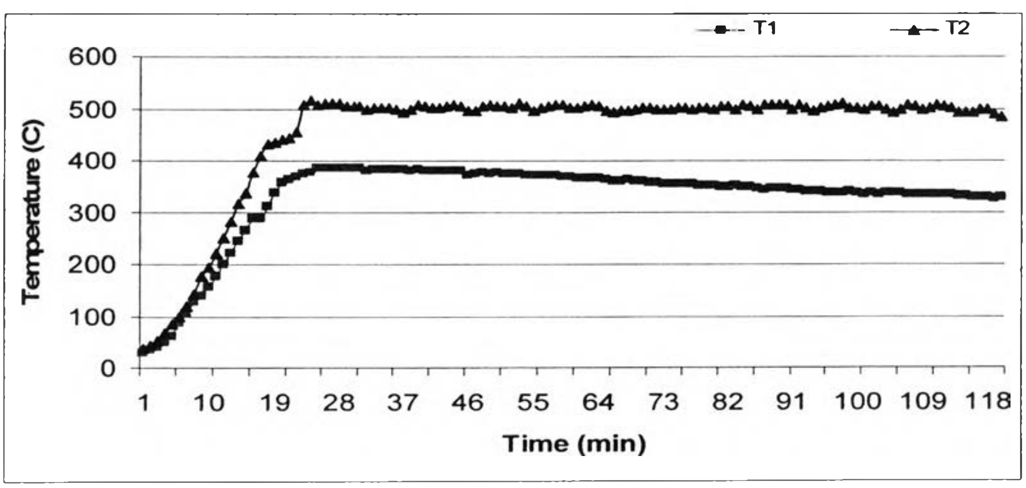


Table A2 Operating temperatures, non catalytic pyrolysis (Catalytic temp. 350°C): 17/06/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.1541 g
3. Pyrolysis oils = 13.1442 g
4. Pyrolysis Gas = 2.7017g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	37.1	40.7	32	359.7	502.2	62	358.5	503.2	92	352.7	494.9
4	48.5	51.8	34	363.4	495.9	64	354.6	495.5	94	353.2	508.6
6	70.2	77.3	36	365.2	507.8	66	353.8	506.6	96	354.2	501.8
8	100.4	112.3	38	364.6	501.6	68	354.7	496.6	98	355.7	504.9
10	137.3	159.6	40	366.8	500.1	70	353.4	497.2	100	356.6	502.5
12	178.2	212.8	42	367.6	508.7	72	354.2	506.5	102	354.7	496.4
14	221.2	274.3	44	363.4	497.4	74	355.4	502.7	104	349.8	508.2
16	266.1	336.5	46	363.4	497.4	76	352.7	501.4	106	352.6	503.8
18	276.6	398.7	48	363	500.4	78	350.7	501.1	108	352.2	503.6
20	309	443.6	50	363.2	502.6	80	352	498.7	110	350.6	500.8
22	351.4	471.2	52	357.5	497.6	82	353	500.2	112	351.8	501.6
24	351	455.1	54	360.1	500.1	84	358.1	507	114	350.8	503.7
26	345.8	507.8	56	359	506.1	86	355.2	498.2	116	350.2	501.3
28	348.5	496.6	58	357.4	498.4	88	355.1	505.1	118	349.9	499.3
30	353.2	511.2	60	359.4	507.9	90	344.7	506.7	120	348.6	501.2

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

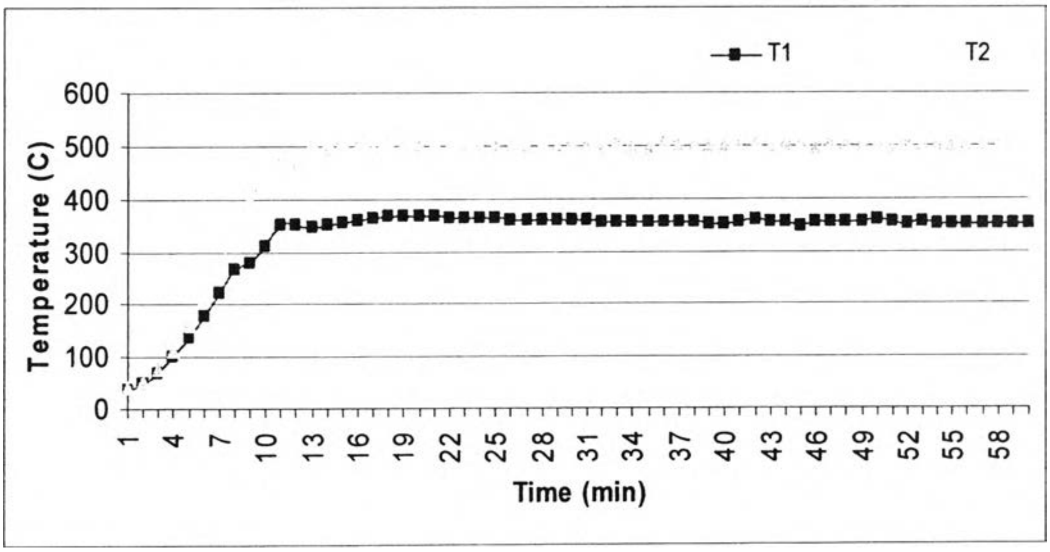


Table A3 Operating temperatures, non catalytic pyrolysis (Catalytic temp. 450°C): 17/06/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.1541 g
3. Pyrolysis oils = 13.1442 g
4. Pyrolysis Gas = 2.7017g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	33.8	31.4	32	402.8	524.6	62	450	500	92	448.2	499.9
4	37.9	45.5	34	404.6	517.6	64	450.4	500.5	94	449.3	499.8
6	100.7	70.9	36	416.2	513	66	449.8	500.2	96	449.9	500.3
8	143.6	110.9	38	447.6	507.5	68	451.3	500.1	98	450.3	500.6
10	169	158.6	40	458.8	502.3	70	449.5	500.1	100	450.2	500.6
12	210.8	212.8	42	453.1	500.3	72	451.7	500.4	102	451	499.7
14	259.2	278.4	44	448.9	505.1	74	448.4	499.4	104	451	500.7
16	324.3	362.9	46	455.4	503.3	76	449.6	500	106	449.7	500.5
18	355.8	420.9	48	450	505.2	78	450.8	500.6	108	449.4	500.1
20	362.3	435.4	50	444.6	500.7	80	450	499.8	110	449.9	499.4
22	380.3	451.2	52	444.7	494.7	82	447.7	499.4	112	451.4	500.7
24	391.1	517.6	54	446.8	496.9	84	449	500.2	114	449.8	500.2
26	400.2	533.9	56	449.5	499.5	86	450.4	500.3	116	449.9	499.3
28	401.7	527.6	58	448.8	500.8	88	450.8	499.7	118	450.6	500.8
30	396.7	534.5	60	449.8	498.3	90	450.7	500	120	450	500.4

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

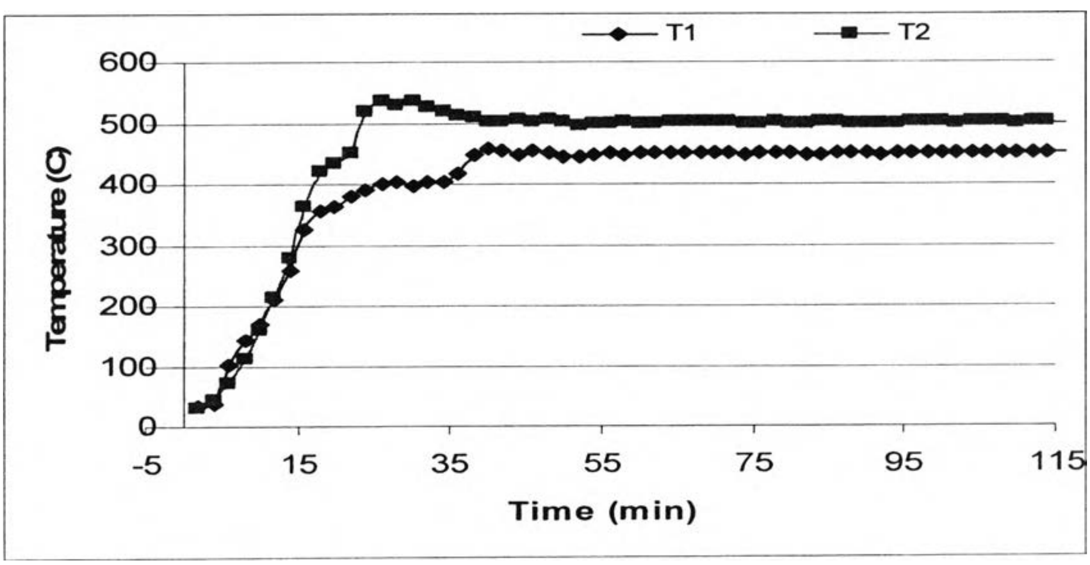


Table A4 Operating temperatures, (0.25 wt % Pd/H-Beta): 17/08/2007

1. Sample = 30.0047 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.3569 g
3. Pyrolysis oils = 8.3016 g
4. Pyrolysis Gas = 7.3415 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.1	31.8	32	345.5	507.3	62	363.4	508.6	92	347.6	500.5
4	34.4	38.8	34	347.2	498.6	64	363.1	506.7	94	346.4	501.3
6	35.3	54.8	36	350.2	507.8	66	361.8	504.6	96	345.8	500.2
8	41.7	80.8	38	353.1	502.7	68	361.4	503.6	98	348	499.7
10	45.5	113.3	40	356.3	494.4	70	359.2	492.7	100	344.6	500.6
12	70.5	163.4	42	359.5	509.5	72	357.4	497.8	102	343.6	499.3
14	134.7	225.4	44	361.9	504.4	74	357.9	501	104	342.7	501.3
16	154.4	257.3	46	363.7	500.3	76	356.4	499.5	106	342.1	499.7
18	158.9	265.3	48	366.1	502.1	78	355.4	501	108	340.8	500.5
20	172.7	291.1	50	366.1	493.5	80	354.6	499.5	110	340.1	500
22	196.9	341.4	52	365.9	493.2	82	353.4	499	112	339.1	499.8
24	274.6	423.6	54	366.4	507	84	351.1	500	114	338	501.3
26	306.4	449.7	56	366.6	491	86	351.3	499.6	116	337.5	499.4
28	336.1	510.3	58	364.5	486.8	88	350.6	499.8	118	337.1	501.6
30	343.4	515.5	60	363.5	492.5	90	348.9	499.5	120	336.8	501.2

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

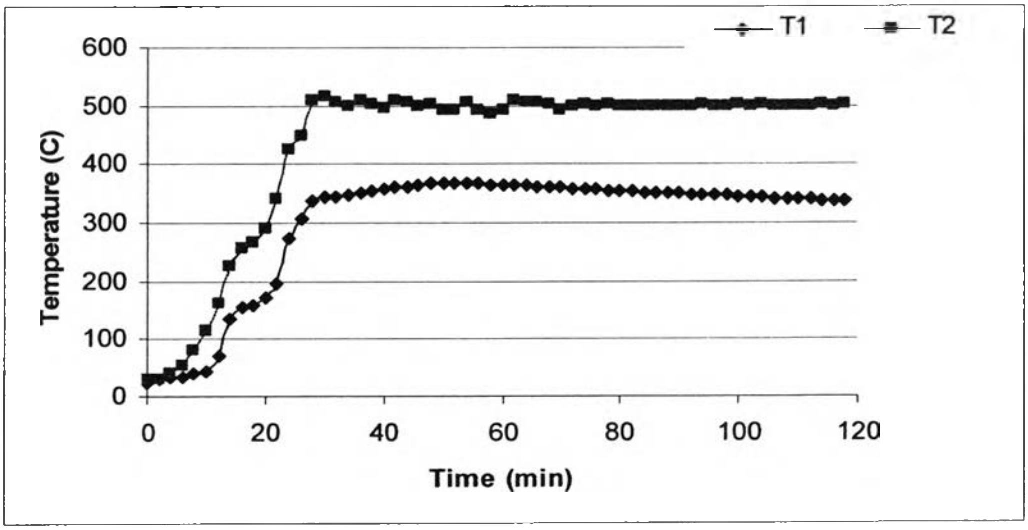


Table A5 Operating temperatures, (0.50 wt % Pd/H-Beta): 17/08/2007

1. Sample = 30.0047 g , N2 flow rate = 30 ml/min
2. Carbon black = 13.1372 g
3. Pyrolysis oils = 11.3295 g
4. Pyrolysis Gas = 5.5333 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28.9	25.4	32	337.6	514.7	62	357.2	502.3	92	360.7	495.2
4	32.1	26.9	34	341.3	509.9	64	358.9	497.8	94	360.3	497.8
6	37.6	30.9	36	340	507.6	66	360.4	504.8	96	359.4	507.8
8	42.3	37.2	38	344.8	502.7	68	361.7	505.8	98	358.7	505.1
10	49.5	45.2	40	347.6	500	70	362.7	502.4	100	358.6	501.2
12	56.3	54.9	42	348.6	498.8	72	363.9	497.2	102	357.6	497.7
14	67.1	67.9	44	350.3	506	74	363	497.2	104	356	504.3
16	74.1	83.4	46	349.2	507.4	76	362.7	506.2	106	356.3	506.7
18	89.3	103.7	48	348.2	505.5	78	363	507.3	108	354.7	504.4
20	101.4	124.5	50	350.7	501.9	80	362.4	500.4	110	353.6	504.4
22	119.6	159.6	52	352.5	495.9	82	363.1	497.8	112	353.9	500.6
24	134.2	177.4	54	353.3	494.4	84	362.8	500.8	114	352.4	501.9
26	207.4	299.7	56	356.6	500.4	86	361.9	507.9	116	352	496
28	291.7	422.5	58	357.3	507.4	88	361.5	505.2	118	351.3	505.1
30	338.9	499.8	60	356.4	506	90	361	500.8	120	350.7	502.3

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

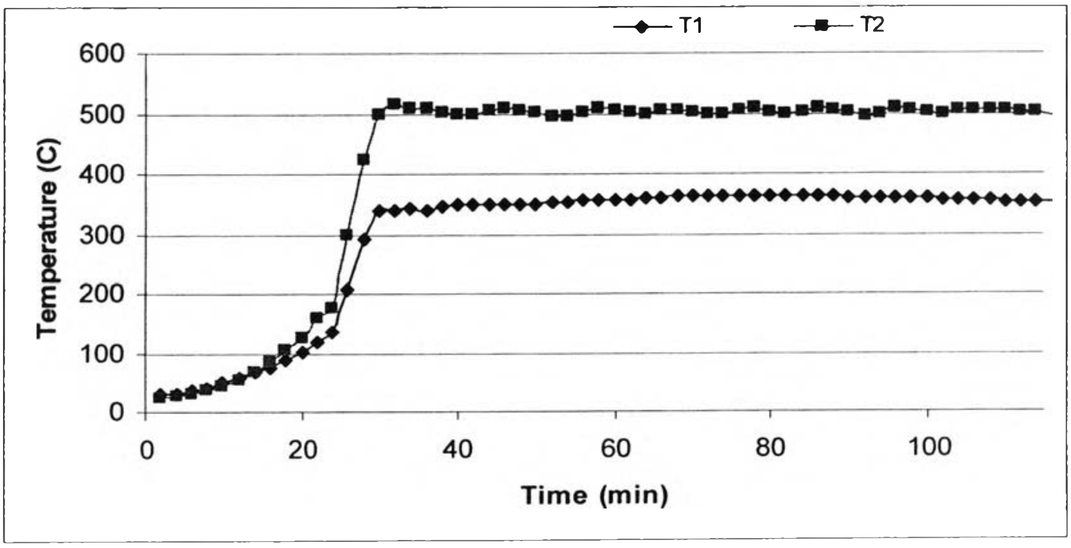


Table A6 Operating temperatures, (0.75 wt % Pd/H-BETA): 15/08/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 13.4848 g
3. Pyrolysis oils = 9.6268 g
4. Pyrolysis Gas = 6.8884 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28	30.1	32	310.6	502.4	62	403.2	499.4	92	370	500
4	31.4	40.3	34	331.3	502.2	64	402.3	499.8	94	368.4	499.5
6	39.4	61.7	36	348.9	499.7	66	399.1	500.3	96	366.8	499.5
8	46.8	82.9	38	367.3	505.7	68	398.5	500.2	98	365.2	500
10	69.5	136.3	40	376.3	504.6	70	396.3	500	100	363	500
12	84.1	169.5	42	387.2	497.2	72	392.3	499.2	102	361.7	500.2
14	108.2	237.5	44	396.5	488.9	74	389.3	500.4	104	359.8	499.2
16	120.6	284.3	46	399.4	505.7	76	386.8	501	106	357	498.7
18	161.4	357.8	48	403.1	498	78	385.6	499.5	108	355	501
20	246.5	455.9	50	404.3	505.6	80	383.3	499.6	110	354.4	499.1
22	292.6	484.3	52	406.5	499.1	82	382.5	500.1	112	354.4	500.4
24	329.4	516.9	54	409.6	492.2	84	379.6	500.7	114	351.4	500.1
26	296.7	511.3	56	410.4	495.9	86	374.5	499.7			
28	281.2	506.2	58	408.5	499.9	88	372.8	500.7			
30	289.2	502.1	60	405.1	502.8	90	371.3	503			

