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APPENDICES

Appendix A Raw Data

Table A-1 The product distributions from tire pyrolysis with various heating rates

Sample	% Yield		
	Gas	Liquid	Solid
HT10[a]	8.73	50.43	40.84
HT15	7.31	52.56	40.13
HT20	6.29	53.24	40
HT30	4.07	54.93	41

[a] heating rate

Table A-2 The gas composition from tire pyrolysis with various heating rates shown in % volume

Gases	% Volume			
	HT10[a]	HT15	HT20	HT30
Methane	34.70	24.62	25.03	21.90
Ethylene	5.63	5.29	6.64	5.46
Ethane	13.60	11.83	13.42	10.58
Propylene	5.52	4.96	5.69	5.03
Propane	6.76	5.99	6.30	5.38
C_4	13.67	16.76	17.39	21.18
C_5