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

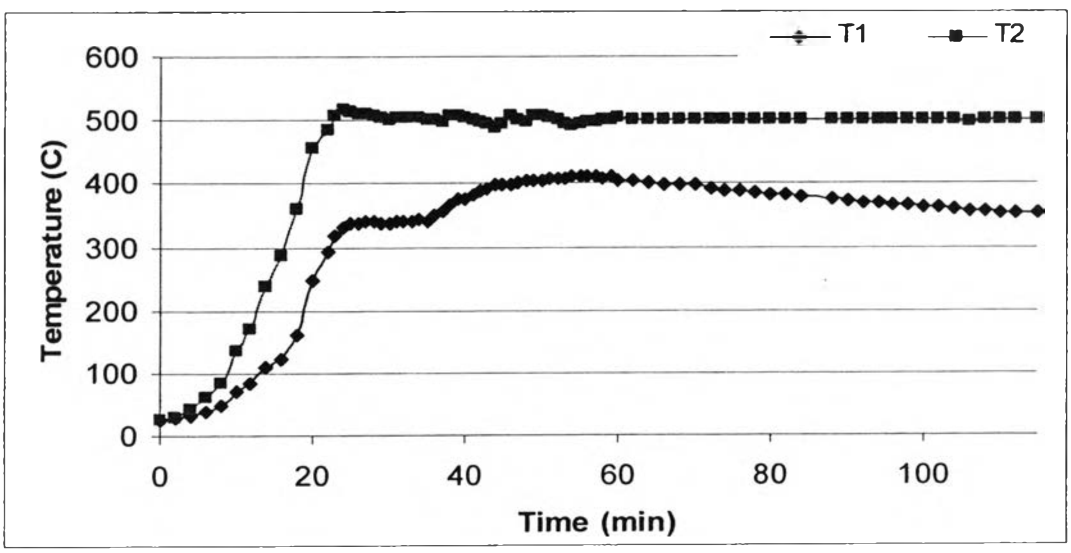


Table A7 Operating temperatures, (1 wt % Pd/H-BETA); 22/07/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.1446 g
3. Pyrolysis oils = 9.0614 g
4. Pyrolysis Gas = 6.794 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	31.1	26.9	32	350	501.9	62	354	498.5	92	332.6	501.2
4	41.5	37.2	34	353.3	494.4	64	352.4	506.3	94	331.3	501.9
6	55.3	54.9	36	355.6	507.4	66	351.1	500.7	96	330	498.4
8	74.1	83.4	38	357.2	502.3	68	349.7	504.8	98	329.3	505.1
10	100.4	124.5	40	360.5	504.8	70	348.3	501.4	100	328	497.4
12	134.6	177.4	42	362.6	502.4	72	346	495.2	102	326.8	507.7
14	169.9	234.8	44	363	497.2	74	345.3	505.6	104	325.7	497.6
16	206	299.7	46	363	507.3	76	343.8	497.1	106	324.8	504.4
18	243.9	374.5	48	362.5	497.8	78	343.2	506.7	108	323.2	504.4
20	323.1	441.4	50	361.7	507.9	80	342.8	498.5	110	321.7	504.4
22	326.1	499.8	52	361	500.8	82	341.8	506.3	112	321.3	500.6
24	336	509.9	54	360	497.8	84	340.6	502.7	114	320.6	501.9
26	344.2	502.7	56	358.7	505.1	86	336.9	498.3	116	320.1	496
28	347.6	498.8	58	357.6	497.7	88	335.5	507	118	319.2	505.1
30	349	507.4	60	355.5	506.7	90	333.8	503	120	318.9	502.3

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

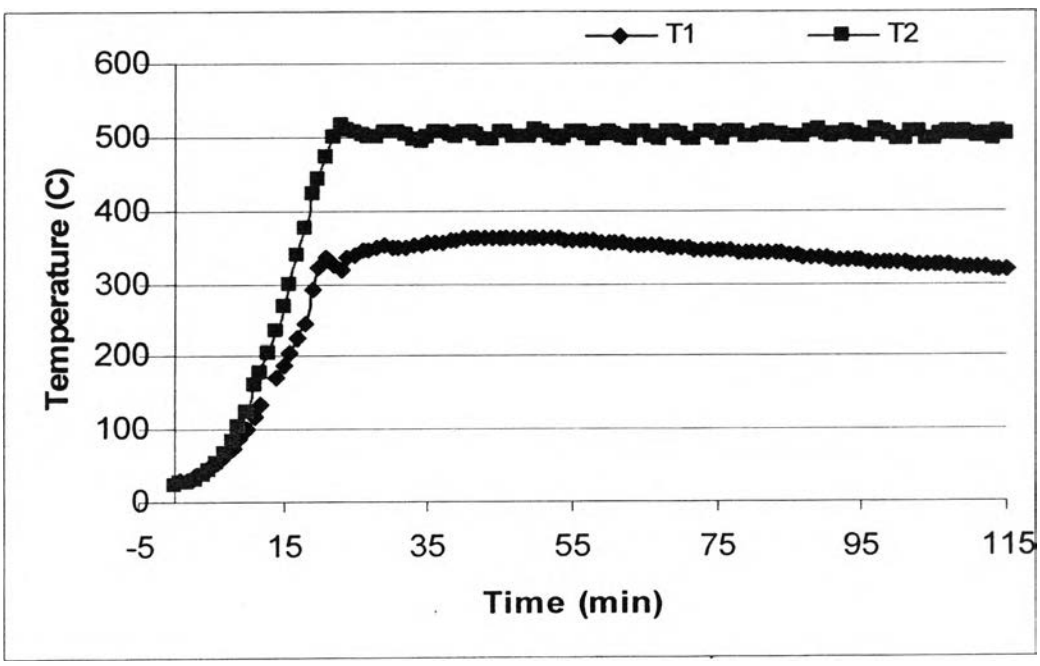


Table A8 Operating temperatures, (1.25 wt % Pd /H-BETA): 23/07/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 13.6148 g
3. Pyrolysis oils = 8.5184 g
4. Pyrolysis Gas = 7.8668 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.6	38.9	32	360.1	497.1	62	367	499.6	92	356.9	500.6
4	31.5	43	34	364.2	506.5	64	366.2	501.3	94	357.3	499.3
6	44.1	60.4	36	358.2	498.1	66	365.4	499	96	356.3	500.6
8	52.5	83.7	38	367.3	505.8	68	365.1	500.6	98	351	499.6
10	74	121.5	40	360.6	497.1	70	364.1	500.5	100	354.6	501.4
12	98.5	163.4	42	363.3	506.1	72	362.6	499.5	102	354.4	500.1
14	133.5	226.3	44	364.5	502.7	74	362.1	500	104	354.1	499.5
16	169.8	282.2	46	365.9	503.7	76	361.6	499	106	353.4	500.4
18	210.8	348.9	48	365.7	500.3	78	361.8	499.7	108	352.8	501.4
20	285.4	423.8	50	366.4	491.6	80	359.2	500.3	110	353	500.2
22	327.5	477.7	52	367.8	492.7	82	358.9	499.9	112	352.3	499.3
24	335.3	515.4	54	367.9	497.8	84	358.2	500.2	114	350.5	500.8
26	333.5	500.6	56	367.7	501.2	86	357.9	500.1	115	351	499.4
28	343.9	505.7	58	367.7	501.2	88	358.1	499.8			
30	345.5	496.3	60	367.9	500.1	90	358	500.8			

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

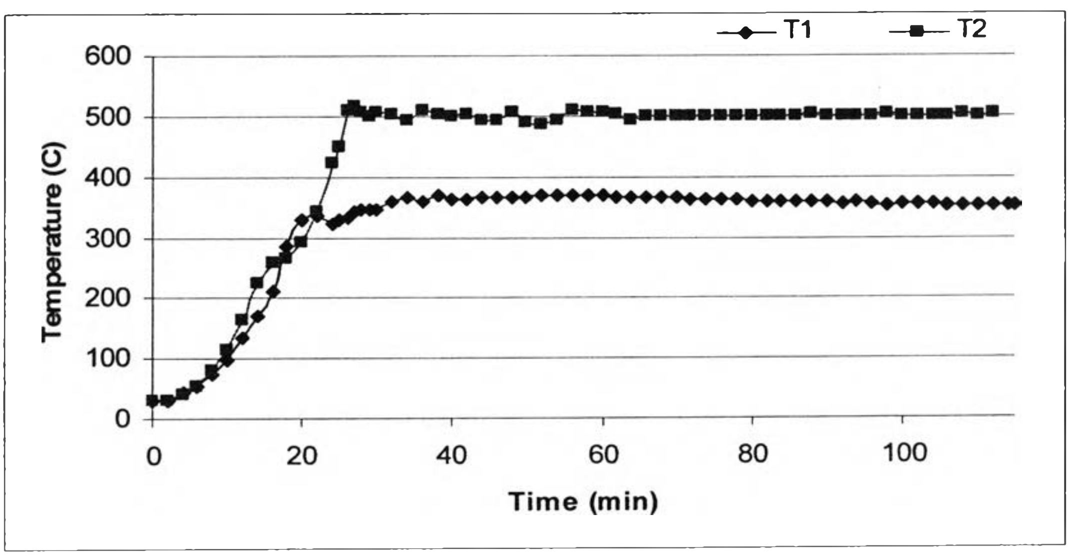


Table A9 Operating temperatures, (0.25 wt % Pd/H-BETA, Cat temp 400°C) : 26/10/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.0143 g
3. Pyrolysis oils = 9.51 g
4. Pyrolysis Gas = 6.4757 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	28.6	26.5	32	423.9	518.4	62	418.9	500.3	92	395.6	500.2
4	32.5	33.4	34	445.6	516.5	64	415.7	499.5	94	395.1	500.4
6	40.3	50.2	36	447.4	504.9	66	410.7	499.5	96	395.5	500
8	46.2	80.5	38	455.9	502.8	68	407.6	500.3	98	399.4	499.9
10	55.9	133.3	40	454.7	499.7	70	403.5	500.3	100	399.8	500.5
12	59	144.2	42	452.1	504.4	72	401.6	499.7	102	399.7	500.5
14	75.7	193.4	44	448	490.4	74	398.3	499.7	104	399.8	499.9
16	94.6	238.7	46	444.8	492.4	76	403.5	500.1	106	399.8	499.6
18	125.2	296.9	48	441.1	507.4	78	409.5	500.7	108	399.8	500.3
20	170.1	375.3	50	438.9	499.4	80	408.8	500.7	110	399.3	500.4
22	225.8	436.7	52	435.6	500.2	82	406.2	500.7	112	399.4	500
24	276.7	488	54	433	504.7	84	402.4	499.8	114	400.1	500
26	321.1	504.7	56	430.8	498.7	86	400.6	499.8	116	400.2	500.2
28	356.7	515.4	58	427.1	493.7	88	397.6	499.8	118	400.6	500.2
30	356	516.2	60	420.7	498.4	90	400.3	499.8	120	400	500.4

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

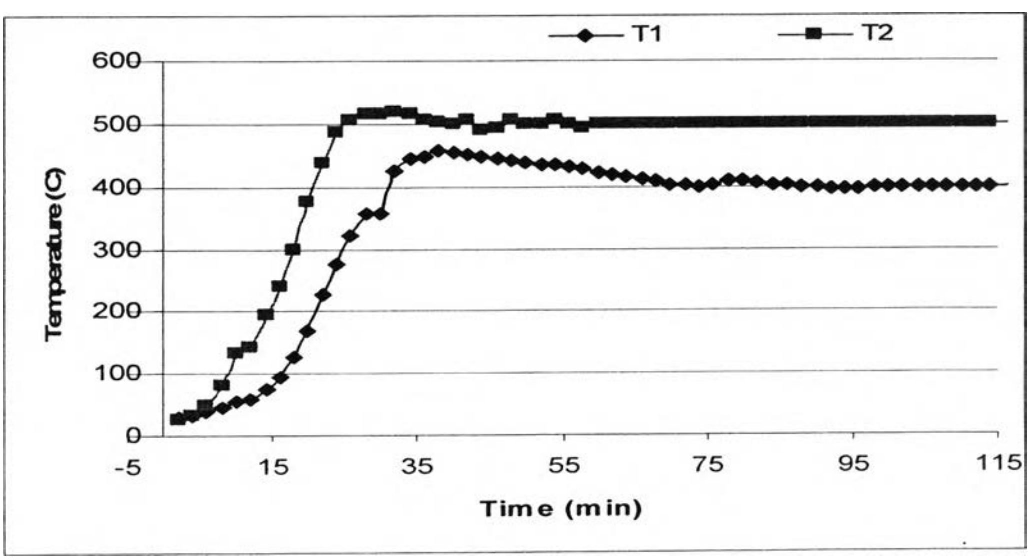


Table A10 Operating temperatures, (0.25 wt % Pd/H-BETA, Cat temp 450°C): 28/10/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 14.134 g
3. Pyrolysis oils = 10.27g
4. Pyrolysis Gas = 5.596g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.3	31.4	32	479.6	544.2	62	450.2	499.6	92	450.5	501.5
4	36.9	36.8	34	473.1	536.5	64	450	500.9	94	449.9	498.7
6	52.5	48.3	36	469.4	529.5	66	450.2	500.8	96	449.9	498.3
8	90.5	87.6	38	467.8	525.6	68	450.5	500.2	98	449.3	500.4
10	115.7	118.9	40	458.7	510.9	70	450.3	498.6	100	449.7	501.6
12	156.9	203.4	42	456.6	507.5	72	450.8	500.1	102	450.2	500
14	198.4	237.6	44	452.5	504	74	450.4	501.3	104	450.5	499.5
16	241.1	257.6	46	449.9	500.9	76	450.4	500	106	449.3	500.1
18	288	343.2	48	450.3	503.9	78	450.1	498.8	108	450.3	501.3
20	333.9	413.7	50	450.5	502.9	80	450.1	499.4	110	450.3	500.3
22	351.8	480.5	52	450.4	498.3	82	450.5	500.7	112	450.3	498.7
24	390.4	525.7	54	450.6	498.9	84	449.3	500.8	114	449.6	499.8
26	443.2	535.5	56	450.7	501.3	86	449.3	500.2	116	450.3	504.8
28	460.7	538.4	58	450.7	502	88	449.4	499.6	118	450.4	502.4
30	482.2	546.4	60	450.2	500.8	90	449.7	500.9	120	450.7	498.2

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

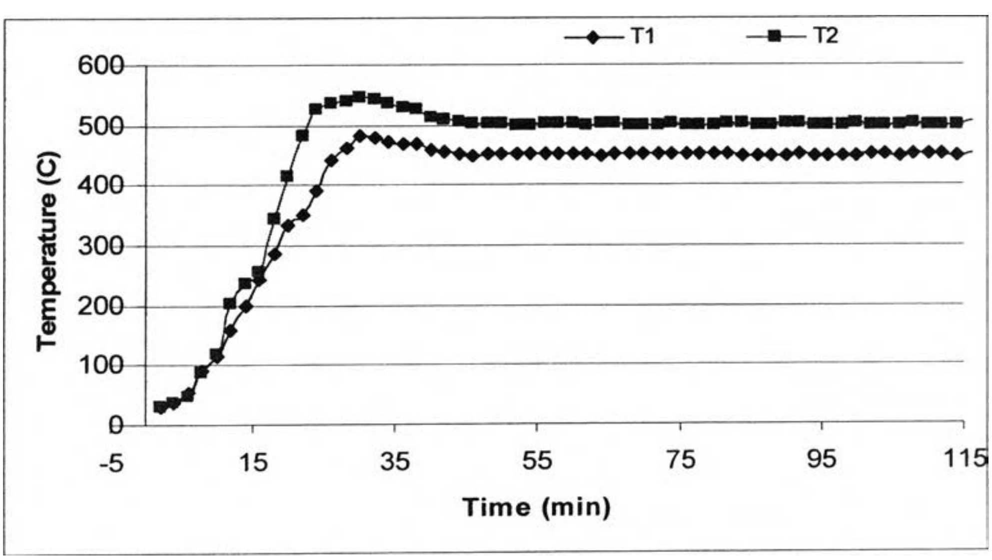


Table A11 Operating temperatures, (0.25 wt % Pd/H-BETA, Cat temp 500°C): 28/10/2007

1. Sample = 30 g , N2 flow rate = 30 ml/min
2. Carbon black = 13.83 g
3. Pyrolysis oils = 11.43 g
4. Pyrolysis Gas = 4.74 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.3	31.4	32	479.6	544.2	62	450.2	499.6	92	450.5	501.5
4	36.9	36.8	34	473.1	536.5	64	450	500.9	94	449.9	498.7
6	52.5	48.3	36	469.4	529.5	66	450.2	500.8	96	449.9	498.3
8	90.5	87.6	38	467.8	525.6	68	450.5	500.2	98	449.3	500.4
10	115.7	118.9	40	458.7	510.9	70	450.3	498.6	100	449.7	501.6
12	156.9	203.4	42	456.6	507.5	72	450.8	500.1	102	450.2	500
14	198.4	237.6	44	452.5	504	74	450.4	501.3	104	450.5	499.5
16	241.1	257.6	46	449.9	500.9	76	450.4	500	106	449.3	500.1
18	288	343.2	48	450.3	503.9	78	450.1	498.8	108	450.3	501.3
20	333.9	413.7	50	450.5	502.9	80	450.1	499.4	110	450.3	500.3
22	351.8	480.5	52	450.4	498.3	82	450.5	500.7	112	450.3	498.7
24	390.4	525.7	54	450.6	498.9	84	449.3	500.8	114	449.6	499.8
26	443.2	535.5	56	450.7	501.3	86	449.3	500.2	116	450.3	504.8
28	460.7	538.4	58	450.7	502	88	449.4	499.6	118	450.4	502.4
30	482.2	546.4	60	450.2	500.8	90	449.7	500.9	120	450.7	498.2

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

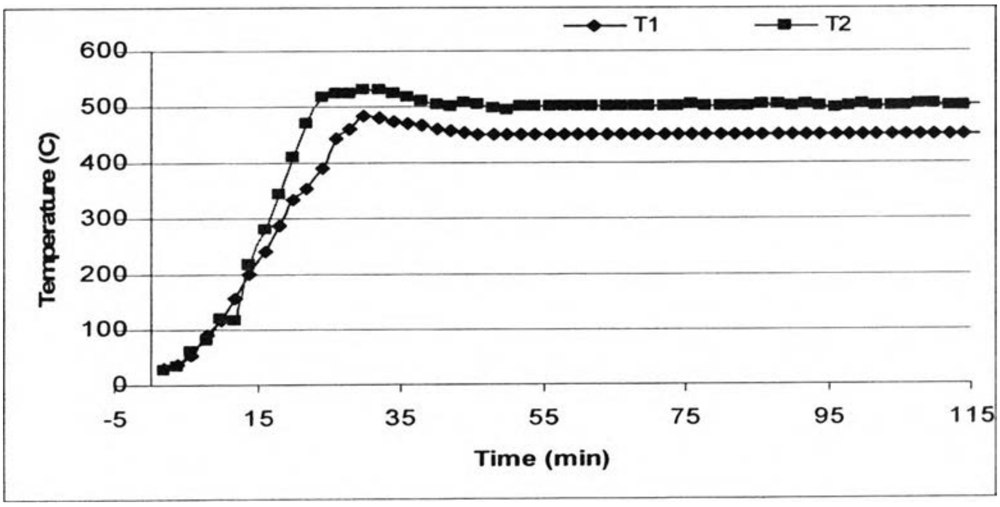


Table A12 Operating temperatures, (0.25 wt % Pd/H-BETA, Residence time 5 min): 31/11/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 15 ml/min
2. Carbon black = 13.82 g
3. Pyrolysis oils = 10.94 g
4. Pyrolysis Gas = 5.24 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	30.4	30.7	32	380.7	503.3	62	385.5	499.3	92	349.6	500.4
4	34.4	37.8	34	380	498.7	64	382.9	500.1	94	348.9	500.3
6	48.2	68.5	36	386.4	504.9	66	380.2	500.3	96	345.9	499.9
8	63.6	89.4	38	394.6	499.7	68	372	499.9	98	345.5	499.8
10	91.3	139.4	40	399.5	499.8	70	374	499.9	100	343.3	500.2
12	115.1	185.7	42	401.8	498.5	72	372.5	500.3	102	342.6	500.2
14	150.3	252.3	44	403.3	509.2	74	369.4	500.1	104	340.7	500
16	186.2	315.2	46	403.2	498.5	76	367.3	500.1	106	339.7	499.8
18	250.7	394.4	48	402.9	505.7	78	363.9	500	108	338.6	500
20	301.9	444.5	50	400.7	500.8	80	361.4	500.2	110	337.2	500.2
22	315.1	514.9	52	397.7	497.6	82	359.7	499.7	112	335.7	500
24	320.2	517.5	54	394.6	494.7	84	356.7	500.2	114	334.7	499.9
26	315.7	511.6	56	392.1	500.4	86	354.9	500.3	116	334.1	499.9
28	317.1	509.9	58	390.6	500	88	353.8	500.1	118	332.8	500.4
30	339	506.8	60	386	499.4	90	353	500	120	332.8	500.3

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

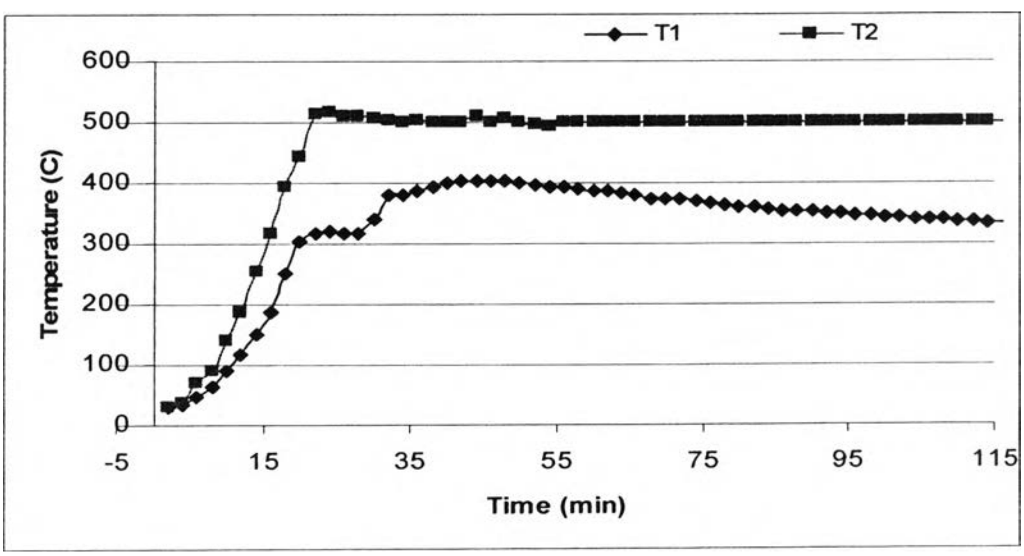


Table A13 Operating temperatures, (0.25 wt % Pd/H-BETA, Residence time 15 min): 29/11/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 50 ml/min
2. Carbon black = 13.36 g
3. Pyrolysis oils = 8.86 g
4. Pyrolysis Gas = 7.78 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.7	29.1	32	334.1	500.3	62	354.3	498.8	92	341.6	497
4	35.8	43.5	34	340.5	489.6	64	353.6	503.2	94	341	497.7
6	59.4	81.3	36	344.6	499.3	66	353.8	500.6	96	340.6	499.1
8	71.6	100.4	38	347.4	507.5	68	353.2	509.6	98	339.7	500.7
10	106.3	165.4	40	349.6	501.6	70	353.1	510.5	100	338.6	500.7
12	120	189.2	42	351.5	507.8	72	352.3	510.4	102	337.5	500.9
14	163.1	270.3	44	353.3	500.2	74	351.6	509.3	104	336.5	501.8
16	189.5	310.6	46	354.3	489.7	76	350.4	506.4	106	336.3	501.9
18	252.3	400.2	48	356.3	476.9	78	349.9	503.6	108	325.8	500.4
20	319.5	467.2	50	356.1	474.8	80	349.1	502.6	110	335.3	500.7
22	345.1	513.2	52	355.9	475.3	82	347.2	498.4	112	334.2	502.3
24	323.5	514.2	54	355.6	476.2	84	347	497.6	114	332	500.7
26	316.3	506.1	56	355.1	479.3	86	349.3	496.6	116	332.2	500.1
28	314.5	498.7	58	354.9	485.7	88	343.6	496.4	118	331.5	500.7
30	327.7	505.8	60	354.7	490.1	90	342.3	496.7	120	330.4	500

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

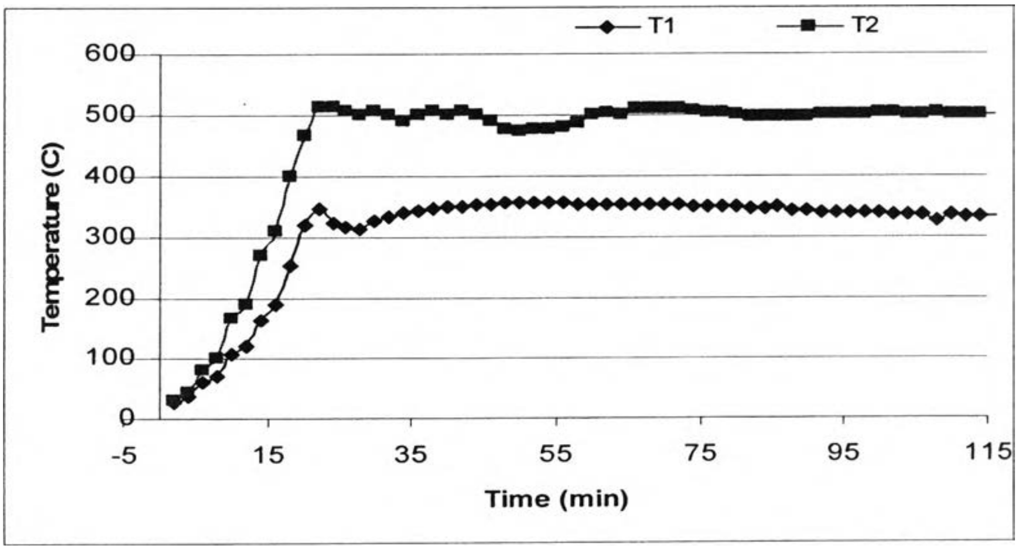


Table A14 Operating temperatures, (0.25 wt % Pd/H-BETA, Residence time 50 min): 29/11/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 15 ml/min
2. Carbon black = 13.37g
3. Pyrolysis oils = 9.05 g
4. Pyrolysis Gas = 7.58 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	29.7	27.8	32	362.8	506.6	62	371.6	501.5	92	352.8	500.1
4	34.2	36.4	34	368.5	498.7	64	371.1	503.8	94	351.4	499.8
6	43.2	51.8	36	372	498.6	66	369.6	501.3	96	350	500.1
8	63.1	85.1	38	370.8	487.6	68	369.5	501.7	98	348.8	500.4
10	92.2	132.7	40	375.5	508.7	70	362.4	499.6	100	348.1	500
12	114.6	181.8	42	378.6	498.3	72	366.9	500.3	102	347	500.4
14	145.4	234.2	44	379.3	506.1	74	369.5	500.3	104	345.6	499.7
16	168.4	286.3	46	379.5	500.7	76	363.1	499.3	106	344.3	500.1
18	209.1	357.4	48	379.2	488.3	78	361.5	500.3	108	343.3	500.5
20	294.5	450.3	50	377.6	486.2	80	359.7	501.4	110	342.3	499.7
22	330.7	487.2	52	376.1	485.4	82	359.1	499.9	112	341.1	500.2
24	335.7	515.2	54	375.4	499.9	84	356.9	499.3	114	340.7	500.1
26	343.9	508.2	56	374.5	497.9	86	355.1	500.3	116	339.5	498.3
28	349.4	503.7	58	373.5	497.6	88	352.4	500.1	118	338.6	499.7
30	355.7	497.6	60	372.8	501.8	90	353.5	499.9	120	337.7	499

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

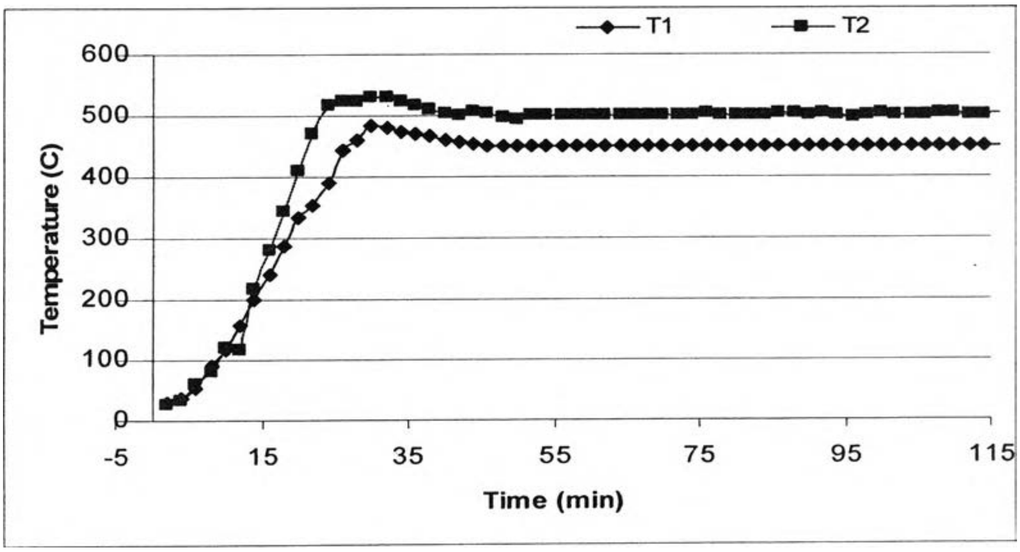


Table A15 Operating temperatures, (0.25 wt % Pd/H-BETA , Ion-exchange): 10/01/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 25 ml/min
2. Carbon black = 13.36g
3. Pyrolysis oils = 9.00 g
4. Pyrolysis Gas = 7.64 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.5	28.1	32	383.7	505.2	62	371.2	502.2	92	356.5	500.7
4	32.7	37.2	34	385.6	500.7	64	375.8	507.3	94	355.7	501.1
6	43.2	53.7	36	387.1	491.2	66	375	509.3	96	354.9	501.6
8	60.3	79.1	38	388.7	505.9	68	372.9	508.1	98	353.8	501.2
10	91.3	119.4	40	389.6	498.3	70	372.1	506.3	100	352.3	500.7
12	125.3	164.8	42	389.6	500.6	72	371.2	504.8	102	351.8	500.3
14	156.7	224.2	44	389.7	505	74	369.1	501.7	104	350.3	499.9
16	182.3	278.5	46	388.9	497.2	76	368.1	499.8	106	349.2	499.8
18	261.3	424.6	48	387.2	485.7	78	366.3	497.2	108	348.2	500.4
20	275.6	440.6	50	385.3	479.5	80	364.6	496.6	110	347.2	499.6
22	363.1	514.4	52	383.3	478.7	82	363	496.2	112	346.2	499.7
24	368.5	513.1	54	381.3	484.9	84	361.9	495.6	114	345.7	500.2
26	373.7	507.5	56	379.7	488.1	86	360.2	498.2	116		
28	376.5	501.8	58	378.8	492.7	88	359.2	499.1	118		
30	378.2	499.1	60	378	499.6	90	357.9	499.6	120		

* T1 is the catalytic temperature * T2 is the pyrolysis temperature

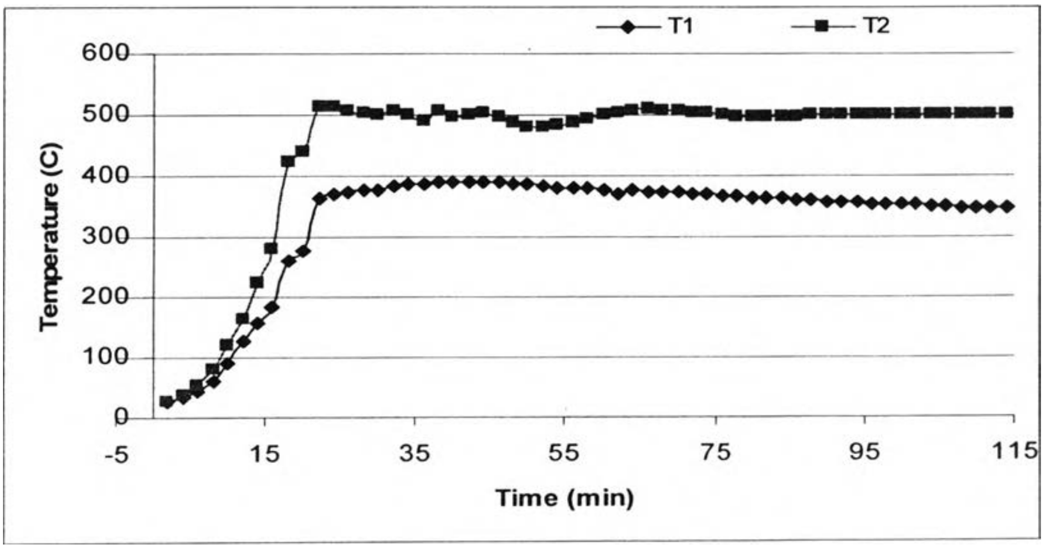


Table A16 Operating temperatures, (0.50 wt % Pd/H-BETA , Ion-exchange): 11/01/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 25 ml/min
2. Carbon black = 13.56 g
3. Pyrolysis oils = 9.07 g
4. Pyrolysis Gas = 7.37 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.4.	26.8	32	364.3	497.3	62	365.1	507.4	92	350.7	499.4
4	33.5	37.6	34	366.3	488.9	64	365.3	508.6	94	350.1	499.1
6	44.6	45.3	36	368.2	492.5	66	365	510	96	349.3	501.5
8	71	95.2	38	373.9	508.8	68	364.7	512.7	98	348.6	502.4
10	92.3	128.9	40	374.4	500.6	70	364	509.5	100	347.8	503.3
12	121.1	181.4	42	376.1	500.4	72	363.4	508.2	102	351.8	500.3
14	151.9	241.3	44	375.3	500.8	74	362.1	504.6	104	350.3	499.9
16	185.3	299.3	46	375.8	502.5	76	360.1	501.1	106	349.2	499.8
18	231.8	377.1	48	374.5	498.8	78	358.7	499	108	348.2	500.4
20	295	442.1	50	373.2	484.9	80	357.3	496.4	110	347.2	499.6
22	343.4	493.5	52	370.6	475.2	82	356.3	495.4	112	343.4	499.4
24	353.2	514.8	54	369.6	473.5	84	355.6	495.2	114		
26	359.2	508.6	56	368.1	480.9	86	354.4	495	116		
28	361.2	498.8	58	366.7	487.8	88	352.8	496	118		
30	362.9	503.7	60	366.5	494.5	90	352.9	495.2	120		

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature

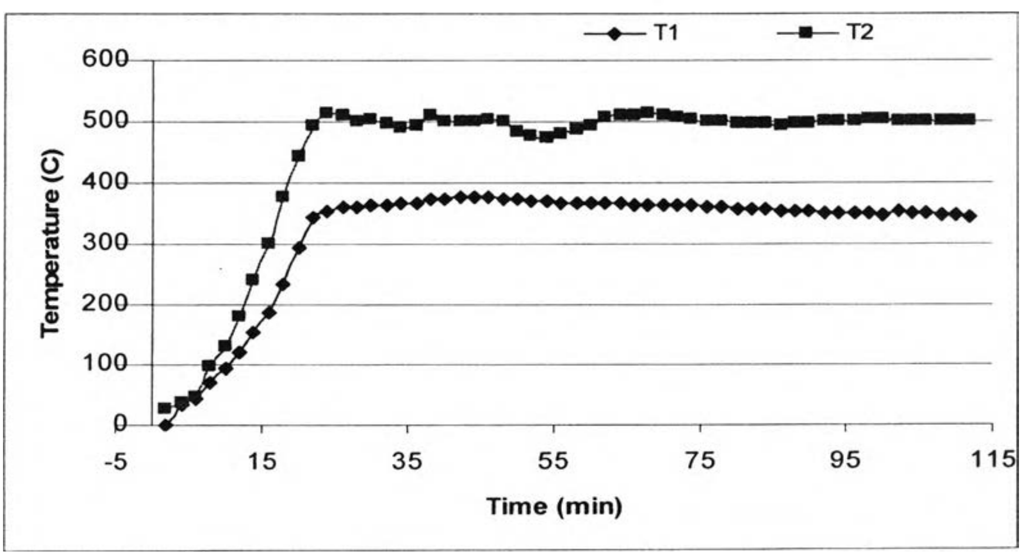
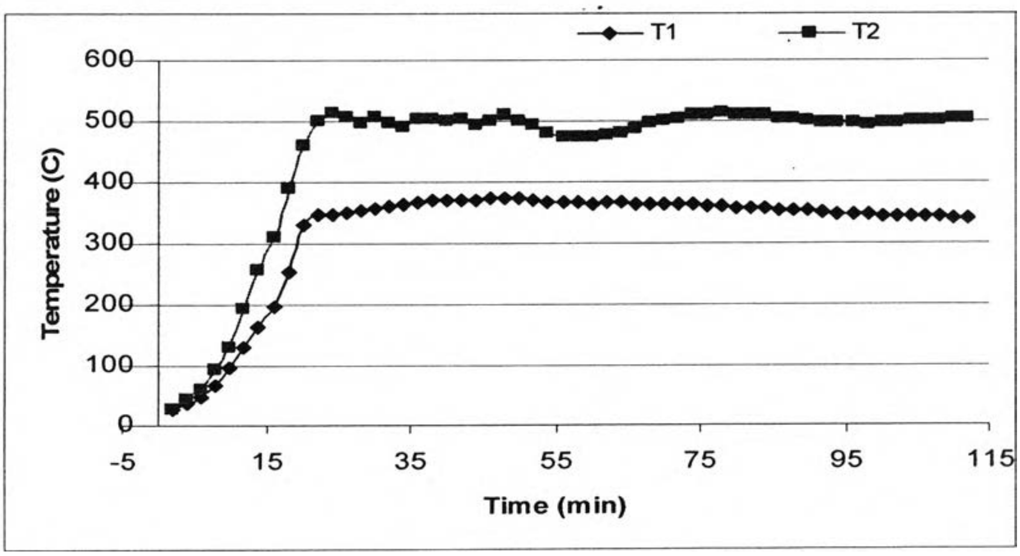


Table A17 Operating temperatures, (1.00 wt % Pd/H-BETA , Ion-exchange): 29/11/2007

1. Sample = 30 g , Catalytic temp. = 350°C, N2 flow rate = 25 ml/min
2. Carbon black = 13.30g
3. Pyrolysis oils = 8.93 g
4. Pyrolysis Gas = 7.77 g

Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2	Time (min)	T1	T2
2	27.9	28.2	32	361.5	498.2	62	365.1	475.2	92	349.4	496.5
4	35.3	43.1	34	363.6	490.5	64	365.3	479.6	94	345.5	496.7
6	45.5	60.9	36	365.6	503.2	66	365	486.2	96	346.6	496
8	66.5	94.6	38	368.8	504.1	68	364.7	496.4	98	346.1	494
10	95.4	130.5	40	369.7	499	70	364	498.8	100	344.6	496.3
12	130.5	193.7	42	371.1	504.1	72	363.4	504.1	102	344.3	496.8
14	164.8	257.2	44	371.6	492.5	74	362.1	508.6	104	343	499
16	196.7	309.9	46	371.7	499.8	76	360.1	511	106	342.5	499.3
18	252.5	389.7	48	372.5	509.5	78	358.7	512	108	341.7	501.3
20	330.7	461.2	50	372.5	500.7	80	357.3	511	110	340.9	501.8
22	346.2	500.8	52	371	492.7	82	356.3	509.8	112	339.9	502.2
24	347	514.9	54	368.1	479.5	84	355.6	508.4	114		
26	350.4	506.1	56	366.3	474.4	86	354.4	503.4	116		
28	354.6	498.3	58	365.6	473.8	88	352.8	502.4	118		
30	358.2	507	60	364.1	473.4	90	352.9	499.2	120		

* T1 is the catalytic temperature   * T2 is the pyrolysis temperature



Appendix B The Pyrolysis Gas Composition

Table B1 The volume percentage of gas product at different catalytic temperatures

gas composition	Catalytic temp of non-catalytic pyrolysis (°C)			Catalytic temp of 0.25%Pd/H-BETA (°C)			
	350	400	450	350	400	450	500
Methane	39.308	43.213	38.607	14.596	10.742	13.232	9.599
Ethylene	7.067	11.925	7.006	5.480	4.515	4.484	5.042
Ethane	11.273	16.922	11.001	11.449	8.141	8.212	8.335
Propylene	5.221	8.004	6.010	8.370	10.532	10.260	8.519
Propane	4.966	5.080	4.285	7.592	6.766	5.383	7.167
Mixed C4	9.677	8.441	10.389	25.423	27.484	26.295	29.715
Mixed C5	4.815	4.467	4.818	13.779	16.158	15.817	15.880
>C5	2.554	1.946	2.443	13.309	15.662	16.318	15.742

Table B2 The volume percentage of gas products at different palladium loading amounts (incipient wetness impregnation)

gas composition	The percentage of palladium on H-BETA (wt%)					
	H-BETA	0.25	0.5	0.75	1	1.25
Methane	19.08	14.60	16.03	14.05	13.16	13.43
Ethylene	9.64	5.48	7.40	6.39	5.67	6.13
Ethane	15.31	11.45	12.02	12.03	11.32	12.48
Propylene	8.81	8.37	10.18	10.60	8.77	9.19
Propane	8.32	7.59	7.77	7.78	7.17	8.24
Mixed C4	20.30	25.42	25.52	25.84	25.02	26.88
Mixed C5	11.33	13.78	11.73	12.86	14.52	13.35
>C5	5.06	10.12	7.32	8.06	10.77	8.16

Table B3 The space time yield of gas products at various residence time

gas composition	Residence time (min)			
	5	15	25	50
	Space time yield (mol/min) x 10^5			
Methane	3.888	5.712	5.750	5.872
Ethylene	1.221	1.563	1.497	1.534
Ethane	1.973	2.694	2.790	2.751
Propylene	1.442	1.553	1.772	1.508
Propane	1.094	1.338	1.608	1.423
Mixed C4	3.407	3.833	4.403	3.842
Mixed C5	1.686	1.732	1.807	1.574
>C5	1.996	1.266	1.211	0.939

Table B4 The volume percentage of gas products at different palladium loading amounts (Ion-exchange catalysts)

gas composition	The percentages of palladium on H-BETA (wt%)		
	0.25	0.50	1.0
Methane	34.536	35.840	32.015
Ethylene	4.481	5.767	7.8918
Ethane	9.144	9.273	14.694
Propylene	5.258	6.184	8.135
Propane	4.804	4.798	6.3433
Mixed C4	12.821	12.566	16.8
Mixed C5	6.421	5.323	7.8519
>C5	5.405	3.651	6.268

APPENDIX C Product Distribution

Table C1 The weight percentage of gas, liquid, and solid at different catalytic temperatures

Product	Catalytic temp of non-catalytic pyrolysis (°C)			Catalytic temp of 0.25%Pd/H-BETA (°C)			
	350	400	450	350	400	450	500
liquid	47.26	43.81	41.55	34.35	31.70	34.23	38.09
gas	6.19	9.01	11.72	17.79	21.58	18.65	15.80
solid	46.55	47.18	46.73	47.85	46.71	47.11	46.09

Table C2 The weight percentage of gas, liquid, and solid at different palladium loading amounts (incipient wetness impregnation)

Product	The percentage of palladium on H-BETA (wt%)					
	H-BETA	0.25	0.5	0.75	1	1.25
liquid	31.40	27.67	37.76	32.08	30.20	28.39
gas	19.46	24.47	18.44	22.96	22.65	26.22
solid	49.14	47.85	43.78	44.94	47.15	45.38

Table C3 The weight percentage of gas, liquid, and solid at various residence time

Product	Residence time (min)			
	5	15	25	50
liquid	3.888	5.712	5.750	5.872
gas	1.221	1.563	1.497	1.534
solid	1.973	2.694	2.790	2.751

Table C4 The weight percentage of gas, liquid, and solid at different palladium loading amounts (Ion-exchanged catalysts)

Product	The percentages of palladium on H-BETA (wt%)		
	0.25	0.50	1.0
liquid	34.536	35.840	32.015
gas	4.481	5.767	7.8918
solid	9.144	9.273	14.694

APPENDIX D Amount of Asphaltene in Pyrolysis oil

Table D1: The amount of asphaltene in pyrolysis oil

No.	Batch	detail	Asphaltene in oil (wt %)
1	Catalytic temp	Non cat 350°C	0.062
2		Non cat 400°C	0.118
3		Non catT450°C	0.234
4		Cat 400°C	0.038
5		Cat 450°C	0.048
6		Cat 500°C	0.066
7	Residence time	5 min	0.042
8		15 min	0.056
9		50 min	0.057
10	Incipient wetness impregnation	0.25%Pd/H-BETA	0.057
11		0.5%Pd/H-BETA	0.146
12		0.75%Pd/H-BETA	0.040
13		1%Pd/H-BETA	0.036
14		1.25%Pd/H-BETA	0.025
15	Ion-exchange	0.25%Pd/H-BETA	0.010
16		0.5%Pd/H-BETA	0.029
17		1%Pd/H-BETA	0.012

APPENDIX E Product distribution of Maltenes

Table E1: Product distribution of maltenes for non-catalytic pyrolysis (400°C)

Based on 100%wt	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
	1.392	28.693	39.627	8.223	22.065
Saturated HC.	1.66	38.38	45.04	15.54	7.68
Mono-aromatic	6.84	9.25	18.18	34.23	18.31
Di-aromatic	10.42	7.97	8.45	16.23	27.88
Poly-aromatic	47.61	22.76	11.91	13.16	23.79
Polar-aromaitc	32.46	20.64	15.40	19.83	21.33
Total aromatics	97.33	60.61	53.95	83.45	91.30

Table E2: Product distribution of maltenes for non-catalytic pyrolysis (350°C)

Based on 100%wt	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
	6.768	39.343	31.996	6.220	15.671
Saturated HC.	49.87	59.87	22.50	6.38	4.80
Mono-aromatic	8.35	19.83	29.48	13.80	11.14
Di-aromatic	0.02	0.72	22.65	24.06	18.34
Poly-aromatic	0.04	0.33	9.25	37.05	31.72
Polar-aromaitc	39.27	16.81	13.67	16.27	31.56
Total aromatics	47.68	37.68	75.05	91.18	92.75

Table E3: Product distribution of maltenes for catalytic pyrolysis (1wt%Pd/H-BETA)

Based on 100%wt	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
	6.815	54.551	33.575	2.534	2.522
Saturated	56.64	70.81	19.97	2.61	1.30
Mono-aromatic	0.90	10.42	32.87	11.83	7.96
Di-aromatic	0.03	0.99	21.79	21.33	13.80
Poly-aromatic	16.59	7.40	11.21	30.69	37.05
Polar-aromaitc	22.83	7.37	11.15	30.54	36.87
Total aromatics	40.35	26.18	77.02	94.38	95.69

APPENDIX F Carbon Number Distributions

Table F1 The carbon number distribution of maltenes at various metal loading amounts (Incipient wetness impregnation)

No. carbon.	0.25%Pd /H-BETA	0.50%Pd /H-BETA	0.75%Pd /H-BETA	1%Pd /H-BETA	1.25%Pd /H-BETA
4	0.0000000	0.0000000	0.0000000	0.0023660	0.0000008
5	0.0000000	0.0000000	0.0000000	0.0415228	0.0000201
6	0.0000000	0.0000000	0.0000000	0.1572229	0.0004332
7	0.0000000	0.2674280	0.0000000	0.5397077	0.0076560
8	0.1186369	1.1872746	1.1956578	1.6608857	0.1118558
9	4.1257819	3.0081445	4.5973820	4.4159572	1.3239693
10	18.2511334	5.9668426	11.2448287	9.4018883	9.9560582
11	19.0757575	8.7577757	16.0646073	14.6531818	25.3152049
12	13.9491665	9.8423050	15.1756637	16.3451710	22.7910181
13	10.0852346	9.3538313	11.9257455	14.1505244	14.4745063
14	7.4047434	8.2079850	8.9019758	10.6734809	8.8990932
15	5.5246873	6.9863018	6.6151240	7.6161187	5.5775937
16	4.1850482	5.8985272	4.9614921	5.3613142	3.5821871
17	3.2157945	4.9863999	3.7691909	3.7915333	2.3555759
18	2.5043314	4.2365715	2.9018067	2.7131615	1.5835189
19	1.9749356	3.6228470	2.2630877	1.9693125	1.0865368
20	1.5759120	3.1195301	1.7867252	1.4505401	0.7598172
21	1.2714644	2.7048324	1.4269798	1.0838160	0.5407553
22	1.0364699	2.3611587	1.1520144	0.8208713	0.3911433
23	0.8530708	2.0745376	0.9394163	0.6296672	0.2871845
24	0.7084199	1.8339202	0.7732204	0.4887264	0.2137715
25	0.5931694	1.6305567	0.6419227	0.3834765	0.1611394
26	0.5004447	1.4574905	0.5371417	0.3039028	0.1228680
27	0.4251387	1.3091641	0.4527063	0.2430342	0.0946687
28	0.3634220	1.1811149	0.3840282	0.1959574	0.0736328
29	0.3123972	1.0697416	0.3276637	0.1591676	0.0577594
30	0.2698542	0.9721244	0.2810055	0.1301360	0.0456533
31	0.2340936	0.8858858	0.2420632	0.1070177	0.0363292
32	0.2037993	0.8090826	0.2093050	0.0884522	0.0290825
33	0.1779442	0.7401207	0.1815434	0.0734262	0.0234034
34	0.1557215	0.6776876	0.1578503	0.0611774	0.0189192
35	0.1364924	0.6206987	0.1374949	0.0511263	0.0153540
36	0.1197472	0.5682529	0.1198971	0.0428284	0.0125016
37	0.1050761	0.5195974	0.1045924	0.0359393	0.0102063
38	0.0921458	0.4740970	0.0912049	0.0301893	0.0083495
39	0.0806825	0.4312091	0.0794273	0.0253654	0.0068396
40	0.0704579	0.3904614	0.0690047	0.0212970	0.0056054
41	0.0612787	0.3514326	0.0597226	0.0178465	0.0045910
42	0.0529774	0.3137343	0.0513967	0.0149009	0.0037520
43	0.0454057	0.2769950	0.0438650	0.0123665	0.0030528
44	0.0384276	0.2408429	0.0369813	0.0101638	0.0024642
45	0.0319147	0.2048898	0.0306085	0.0082239	0.0019622
46	0.0257399	0.1687120	0.0246136	0.0064851	0.0015260
47	0.0197718	0.1318306	0.0188606	0.0048898	0.0011376
48	0.0138681	0.0936858	0.0132043	0.0033814	0.0007798
49	0.0078667	0.0536066	0.0074809	0.0019001	0.0004357
50	0.0015747	0.0107717	0.0014967	0.0003788	0.0000866

Table F2 The carbon number distribution of maltenes at different cat. temperatures

No. carbon.	Non-catalytic pyrolysis			0.25wt% Pd/H-BETA (impregnation)			
	catalytic temperature (°C)						
	350	400	450	350	400	450	500
4	0.0003229	0.0016048	000000000	0000000	0.0387247	0.1330324	2.291E-07
5	0.0020827	0.0109471	000000000	0000000	0.1313845	0.3907439	0.0003556
6	0.0118705	0.0655883	000000000	0000000	0.407926	1.0470358	0.0254052
7	0.0601108	0.3437819	1.1215121	0000000	1.1526885	2.5100162	0.3492468
8	0.2700041	1.5106602	2.2637303	0.1186369	2.9052602	5.1735773	1.7125109
9	1.0476596	4.8369269	3.90733885	4.1257819	6.2489203	8.6900891	4.3552483
10	3.2164800	9.3322347	5.81088286	18.251133	10.752408	11.487963	7.2885498
11	6.7599260	11.1026070	7.3787879	19.075758	14.111255	12.181629	9.3442999
12	9.2577306	10.2334326	8.134177035	13.949166	14.359821	11.045719	10.110444
13	9.4589160	8.6749657	8.063588919	10.085235	12.208514	9.1692842	9.8202207
14	8.5004567	7.2212664	7.464895341	7.4047434	9.4092321	7.308245	8.9085248
15	7.3324047	6.0176651	6.646982727	5.5246873	6.953549	5.7438259	7.7439738
16	6.2706926	5.0466164	5.804114253	4.1850482	5.0794089	4.5111876	6.5595665
17	5.3737055	4.2648057	5.027578134	3.2157945	3.7212308	3.5629069	5.4743917
18	4.6300819	3.6324351	4.348338188	2.5043314	2.7518405	2.8375471	4.5344538
19	4.0150418	3.1176039	3.768658167	1.9749356	2.0594014	2.2812171	3.7458812
20	3.5047457	2.6955494	3.279320198	1.575912	1.5608847	1.8517071	3.0961391
21	3.0792169	2.3471456	2.867744314	1.2714644	1.1980497	1.51732	2.5658871
22	2.7223472	2.0575692	2.521434582	1.0364699	0.9307686	1.2546047	2.134937
23	2.4212731	1.8152601	2.229245514	0.8530708	0.7314414	1.0462593	1.7848841
24	2.1657204	1.6111404	1.981697084	0.7084199	0.5809779	0.8794806	1.5000104
25	1.9474506	1.4380311	1.770906347	0.5931694	0.4660564	0.7447397	1.2673625
26	1.7598235	1.2902164	1.590387626	0.5004447	0.377284	0.6348951	1.0764808
27	1.5974575	1.1631164	1.434827895	0.4251387	0.3079661	0.544554	0.9190167
28	1.4559679	1.0530394	1.299878797	0.363422	0.2532796	0.4696134	0.7883482
29	1.3317647	0.9569939	1.181978316	0.3123972	0.2097129	0.4069287	0.6792376
30	1.2218952	0.8725442	1.078203265	0.2698542	0.1746831	0.3540721	0.5875443
31	1.1239212	0.7976981	0.98614934	0.2340936	0.1462716	0.3091564	0.5099915
32	1.0358224	0.7308205	0.90383426	0.2037993	0.1230397	0.2707048	0.4439804
33	0.9559191	0.6705641	0.829619576	0.1779442	0.1038983	0.2375532	0.3874436
34	0.8828103	0.6158153	0.762147331	0.1557215	0.0880157	0.2087782	0.33873
35	0.8153237	0.5656499	0.70028838	0.1364924	0.0747508	0.1836412	0.2965143
36	0.7524735	0.5192976	0.643099813	0.1197472	0.0636048	0.1615468	0.2597268
37	0.6934261	0.4761120	0.589789468	0.1050761	0.0541861	0.1420101	0.227498
38	0.6374698	0.4355459	0.539685911	0.0921458	0.0461839	0.1246317	0.199115
39	0.5839892	0.3971301	0.492212632	0.0806825	0.0393493	0.1090781	0.1739869
40	0.5324421	0.3604544	0.446865418	0.0704579	0.0334801	0.0950656	0.1516182
41	0.4823384	0.3251515	0.403192042	0.0612787	0.0284106	0.082348	0.1315859
42	0.4332200	0.2908812	0.360773526	0.0529774	0.0240023	0.0707061	0.1135228
43	0.3846420	0.2573161	0.319206251	0.0454057	0.020138	0.0599383	0.0971018
44	0.3361531	0.2241271	0.278084205	0.0384276	0.0167158	0.0498525	0.0820233
45	0.2872751	0.1909687	0.236980549	0.0319147	0.0136452	0.0402579	0.0680034
46	0.2374806	0.1574621	0.195427556	0.0257399	0.0108424	0.0309558	0.0547621
47	0.1861674	0.1231775	0.152893734	0.0197718	0.0082267	0.0217299	0.0420108
48	0.1326285	0.0876113	0.108756572	0.0138681	0.0057163	0.0123329	0.0294372
49	0.0760141	0.0501592	0.062268862	0.0078667	0.0032224	0.0024693	0.0166872

Table F3 The carbon number distribution of maltenes at different residence time

No. carbon.	resince time (min)			
	5	15	25	50
4	1.1243E-05	0.02845944	0.00000000	2.291E-07
5	0.00154379	0.10508694	0.00000000	0.0003556
6	0.04717873	0.35328876	0.00000000	0.0254052
7	0.46345166	1.07489208	0.00000000	0.3492468
8	1.99942009	2.89034346	0.118636852	1.7125109
9	4.84576196	6.50624563	4.125781923	4.3552483
10	7.93551257	11.3343585	18.25113335	7.2885498
11	10.0183885	14.551368	19.07575753	9.3442999
12	10.6736678	14.2859873	13.94916647	10.110444
13	10.1953694	11.8153684	10.08523461	9.8202207
14	9.0870627	8.99418699	7.404743372	8.9085248
15	7.75868522	6.64384429	5.524687267	7.7439738
16	6.45656328	4.88549039	4.185048182	6.5595665
17	5.29672165	3.61616603	3.215794465	5.4743917
18	4.31584764	2.70627771	2.504331415	4.5344538
19	3.51014749	2.050857	1.974935567	3.7458812
20	2.85883001	1.57409324	1.575911982	3.0961391
21	2.33644949	1.22321289	1.271464402	2.5658871
22	1.91861573	0.9618003	1.036469936	2.134937
23	1.58417901	0.76465651	0.853070812	1.7848841
24	1.31570895	0.61420701	0.708419913	1.5000104
25	1.09923655	0.49807201	0.593169431	1.2673625
26	0.92374008	0.40743696	0.500444674	1.0764808
27	0.78059519	0.33595751	0.425138739	0.9190167
28	0.66307885	0.27901861	0.363422015	0.7883482
29	0.56595467	0.23322868	0.312397224	0.6792376
30	0.48513966	0.19607069	0.269854183	0.5875443
31	0.41744253	0.16565896	0.234093613	0.5099915
32	0.3603604	0.14056801	0.203799267	0.4439804
33	0.31192213	0.11971062	0.177944215	0.3874436
34	0.27056778	0.1022504	0.155721499	0.33873
35	0.23505585	0.08753823	0.136492357	0.2965143
36	0.20439193	0.07506585	0.119747221	0.2597268
37	0.17777351	0.06443154	0.105076079	0.227498
38	0.15454731	0.05531464	0.092145775	0.199115
39	0.13417598	0.04745641	0.080682465	0.1739869
40	0.11621215	0.04064554	0.070457917	0.1516182
41	0.10027778	0.03470707	0.061278689	0.1315859
42	0.08604774	0.02949383	0.052977423	0.1135228
43	0.07323625	0.02487959	0.045405655	0.0971018
44	0.06158537	0.02075356	0.038427637	0.0820233
45	0.05085472	0.01701556	0.031914725	0.0680034
46	0.04081142	0.01357166	0.025739877	0.0547621
47	0.03121962	0.01032976	0.01977179	0.0420108
48	0.02182832	0.0071947	0.013868073	0.0294372
49	0.01235612	0.00406228	0.007866708	0.0166872
50	0.00247107	0.0008115	0.001574706	0.0033394

Table F4 The carbon number distribution of maltenes from various catalysts (ion-exchanged catalysts)

No. carbon.	wt% of Pd loading on H-BETA		
	0.25	0.5	1
4	0.0432603	0.0000002	0.0118317
5	0.1429870	0.0000129	0.1717758
6	0.4334711	0.0006390	0.4958838
7	1.2001303	0.0245378	1.3096796
8	2.9837943	0.7215370	3.1108011
9	6.4113912	10.4329798	6.4074501
10	11.2111185	25.5388754	10.8413699
11	15.1014648	19.9157285	14.3802824
12	15.6202816	13.0632796	14.9453706
13	13.1711244	8.6654577	12.8409840
14	9.8291361	5.8742150	9.8169585
15	6.9260961	4.0663824	7.0866058
16	4.7885483	2.8706973	5.0097960
17	3.3123651	2.0640651	3.5359037
18	2.3132888	1.5096780	2.5150090
19	1.6373490	1.1219386	1.8102903
20	1.1760694	0.8462608	1.3207201
21	0.8573087	0.6472029	0.9769077
22	0.6339198	0.5013599	0.7323645
23	0.4751012	0.3930257	0.5560935
24	0.3605805	0.3115008	0.4273332
25	0.2768675	0.2493914	0.3320528
26	0.2148732	0.2015190	0.2606656
27	0.1683935	0.1642108	0.2065434
28	0.1331388	0.1348299	0.1650487
29	0.1061054	0.1114624	0.1328982
30	0.0851642	0.0927036	0.1077404
31	0.0687885	0.0775123	0.0878722
32	0.0558705	0.0651089	0.0720467
33	0.0455980	0.0549043	0.0593416
34	0.0373690	0.0464493	0.0490676
35	0.0307325	0.0393979	0.0407041
36	0.0253473	0.0334814	0.0338543
37	0.0209527	0.0284889	0.0282125
38	0.0173474	0.0242534	0.0235411
39	0.0143745	0.0206412	0.0196532
40	0.0119103	0.0175438	0.0164007
41	0.0098565	0.0148723	0.0136643
42	0.0081338	0.0125529	0.0113476
43	0.0066776	0.0105227	0.0093706
44	0.0054343	0.0087276	0.0076665
45	0.0043587	0.0071194	0.0061782
46	0.0034112	0.0056536	0.0048549
47	0.0025560	0.0042875	0.0036501
48	0.0017591	0.0029780	0.0025185
49	0.0009854	0.0016784	0.0014132
50	0.0001962	0.0003350	0.0002815

Table F5 The carbon number distribution of saturated hydrocarbons

No. carbon.	H-BETA	Non cat (RT 350)	1%Pd /H-BETA
4	0.000000	0.0000000	0.0023660
5	0.000000	0.0109471	0.0415228
6	0.0000061	0.0655883	0.1572229
7	0.0075518	0.3437819	0.5397077
8	0.4270803	1.5106602	1.6608857
9	3.7782026	4.8369269	4.4159572
10	10.9602042	9.3322347	9.4018883
11	16.5020251	11.1026070	14.6531818
12	17.1538145	10.2334326	16.3451710
13	14.5661671	8.6749657	14.1505244
14	11.1171307	7.2212664	10.6734809
15	8.0455592	6.0176651	7.6161187
16	5.6891006	5.0466164	5.3613142
17	3.9970277	4.2648057	3.7915333
18	2.8164058	3.6324351	2.7131615
19	2.0004933	3.1176039	1.9693125
20	1.4362096	2.6955494	1.4505401
21	1.0434416	2.3471456	1.0838160
22	0.7674470	2.0575692	0.8208713
23	0.5713437	1.8152601	0.6296672
24	0.4303498	1.6111404	0.4887264
25	0.3277546	1.4380311	0.3834765
26	0.2522097	1.2902164	0.3039028
27	0.1959386	1.1631164	0.2430342
28	0.1535582	1.0530394	0.1959574
29	0.1213029	0.9569939	0.1591676
30	0.0965097	0.8725442	0.1301360
31	0.0772753	0.7976981	0.1070177
32	0.0622249	0.7308205	0.0884522
33	0.0503547	0.6705641	0.0734262
34	0.0409244	0.6158153	0.0611774
35	0.0333827	0.5656499	0.0511263
36	0.0273146	0.5192976	0.0428284
37	0.0224047	0.4761120	0.0359393
38	0.0184110	0.4355459	0.0301893
39	0.0151461	0.3971301	0.0253654
40	0.0124634	0.3604544	0.0212970
41	0.0102470	0.3251515	0.0178465
42	0.0084043	0.2908812	0.0149009
43	0.0068605	0.2573161	0.0123665
44	0.0055544	0.2241271	0.0101638
45	0.0044344	0.1909687	0.0082239
46	0.0034566	0.1574621	0.0064851
47	0.0025816	0.1231775	0.0048898
48	0.0017722	0.0876113	0.0033814
49	0.0009910	0.0501592	0.0019001
50	0.0001971	0.0100815	0.0003788

Table F6 The carbon number distribution of total aromatics

No. carbon.	H-BETA	Non cat (RT 350)	1%Pd /H-BETA
4	0.00000	0.000000	7.264E-06
5	1.78140	0.001830	0.0001695
6	2.89384	0.0100592	0.1219902
7	4.45163	0.2475872	0.3107968
8	5.98769	0.8472999	0.863619
9	5.63930	2.0093683	1.4536517
10	4.93041	3.0867221	2.0108219
11	4.99638	3.5191704	2.6688362
12	5.28557	3.7427964	3.8970704
13	5.30453	3.9667843	5.7065232
14	4.84122	4.0622722	6.5469225
15	3.98633	3.983995	5.8042425
16	3.02515	3.7523206	4.5265528
17	2.18361	3.4001109	3.3576084
18	1.53842	3.0110401	2.4610882
19	1.07590	2.6484483	1.8136384
20	0.75443	2.3297159	1.3509126
21	0.53337	2.0530949	1.0180056
22	0.38126	1.814189	0.775932
23	0.27584	1.6088184	0.5979448
24	0.20195	1.4327637	0.4656361
25	0.14941	1.2818194	0.3662129
26	0.11144	1.1520542	0.2907
27	0.08361	1.0399867	0.2327452
28	0.06312	0.9426374	0.1878133
29	0.04807	0.8575049	0.1526379
30	0.03699	0.7825097	0.1248445
31	0.02875	0.7159304	0.1026914
32	0.02253	0.6563438	0.0848892
33	0.01777	0.6025729	0.0704741
34	0.01410	0.5536421	0.0587193
35	0.01123	0.5087411	0.0490716
36	0.00899	0.467194	0.0411057
37	0.00722	0.4284333	0.0344918
38	0.00581	0.3919786	0.0289716
39	0.00468	0.3574173	0.0243404
40	0.00378	0.3243887	0.0204349
41	0.00305	0.2925688	0.0171228
42	0.00246	0.2616567	0.0142956
43	0.00198	0.2313613	0.0118634
44	0.00158	0.2013889	0.0097497
45	0.00125	0.1714289	0.0078884
46	0.00096	0.1411398	0.0062202
47	0.00071	0.1101318	0.0046899
48	0.00048	0.0779482	0.003243
49	0.00027	0.044045	0.0018224
50	0.00005	0.0078723	0.0003476

APPENDIX G True Boiling Point Curves

Table G1 True boiling point curves of non-catalytic pyrolysis (Catalytic temp.350°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	43.1	41.1	22.7	22.2	21.6	40.7
5	154.4	71.1	75.5	226.5	70.7	52.6
10	158.1	78.6	194.4	272.8	71.1	197.9
15	169.3	84.3	227.5	284.5	71.5	216.9
20	177.1	157.6	234.2	292.6	71.9	237.8
25	190.6	169.7	245.7	299.4	72.3	257.6
30	201.6	173.8	254.1	304.2	72.6	279.4
35	210.5	187.1	262.8	312.4	73.0	298.7
40	219.9	194.1	272.1	317.7	73.4	317.6
45	231.8	204.1	277.9	324.1	73.8	337.9
50	244.8	211.4	286.5	330.4	74.2	357.4
55	259.6	219.1	293.8	335.5	74.5	376.1
60	274.6	228.7	304.4	344.4	86.6	388.9
65	289.1	240.1	315.7	354.5	312.9	403.4
70	305.1	254.9	327.3	365.6	337.4	417.4
75	322.9	272.9	339.4	377.8	354.3	431.9
80	342.4	289.2	355.9	391.6	370.4	448.5
85	366.7	311.7	373.1	406.9	387.6	470.6
90	394.7	342.8	394.2	424.1	408.5	499.8
95	433.8	397.4	423.8	449.1	439	535
100	563.1	568.2	487.1	501.7	501	576.6

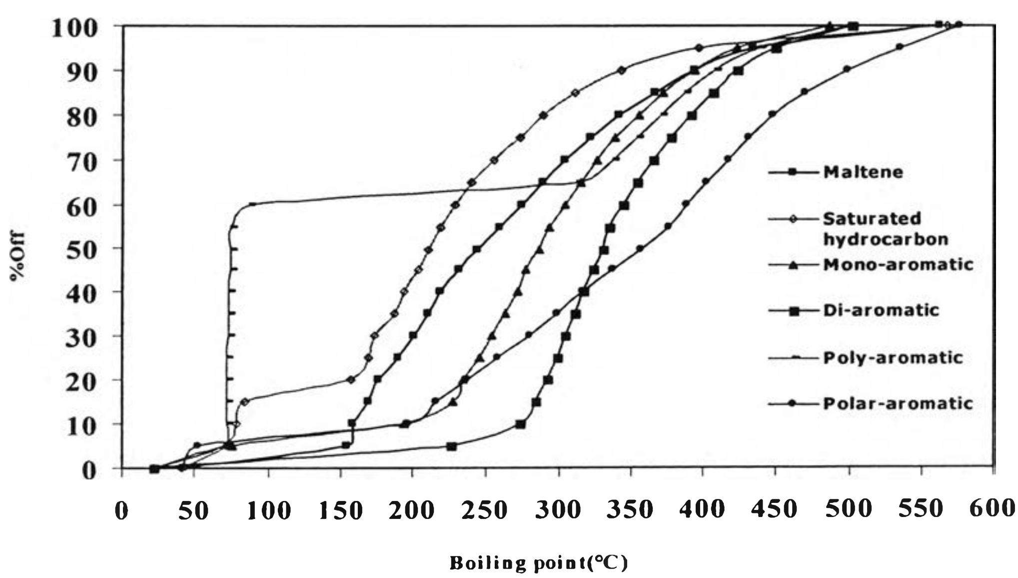


Table G2 True boiling point curves of non-catalytic pyrolysis (catalytic temp. 400°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	20.8	21.4	21.2	20.5	39.9	28.6
5	21.8	79.2	69.3	45.8	44.1	48.6
10	22.9	205.2	277.1	57.7	47.5	79.6
15	23.9	214.7	297.8	91.2	54.7	258.9
20	25	224.5	312.6	304.7	77.0	289.3
25	26.1	232.5	325.1	358.7	214.3	309.4
30	27.1	240.5	335.2	382.3	256.9	328.8
35	28.2	249.5	346.3	396.9	306.0	346.5
40	29.2	258.5	355.8	407.6	341.5	362.2
45	30.3	269.2	364.3	416.2	374.7	378.4
50	31.4	277.1	372.6	425.5	403.1	388.9
55	32.4	286.7	380.2	434.7	421.4	404.9
60	37.1	298.1	388.2	444.0	438.3	420.8
65	72.1	311.1	396.6	454.3	456.9	435.1
70	72.8	326.1	405.3	465.7	477.6	439.5
75	170.6	343.9	414.1	478.6	497.6	454.3
80	180	366.1	425.1	494.0	516.4	473.3
85	222.8	389.7	438.6	510.3	532.2	494.8
90	348.6	418.1	458.1	531.0	547.1	516.7
95	404.3	462.9	497.6	553.4	563.8	542.3
100	481.9	570.2	573.6	579.2	580.5	577.5

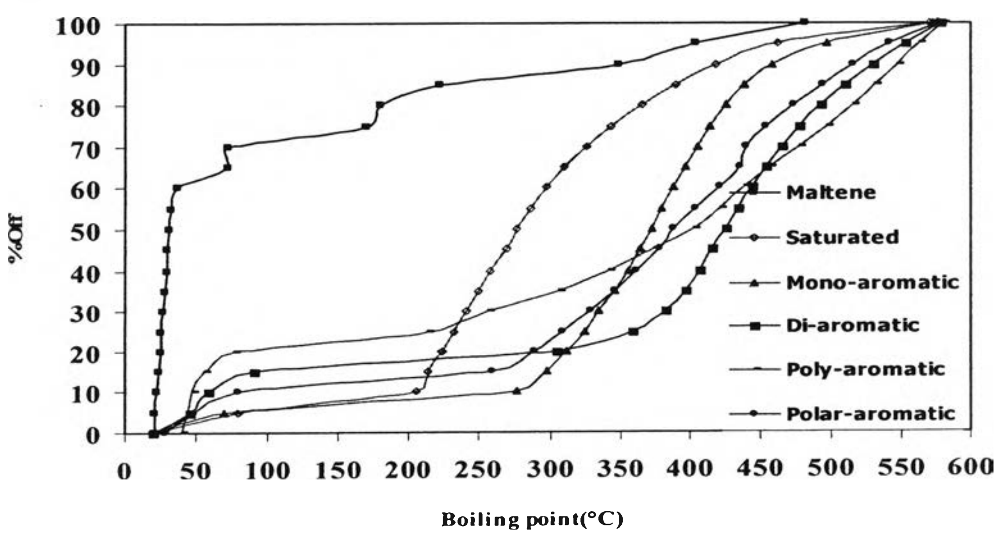


Table G3 True boiling point curves of non-catalytic pyrolysis (catalytic temp. 450°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.8	22.7	22.2	22.7	21.8	21.8
5	155.3	83.0	67.7	74.2	72.6	166.8
10	158.5	169.6	77.4	78.6	73.0	169.1
15	171.1	182.1	82.1	87.2	73.4	188.2
20	187.3	191.2	180	179.0	73.8	210.5
25	203.2	201.7	184.7	182.5	74.2	232.7
30	214.4	210.5	189.7	185.3	74.5	251.3
35	225.7	220.9	195.6	189.2	74.9	273
40	237.3	231.3	198.8	193.2	75.3	290.9
45	251.3	243.6	202.5	196.7	76.1	310.5
50	264.8	256.3	208.1	198.9	184.5	328.6
55	276.3	270.0	219.8	201.7	204.2	347.4
60	288.5	280.0	291.5	206.0	272.4	365.2
65	302	292.3	350.8	209.2	330.2	383.2
70	318	306.3	370.7	218.2	369.6	396.4
75	333.4	322.3	385.6	294.9	396.5	407.9
80	353	339.1	399.5	380.4	411.3	422.5
85	374.7	362.0	410.3	404.7	425.1	441.5
90	400.3	387.4	426.4	424.1	442.3	463.7
95	427.7	417.0	451.1	453.4	467.8	490.6
100	492.6	479.0	502.3	507.2	516.5	528.7

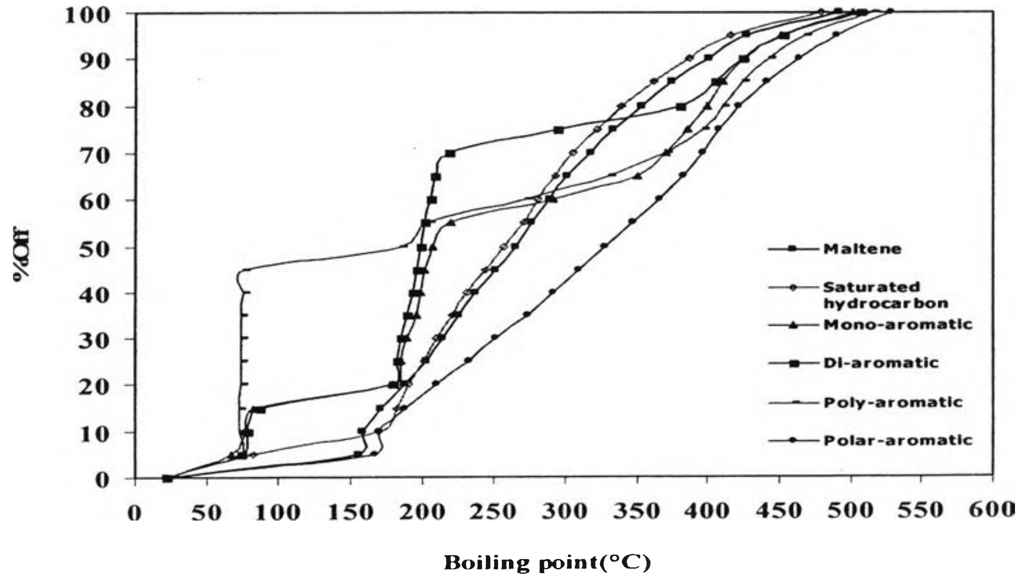


Table G4 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, incipient wetness impregnation)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	23.1	22.2	21.8	21.6	21.2	21.4
5	154	168.4	74.4	25.6	22.9	23.5
10	156.9	177.3	214.9	71.5	25.0	26.7
15	167.7	185.3	231.6	182.6	27.8	32
20	170.4	191.8	234.5	256.3	34.6	75.3
25	172.7	197.7	244.7	271.1	73.9	178.2
30	182.8	203.8	249.8	276.5	175.9	209.1
35	186.4	209.6	254.8	278.2	229.0	239.9
40	193	214.2	262.1	285.0	292.1	262
45	201.6	220.2	268.3	291.8	320.9	282.5
50	207.9	225.1	273.7	294.8	335.6	302.2
55	214.8	232.5	279.8	301.1	350.5	323.5
60	223.2	240.0	287.1	308.9	366.1	344.5
65	232.7	249.9	293.1	319.1	381.4	357.5
70	244.7	260.1	302.1	329.7	393.7	386.7
75	258.8	271.6	311.9	341.1	409.3	393.3
80	275.4	283.2	323.6	356.8	426.7	416.8
85	293.3	298.3	337.5	377.9	449.4	442.3
90	320.1	321.0	360.8	406.9	474.1	471.2
95	368	364.5	402.7	451.4	502.8	504.5
100	525.3	518.8	524.3	526.1	561	563.5

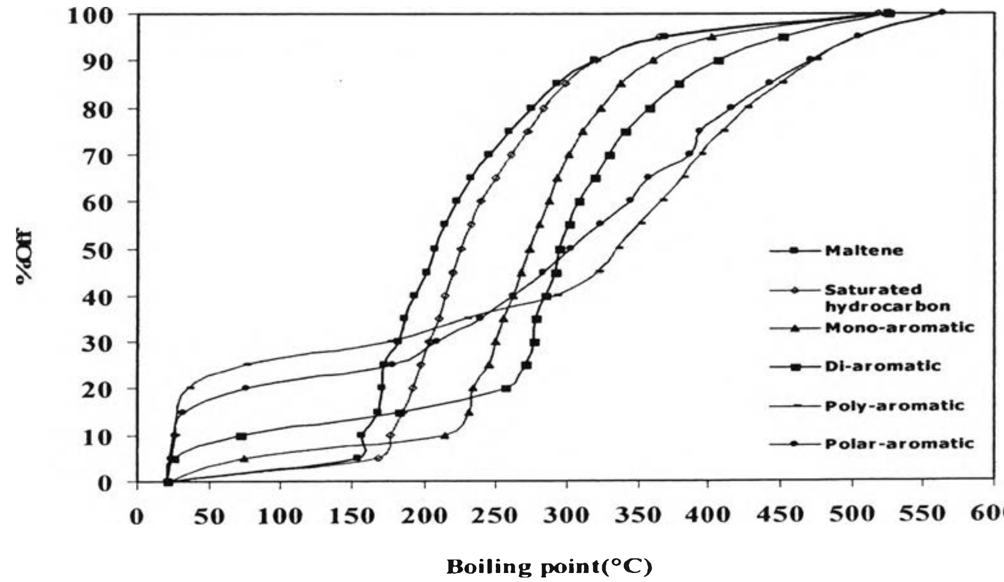


Table G5 True boiling point curves of catalytic pyrolysis (0.50%Pd/H-BETA, incipient wetness impregnation)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21	22.5	23.1	23.1	23.1	21
5	111.8	74.1	77	80.9	75.1	22
10	145.2	80.6	153.6	155.5	156.1	23.9
15	155	154.1	156.6	157.9	167.2	73.8
20	156.3	156.2	165.6	167.7	172.4	200.5
25	159.1	160	170.6	170.2	188.3	227.6
30	168.3	169.7	176.7	172.1	203.7	253.2
35	170.6	171.2	186.7	178.1	230.2	278.3
40	172.6	173.8	194.4	184.3	255.9	296
45	183.3	184.1	210.7	189.0	271.6	312.4
50	186.9	186.8	213	193.8	281.7	326.1
55	192.8	192.1	226.2	202.5	292.3	339.9
60	200.7	196.9	231.6	213.6	302.4	352.8
65	208.2	203.9	234.8	232.9	311.5	365.7
70	214.5	211.5	246.6	255.2	322.8	378.3
75	225.6	217.8	255.7	273.5	334.7	389.5
80	239.8	227.7	272.3	294.0	349.8	404.5
85	264.2	244.5	287.8	317.4	368.2	418.2
90	295.3	273.8	315.7	342.6	391.7	438.9
95	350.6	323.3	360.0	382.6	420.5	467.7
100	459.5	444.7	456.6	465.3	484.9	516.6

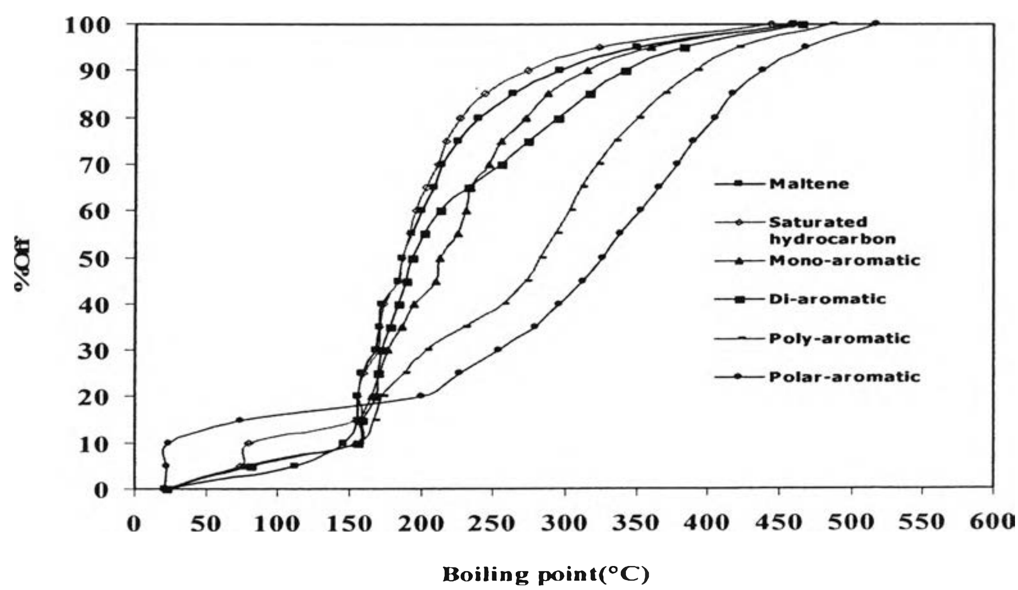


Table G6 True boiling point curves of catalytic pyrolysis (0.75%Pd/H-BETA, incipient wetness impregnation)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.5	22.9	23.1	22.9	21.6	21.4
5	154.6	158.7	213.9	272.5	33.5	23.5
10	158.4	172.6	235.5	287.1	314.0	26.7
15	170.2	185	250.4	292.7	328.2	32
20	173.7	191.3	255.2	296.8	340.1	75.3
25	185.1	195.6	265.6	304.2	348.3	178.2
30	191.7	203.4	272.9	308.4	355.3	209.1
35	197.9	208.2	276.6	314.2	362.6	239.9
40	205	213.2	284.3	319.2	369.4	262
45	212.3	218.7	291.1	325.0	376.1	282.5
50	218.4	223.8	299	331.6	383.0	302.2
55	225.4	230.5	306.7	338.5	390.2	323.5
60	233	235.9	316.5	347.6	397.9	344.5
65	243.1	244.7	326.9	357.4	405.4	367.5
70	254.6	253.9	336.8	368.5	412.9	386.7
75	268.5	265.2	350.4	381.2	422.1	393.3
80	283.1	277.6	367.2	396.3	433.4	416.8
85	301.2	292.9	384.9	411.6	447.4	442.3
90	327.9	316.5	408.6	433.3	465.5	471.2
95	371.6	358.9	441.4	465.7	491	504.5
100	474.6	466.6	509.9	525.7	532.6	563.5

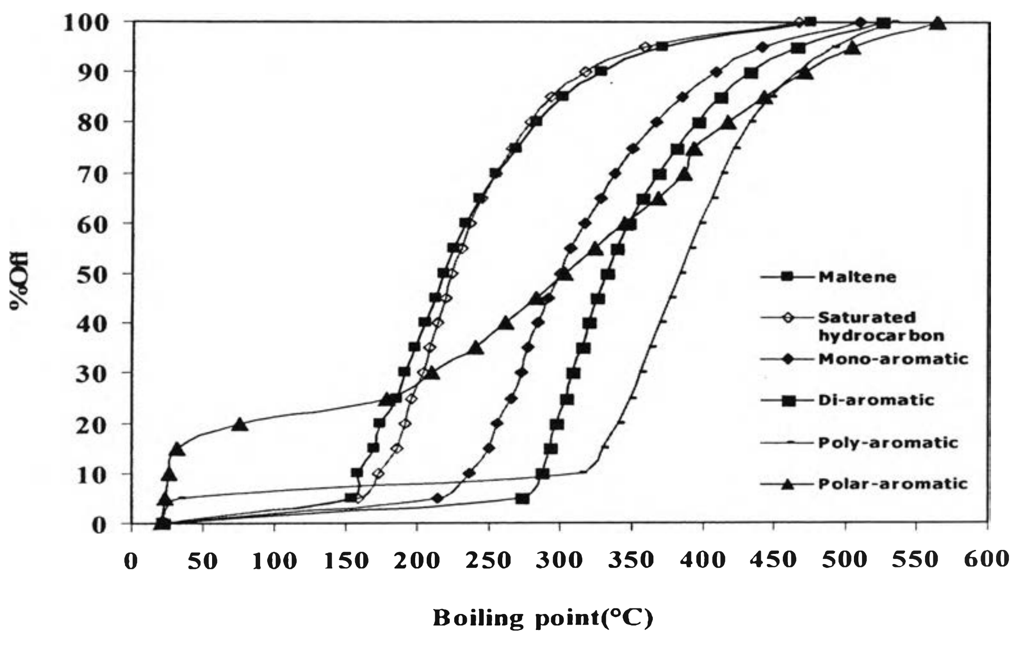


Table G7 True boiling point curves of catalytic pyrolysis (1%Pd/H-BETA, incipient wetness impregnation)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.2	22.5	22	21.6	21.6	21.4
5	76.1	78.4	72.1	26.3	23.9	23.5
10	157.3	169	231.8	74.8	27.8	26.7
15	169.3	173.4	237.6	270.5	74.2	32.6
20	172.8	185.6	248.7	276.6	241.7	75.8
25	185	192.2	253.4	285.0	293.0	212
30	192	198.9	256.8	290.6	311.8	243.5
35	199.7	205.5	264.8	294.6	322.2	264.9
40	207.3	211.9	269.9	300.2	330.3	284.9
45	213.3	214.7	274.6	305.4	339.4	306.1
50	219.3	221.2	280.5	310.3	347.7	324.1
55	225.9	227.0	287.5	316.4	356.2	342.4
60	232.5	232.2	292.6	322.0	365.6	360.3
65	238.6	236.9	300.3	329.3	375.9	378.9
70	248.8	245.5	307.5	335.6	386.8	387.0
75	259	253.7	317.0	345.0	395.7	389
80	272	265.2	327.9	356.8	409.7	405
85	289.2	278.9	340.7	372.7	425.5	425.2
90	314.8	299.0	360.4	394.7	446	446.4
95	356.6	336.7	393.3	427.4	473.2	475.3
100	461	448.5	477.6	491.5	510.4	514.1

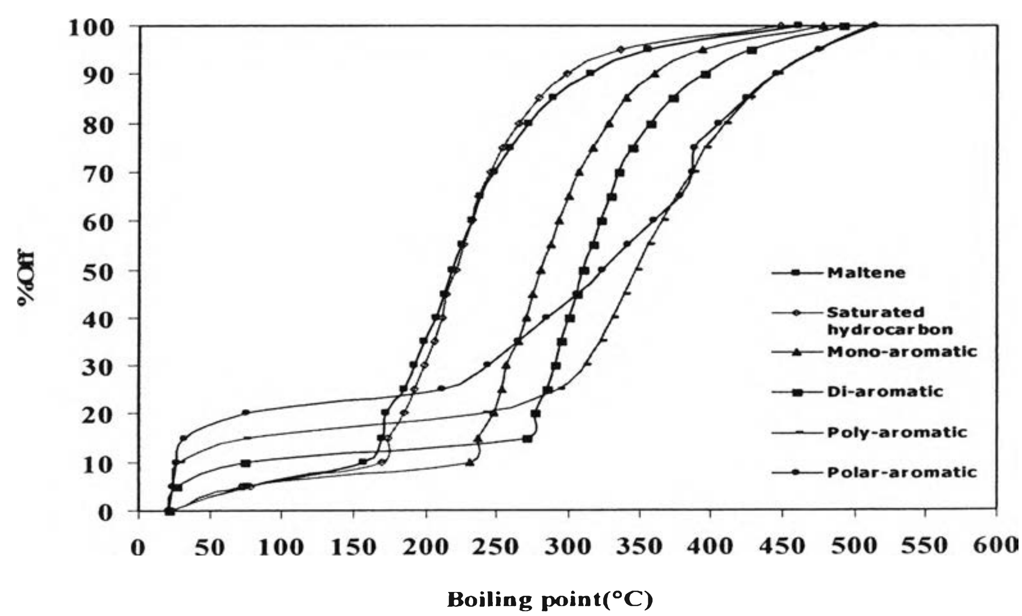


Table G8 True boiling point curves of catalytic pyrolysis (1.25%Pd/H-BETA, incipient wetness impregnation)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22.5	22.9	21.6	22	21.4	21.2
5	115.2	170.4	26.5	74.6	24.2	22.5
10	168.7	182.8	75.1	269	28.4	23.9
15	172.4	186.2	212.1	276.2	74.2	25.8
20	182	191.4	229.1	285.8	75.1	28
25	185.6	193	233.8	292.4	77.0	31.6
30	190.8	198	238.7	298.7	266.6	74.5
35	193	202.9	248.9	305.9	310.0	75.4
40	197.7	205.3	254.6	314.2	328.1	77.9
45	203.1	209.6	262.4	320.4	344.5	190.1
50	207.2	212.9	269.9	328.8	359.5	247.9
55	212.4	215.8	277.4	335.0	376.8	272.7
60	215.8	220.7	285.7	344.5	389.5	296.5
65	222.2	225.0	294.3	355.9	406.8	327.0
70	230.3	232.1	305.7	368.8	415.2	354.2
75	238.6	239.8	320.0	383.0	429.8	385.2
80	253.8	252.1	335.0	400.0	447.5	391.1
85	274.8	268.8	356.0	418.6	466.5	414.8
90	305.6	291.3	384.3	444.1	485.1	444.1
95	366.5	338.9	428.4	477.8	507.2	478.4
100	502.1	478.3	506.8	534.9	552	523.8

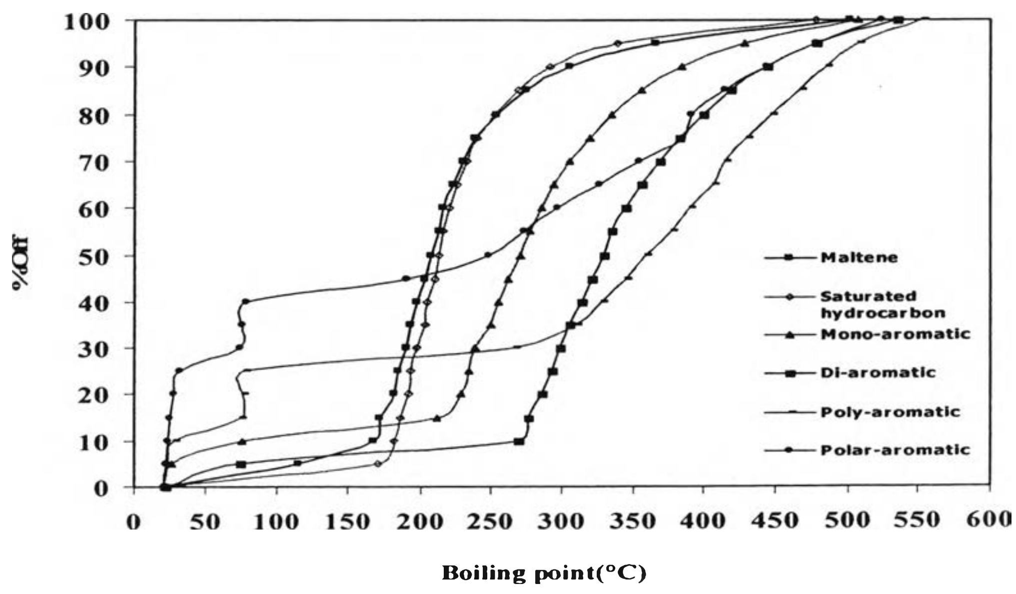


Table G9 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Catalytic temperature 400°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.8	22.7	22.2	22.7	21.8	21.8
5	155.3	83.0	67.7	74.2	72.6	166.8
10	158.5	169.6	77.4	78.6	73.0	169.1
15	171.1	182.1	82.1	87.2	73.4	188.2
20	187.3	191.2	180	179.0	73.8	210.5
25	203.2	201.7	184.7	182.5	74.2	232.7
30	214.4	210.5	189.7	185.3	74.5	251.3
35	225.7	220.9	195.6	189.2	74.9	273
40	237.3	231.3	198.8	193.2	75.3	290.9
45	251.3	243.6	202.5	196.7	76.1	310.5
50	264.8	256.3	208.1	198.9	184.5	328.6
55	276.3	270.0	219.8	201.7	204.2	347.4
60	288.5	280.0	291.5	206.0	272.4	365.2
65	302	292.3	350.8	209.2	330.2	383.2
70	318	306.3	370.7	218.2	369.6	396.4
75	333.4	322.3	385.6	294.9	396.5	407.9
80	353	339.1	399.5	380.4	411.3	422.5
85	374.7	362.0	410.3	404.7	425.1	441.5
90	400.3	387.4	426.4	424.1	442.3	463.7
95	427.7	417.0	451.1	453.4	467.8	490.6
100	492.6	479.0	502.3	507.2	516.5	528.7

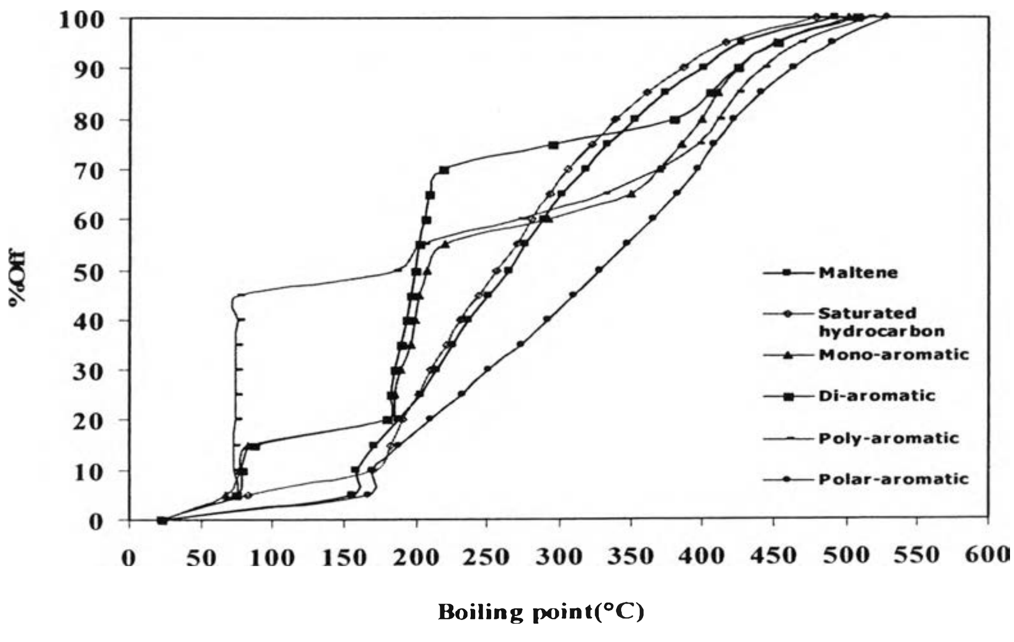


Table G10 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Catalytic temperature 450°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.6	22.5	22.7	22.5	22.2	21.4
5	113.8	76.4	74.1	171.4	71.9	38.6
10	156.4	155.4	80.1	189.6	72.4	170.3
15	168.4	169.4	170.4	200.6	73.2	196.9
20	172.5	172.5	185	214.9	192.9	210.4
25	185.9	184.2	195.9	253.0	288.9	227
30	193.2	189.8	206.5	269.2	296.2	245.2
35	204.4	193	217.3	272.2	307.0	266.6
40	212.7	199.5	231.1	275.9	310.4	286.4
45	220.4	206.5	234.9	277.7	318.1	303.1
50	230.4	212.1	245	286.5	324.6	319.4
55	236.5	214.9	250.8	291.4	331.9	337.7
60	248.9	223.4	255.4	293.6	340.2	357.8
65	259.7	231.5	264.8	301.1	348.3	378.7
70	272.3	238.2	272.8	306.5	356.3	391.9
75	284.7	249.6	280.1	316.5	365.1	405.9
80	298.9	263.1	290.7	328.3	374.9	418.4
85	319	278.6	303.7	342.3	386.7	437
90	346.6	301.9	326.5	364.8	402.8	460
95	392.4	352.3	371.1	403.5	426.2	489.4
100	483.3	463.1	469.9	482.3	495.9	529.9

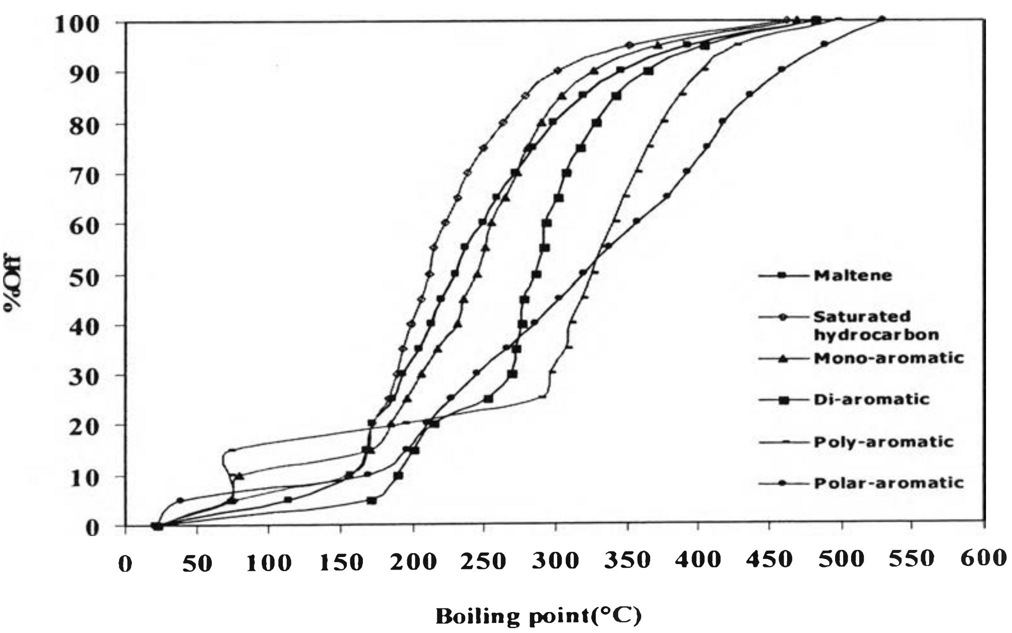


Table G11 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Catalytic temperature 500°C)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22	22	22	22.2	21.8	21.6
5	155.2	69.4	69.7	72.6	71.6	131.2
10	160.1	76.4	75.4	76.7	72.1	169
15	172.3	80	78.7	173.8	72.6	185.1
20	187.2	158.4	175	184.4	73.2	203.6
25	198	173	185.8	191.2	186.9	220.9
30	210.8	186.1	196.2	199.0	312.2	239.7
35	218.2	193.5	203	207.2	328.8	260.6
40	228.9	203.1	226.8	242.5	340.5	280.4
45	236.3	211.8	270.2	294.9	347.9	298.5
50	248.8	218.5	276.3	307.1	354.4	317.7
55	259.8	228.3	285.4	310.1	361.0	335.5
60	271.8	235.3	291.8	317.7	367.2	355.6
65	281.9	248.0	295.7	324.2	374.0	376.7
70	293.2	256.7	304.4	332.3	384.4	391.1
75	306.9	269.4	312.9	342.5	389.8	406.7
80	322.6	281.9	323.3	354.4	400.0	423.3
85	342.1	298.0	336.5	369.8	410.7	444.7
90	368.9	322.6	358.3	390.6	425.1	467
95	406.2	367.6	397.7	418.4	449.1	495.5
100	484.3	457.2	475.6	490.3	504.3	533.4

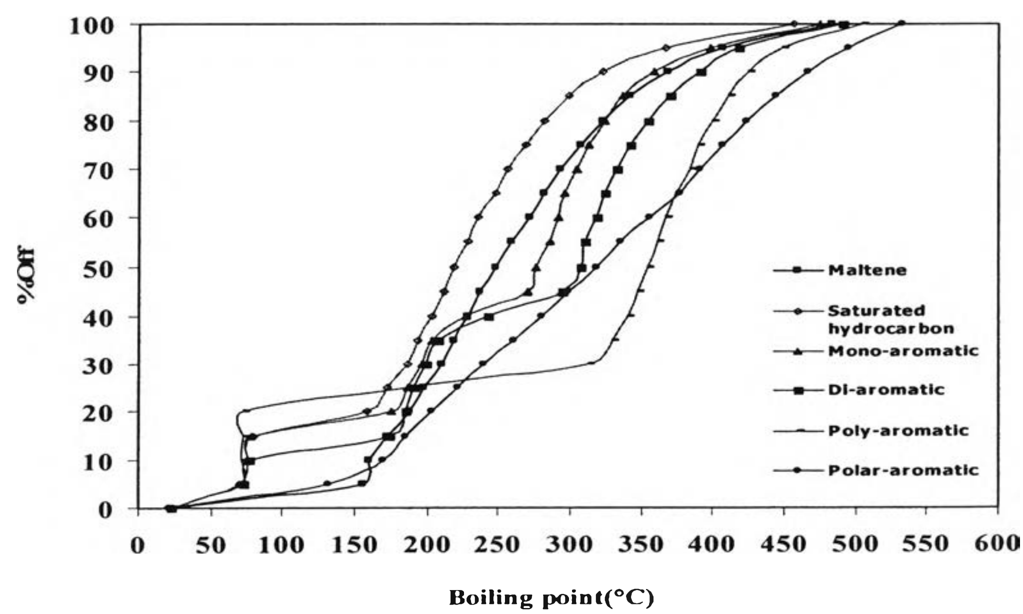


Table G12 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Residence time 5 min)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.8	23.5	22.7	22.7	22.2	21.4
5	153.2	85.6	214.5	78.7	72.4	23.3
10	157.8	168.6	250.8	289.3	72.8	26.1
15	170.3	173.8	258.2	293.6	73.2	30.1
20	180.9	186.8	269.3	301.3	73.5	75.9
25	191.8	193.6	273.1	306.5	73.9	183.8
30	203.7	204.2	276.3	308.3	74.3	227.8
35	213	212	282.5	310.4	74.7	253.2
40	222.4	217.1	287.7	315.7	75.1	274.9
45	231.9	224.5	291.7	318.7	75.4	294.2
50	241.3	231.4	294	322.6	75.8	315.7
55	252	236.5	299.8	326.9	76.2	332.5
60	263	246.0	304.3	331.3	76.6	349.7
65	273.5	253.3	309.1	335.8	88.9	369.2
70	285	262.3	316.2	342.5	338.8	386.6
75	296.1	271.8	323.4	349.4	354.0	397.6
80	309.8	281.9	331.9	357.5	367.7	408.4
85	327	295.4	343.0	368.2	382.5	420.2
90	349.7	315.5	360.0	383.1	402.5	443.6
95	385	353.1	389.6	407.2	428.5	475.3
100	465	442.8	464.1	475.8	501.6	520.3

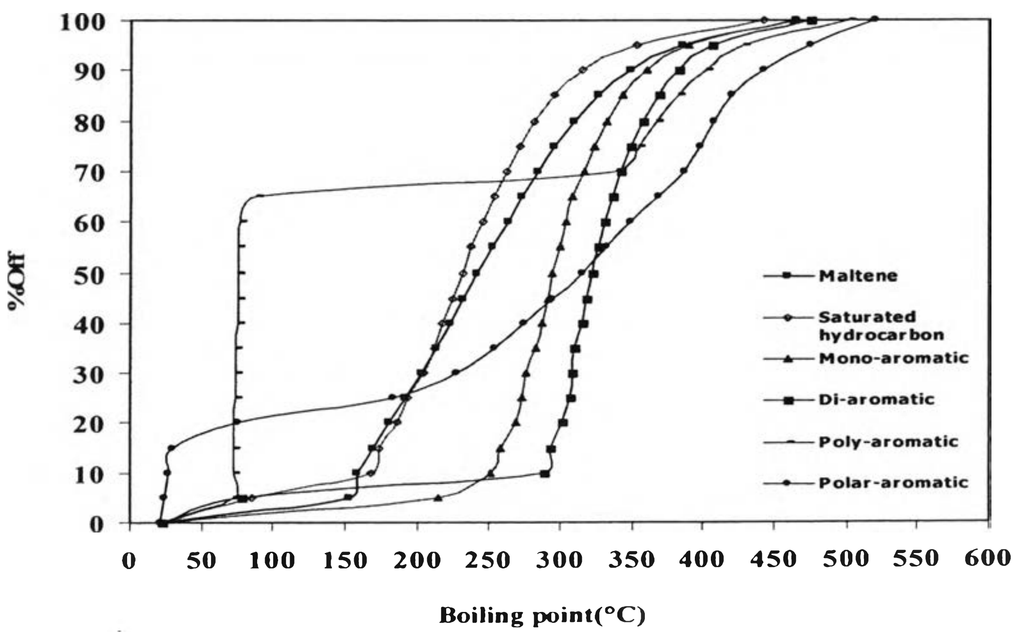


Table G13 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Residence time 15 min)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.4	22.2	22.7	22.7	22.5	20.8
5	110.1	71.5	153.7	109.3	69.1	24.4
10	153.7	74.9	169.8	156.6	69.4	36.3
15	156.8	78	187.4	170.4	69.8	171.3
20	169.1	153.1	193.7	184.6	70.2	201
25	172.2	157	210.9	204.4	70.6	223.3
30	184.5	169.7	211.9	227.5	71.0	243.5
35	191.6	172.3	212.9	236.6	71.3	263.2
40	201.1	184.5	215.4	246.7	71.7	280.8
45	209	191	227.9	254.2	72.1	295.9
50	213.8	198.1	230.9	264.2	72.5	314.7
55	222.2	205.8	232.1	272.2	72.9	332.5
60	230.3	213.3	234	276.8	73.2	350.8
65	236.6	220.8	243.6	285.9	76.7	371.9
70	248.2	227.7	248.3	292.6	201.2	389.8
75	260.5	237.2	254.5	302.7	288.5	405.1
80	275.5	249.7	264.7	314.1	310.0	416.9
85	294.2	265.6	277.9	327.0	332.1	433.4
90	321.7	285.5	295.8	343.3	358.4	453.3
95	367.4	322.6	331.7	373.5	392.7	480.9
100	475.3	433.3	440.0	459.0	475.2	532.7

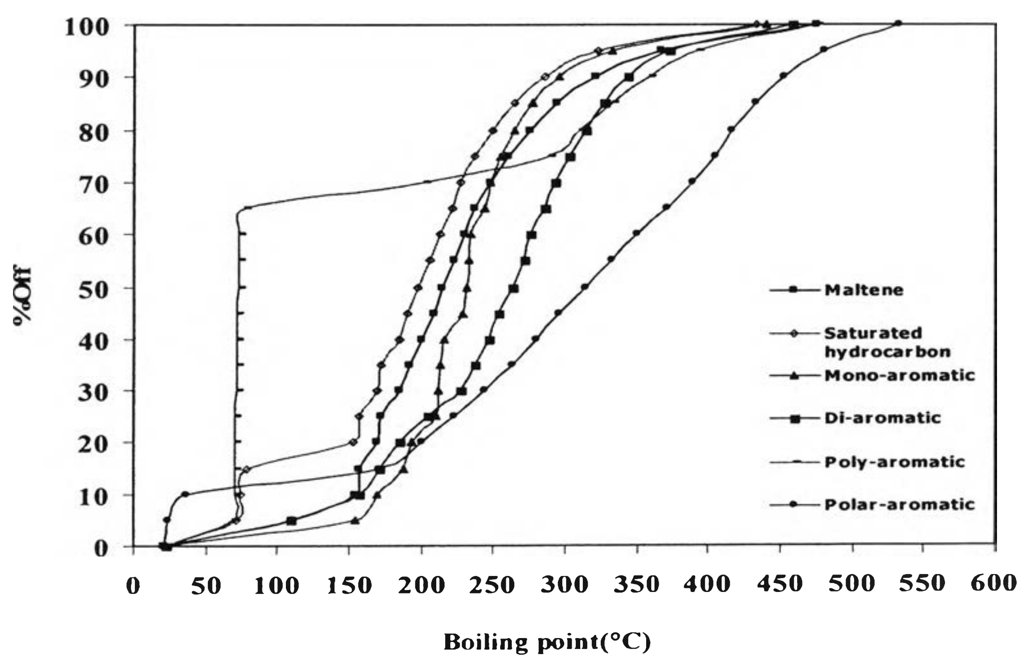


Table G14 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Residence time 50 min)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	22	22	22	22.2	21.8	21.6
5	155.2	69.4	69.7	72.6	71.6	131.2
10	160.1	76.4	75.4	76.7	72.1	169
15	172.3	80	78.7	173.8	72.6	185.1
20	187.2	158.4	175	184.4	73.2	203.6
25	198	173	185.8	191.2	186.9	220.9
30	210.8	186.1	196.2	199.0	312.2	239.7
35	218.2	193.5	203	207.2	328.8	260.6
40	228.9	203.1	226.8	242.5	340.5	280.4
45	236.3	211.8	270.2	294.9	347.9	298.5
50	248.8	218.5	276.3	307.1	354.4	317.7
55	259.8	228.3	285.4	310.1	361.0	335.5
60	271.8	235.3	291.8	317.7	367.2	355.6
65	281.9	248.0	295.7	324.2	374.0	376.7
70	293.2	256.7	304.4	332.3	384.4	391.1
75	306.9	269.4	312.9	342.5	389.8	406.7
80	322.6	281.9	323.3	354.4	400.0	423.3
85	342.1	298.0	336.5	369.8	410.7	444.7
90	368.9	322.6	358.3	390.6	425.1	467
95	406.2	367.6	397.7	418.4	449.1	495.5
100	484.3	457.2	475.6	490.3	504.3	533.4

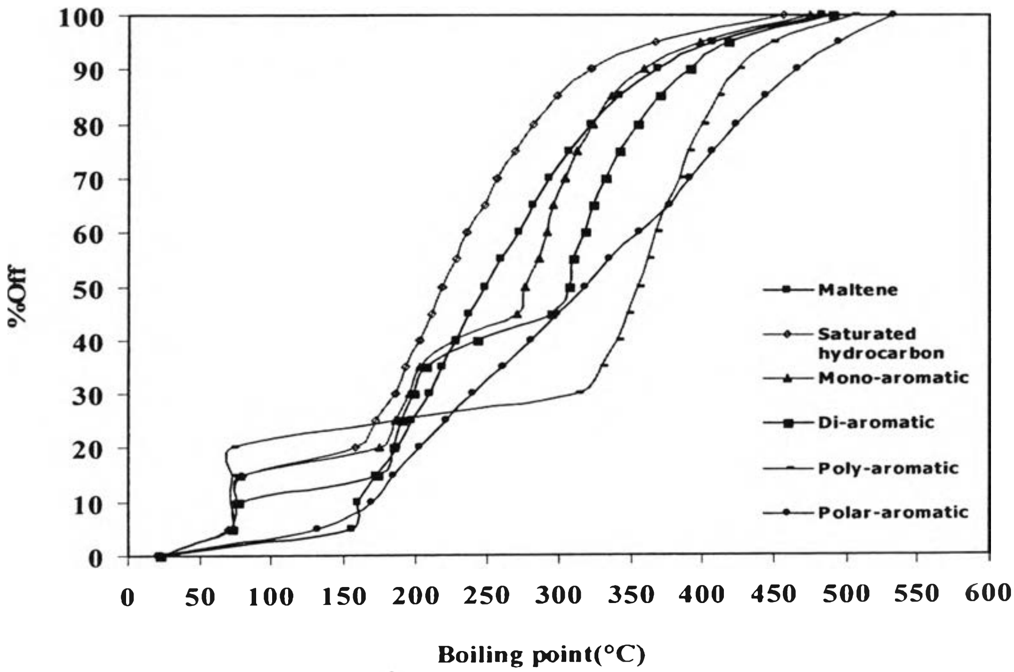


Table G15 True boiling point curves of catalytic pyrolysis (0.25%Pd/H-BETA, Ion-exchanged method)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.4	22.5	22.9	21.2	23.1	21.3
5	112.4	73.6	74.1	23.5	123.0	22
10	155.3	79.2	78.9	26.9	156.3	23.1
15	158	155.4	84.4	35.6	159.8	30.7
20	169.2	162.4	155.3	74.9	169.9	181.2
25	172.3	170.7	157.5	78.5	171.4	211.5
30	184.4	178.7	167.7	188.8	176.4	234.3
35	191.3	185.7	170.7	234.5	184.6	255
40	199	192	177.6	277.9	190.6	270.9
45	207.3	199.2	185.8	305.2	198.6	279.8
50	213	206.3	194.5	325.4	213.6	291.9
55	219.8	212.4	206	341.9	237.5	301.1
60	227	217.0	225.1	357.5	286.1	311.2
65	232.9	224.8	247.6	372.5	294.9	322.0
70	241.2	231.9	259.8	388.0	307.2	332.1
75	251.2	238.6	273.0	403.2	312.6	344.8
80	263.3	249.3	284.8	412.9	322.7	360.3
85	277.9	261.9	299.6	427.9	338.3	380
90	300.4	279.3	320.6	448.5	359	404.3
95	344.8	314.7	355.7	474.4	393.7	435.8
100	466.7	439.4	456.1	516.2	473	505.7

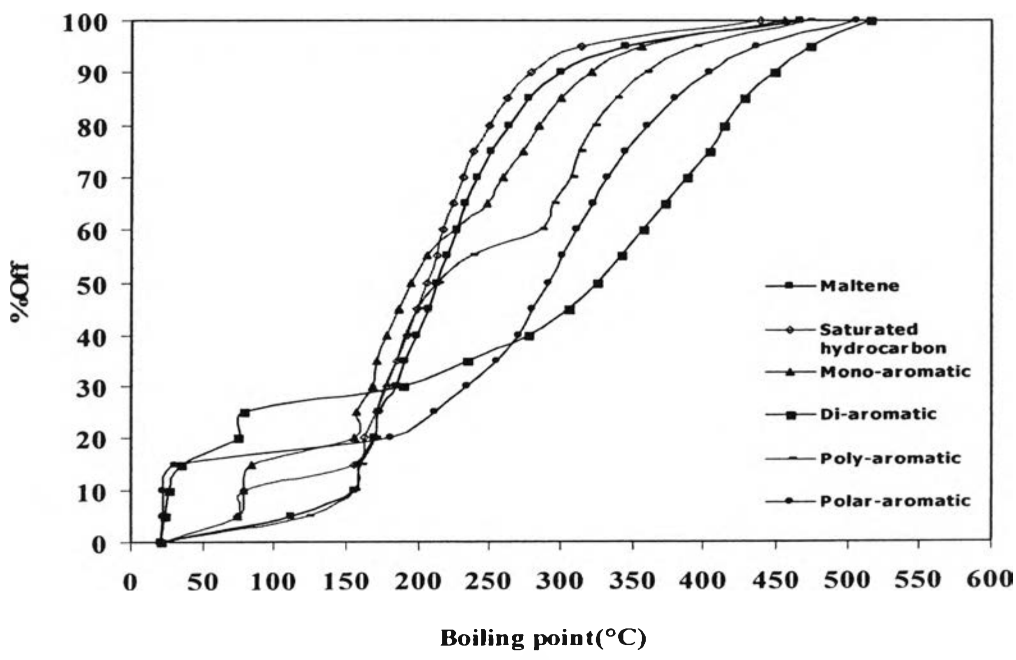


Table G16 True boiling point curves of catalytic pyrolysis (0.50%Pd/H-BETA, Ion-exchanged method)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21	22.5	23.1	23.1	23.1	21
5	111.8	74.1	77	80.9	75.1	22
10	145.2	80.6	153.6	155.5	156.1	23.9
15	155	154.1	156.6	157.9	167.2	73.8
20	156.3	156.2	165.6	167.7	172.4	200.5
25	159.1	160	170.6	170.2	188.3	227.6
30	168.3	169.7	176.7	172.1	203.7	253.2
35	170.6	171.2	186.7	178.1	230.2	278.3
40	172.6	173.8	194.4	184.3	255.9	296
45	183.3	184.1	210.7	189.0	271.6	312.4
50	186.9	186.8	213	193.8	281.7	326.1
55	192.8	192.1	226.2	202.5	292.3	339.9
60	200.7	196.9	231.6	213.6	302.4	352.8
65	208.2	203.9	234.8	232.9	311.5	365.7
70	214.5	211.5	246.6	255.2	322.8	378.3
75	225.6	217.8	255.7	273.5	334.7	389.5
80	239.8	227.7	272.3	294.0	349.8	404.5
85	264.2	244.5	287.8	317.4	368.2	418.2
90	295.3	273.8	315.7	342.6	391.7	438.9
95	350.6	323.3	360.0	382.6	420.5	467.7
100	459.5	444.7	456.6	465.3	484.9	516.6

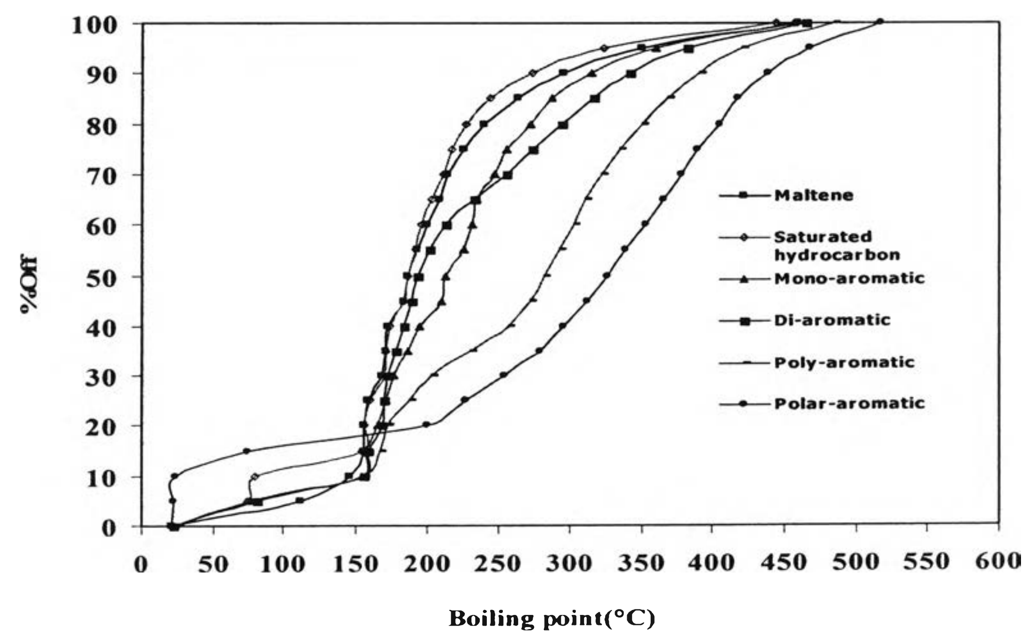
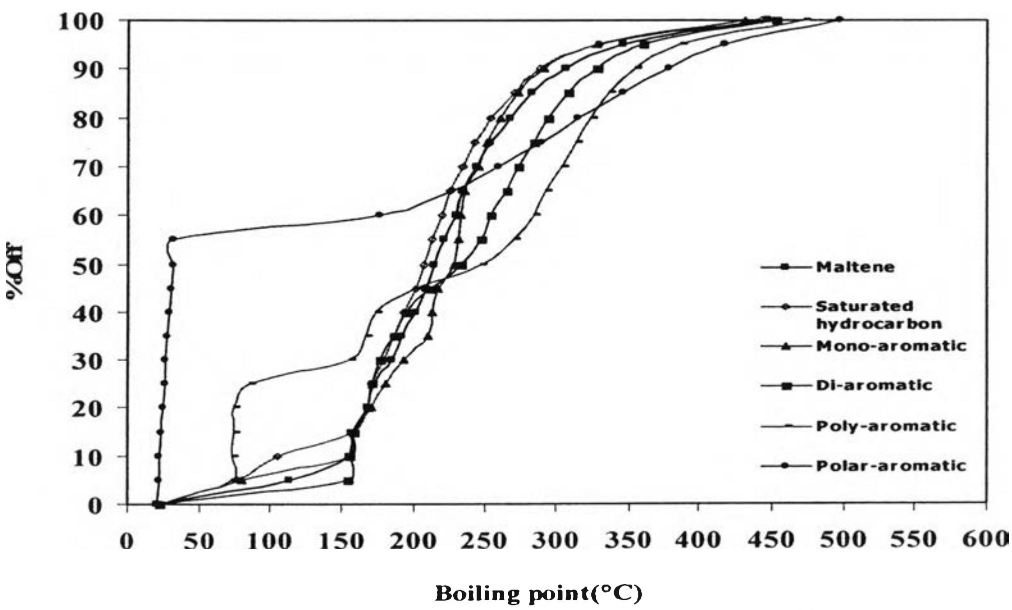


Table G17 True boiling point curves of catalytic pyrolysis (1.00%Pd/H-BETA, Ion-exchanged method)

% OFF	Boiling point (°C)					
	Maltene	Saturated Hydrocarbons	Mono-aromatics	Di-aromatics	Poly-aromatics	Polar-aromatics
0	21.2	22.9	23.3	23.1	23.9	21
5	112.9	76.7	79.5	154.8	72.6	22
10	155.4	104.9	155.6	156.2	73.1	23.1
15	157.6	156.6	159.1	158.9	73.6	24.2
20	168.3	167.9	170.5	168.8	74.5	25.2
25	172.2	171	181.4	171.1	85.0	26.3
30	184.6	179.7	193.2	176.9	156.2	27.3
35	191.9	186.4	210.7	186.2	166.5	28.4
40	201.4	192.9	212.8	194.9	173.9	29.5
45	209.2	201.7	217.5	211.8	199.8	30.5
50	214.1	207.7	228.2	232.3	247.4	31.6
55	222.1	213.7	231.5	246.3	270.2	32.6
60	229.7	220.2	232.7	254.0	284.2	176.2
65	234.5	226.1	235.7	264.7	293.5	227.3
70	244	233.7	245.1	273.3	304.4	260.0
75	253.8	242.5	250.4	284.4	314.0	289.5
80	267.5	254.4	260.2	294.2	324.4	314.9
85	283.4	270.0	273.5	308.7	336.3	345.9
90	306.7	289.4	290.9	328.5	354.4	378.1
95	346.7	328.8	327.4	360.1	386.6	417.4
100	446.8	442.6	431.2	452.7	472.5	497.6



Appendix H The amount of Petroleum fractions in Maltene

Table H1 The amount of petroleum fractions in maltene at different catalytic temperatures (Non-catalytic pyrolysis)

Catalytic temp (°C)	Gasoline (non-cat)	Kerosene (non-cat)	Gas oil (non-cat)	Light Vacuum gas oil (non-cat)	Heavy Vacuum gas oil (non-cat)
350	6.768	39.343	31.996	6.220	15.671
400	1.392	28.693	39.627	8.223	22.065
450	7.293	29.387	36.340	7.618	19.362

Note: final pyrolysis temperature 500°C, N_2 flow rate 30 ml/min

Table H2 The amount of petroleum fractions in maltene at different catalytic temperatures (catalytic pyrolysis)

Catalytic temp (°C)	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
350	4.244	61.361	26.385	3.161	4.848
400	10.846	51.432	31.536	2.860	3.274
450	17.811	43.885	28.097	3.818	6.260
500	6.443	36.564	40.063	6.486	10.445

Note: final pyrolysis temperature 500°C, N_2 flow rate 30 ml/min, using 0.25%Pd/H-BETA as catalysts

Table H3 The amount of petroleum fractions in maltene at different amount of palladium loading amounts

Batch	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
H-BETA	17.763	44.235	33.713	2.018	1.310
0.25%Pd/H-BETA	4.244	61.361	26.385	3.161	4.848
0.75%Pd/H-BETA	5.793	54.411	31.199	3.518	5.078
1%Pd/H-BETA	6.815	54.551	33.575	2.534	2.522
1.25%Pd/H-BETA	1.444	72.537	23.844	1.219	0.956

Note: final pyrolysis temperature 500°C, N_2 flow rate 30 ml/min,

Table H4 The amount of petroleum fractions in maltene at different residence time

The residence time (min)	g/cc/min				
	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
5	7.357357	38.82294	39.28386	5.839245	8.696593
15	10.93391	52.00634	30.4822	2.950762	3.626794
25	4.244419	61.36129	26.38545	3.161005	4.847832
50	6.442767	36.56351	40.06293	6.485708	10.44508

Note: final pyrolysis temperature 500°C, 0.25% Pd/H-BETA

Table H5 The amount of petroleum fractions in maltene obtained from the ion-exchanged catalysts with various metal loading amounts

Batch	Gasoline	Kerosene	Gas oil	Light Vacuum gas oil	Heavy Vacuum gas oil
H-BETA	17.763	44.235	33.713	2.018	1.310
0.25	11.172	55.104	29.983	1.966	1.717
0.50	11.180	67.183	18.353	1.542	1.742
1.00	11.496	53.008	31.095	2.265	2.124

Note: final pyrolysis temperature 500°C, N_2 flow rate 30 ml/min

Appendix I The amount of Chemical compositions in Maltene Fractions

Table I1 The amount of chemical composition in maltene fractions at different catalytic temperature (non-catalytic pyrolysis)

Hydrocarbon fractions	Catalytic temp.(C)		
	350	400	450
Saturated Hydrocarbons	53.77	50.51	58.31
Mono-aromatic	15.77	20.24	13.13
Di-aromatic	7.78	8.74	12.87
Poly-aromatic	14.00	18.11	12.08
Polar-aromatic	2.89	1.28	3.41
Others	5.80	1.12	0.18
Total aromatics	40.44	48.37	41.50

Table I2 The amount of chemical composition in maltene fractions at different palladium loading amounts (ion-exchange method)

Hydrocarbon fractions	Catalytic temp.(C)			
	350	400	450	500
Saturated Hydrocarbons	51.39	60.00	62.45	59.92
Mono-aromatic	12.57	13.08	16.50	16.75
Di-aromatic	12.57	7.96	3.83	8.63
Poly-aromatic	14.76	13.93	10.90	9.16
Polar-aromatic	8.20	4.83	4.71	5.23
Others	0.50	0.18	1.61	0.31
Total aromatics	48.11	39.81	35.94	39.77

Table I3 The amount of chemical composition in maltene fractions at different catalytic temperature (0.25wt%Pd/H-BETA , impregnation)

Hydrocarbon fractions	% Palladium loading		
	0.25	0.5	1
Saturated Hydrocarbons	56.49	54.38	53.41
Mono-aromatic	15.90	16.46	14.88
Di-aromatic	9.65	13.24	14.59
Poly-aromatic	11.07	10.02	14.88
Polar-aromatic	6.81	5.72	1.17
Others	0.09	0.18	1.07
Total aromatics	43.43	45.44	45.53

Table I4 The amount of chemical composition in maltene fractions at different palladium loading amounts (Impregnation method)

Chemical compositions	Non cat	% Palladium loading (wt%)					
		H-BETA	0.25	0.5	0.75	1	1.25
Saturated HC	53.77	67.03	80.98	77.97	75.70	70.60	82.70
Mono-aromatic	15.77	6.81	5.44	10.78	11.15	12.04	8.27
Di-aromatic	7.78	7.90	3.02	2.16	4.69	5.56	1.03
Poly-aromatic	14.00	4.36	3.63	3.59	1.76	3.94	3.10
Polar-aromatic	2.89	5.45	1.81	3.95	6.46	4.86	4.13
Others	5.80	8.45	5.12	1.55	0.24	3.01	0.76
total aromatic	40.44	24.52	13.90	20.48	24.06	26.39	16.54

Table I5 The amount of chemical composition in maltene fractions at different residence time (0.25wt% Pd/H-BETA, impregnation method)

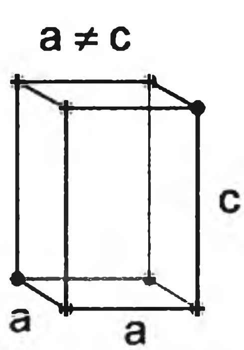
Hydrocarbon fractions	Residence time (min)			
	5	15	25	50
Saturated Hydrocarbons	44.62	55.00	51.39	70.84
Mono-aromatic	14.70	12.81	12.57	10.12
Di-aromatic	12.07	8.75	12.57	3.48
Poly-aromatic	13.12	11.87	14.76	8.86
Polar-aromatic	12.86	10.94	8.20	6.64
Others	2.62	0.63	0.50	0.06
Total aromatics	52.76	44.37	48.11	29.10

Appendix J The Amount of Palladium Loading on H-BETA Using Ion-exchange Method.

Table J1 The amount of palladium loading of ion-exchanged catalyst

Expected Pd loading (wt%)	Measured Pd loading (%wt)
0.25	0.283
0.50	0.504
1.00	1.052

Appendix K Maximum Capacity of Ion-exchanged Zeolite



From idealized cell constant : a= 12.661 Å , c = 26.406 Å

The volume of 1 unit cell

$= (12.661)^2 \times 26.406\ Å^3 \quad = \quad 4232.906\ Å^3$

Tetragonal crystal, Framework density of Beta = 15 T /1000 $Å^3$

So, The amount of Tetrahedral atom

$= (4232.906 / 1000) \times 15.1\ T \quad = \quad 63.9168\ T / \text{unit cell}$

$\approx 64\ T / \text{unit cell}$

For Beta zeolite (HSZ® - 930 NHA, Tosoh company, Singapore)

SiO_2/Al_2O_3 = 27 (mol/mol) then: Si/Al = 13.5 → N_{Si} =13.5 N_{Al}

and: $N_{Si} + N_{Al}$ = 64 = $13.5N_{Al} + N_{Al}$

solving: N_{Si} = 59.6 ≈ 60 N_{Al} = 4.4 ≈ 4

The unit cell formula becomes: $(SiO_2)_{60}(AlO_2^-, H^+)_4$

The total ion exchange capacity

The total ion exchange capacity of zeolite Beta can be calculate:

formular: $(SiO_2)_{60}(AlO_2^-, H^+)_2$ = : $60SiO_2{\bullet}2Al_2O_3{\bullet}2H_2O$

formular weight = 60x60 + 2x102 + 2x18

= 3840 g of zeolite

$= \frac{(2\ \text{equiv.}) \times 1000}{3840}$ = **0.521 meq/ g of Beta** #

Therefore, Pd = 0.521 milli-mol x 106.4 g/mole = 0.0554 g

The maximum percentage of Pd loading = **5.54 wt%** of H-BETA zeolite

Exchange Reaction:

$$2\,[AlO_4^-], H^+ + Pd^{2+} \longrightarrow 2\,[AlO_4^-], Pd^{2+} + 2\,H^+$$

CURRICULUM VITAE

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Presentations:

1. Ekkarin Pintoo, Suchada Butnark, and Sirirat Jitkanka (2007, November 21-24) Study on Uses and Possibilities of Quality Upgrading of Oil Obtained from Tire Pyrolysis: Case of Pd/H-BETA. Poster presented at the 5th Eco-Energy and Materials Science and Engineering, Pattaya, Thailand. (Winner of 1st price for the best poster presentation award)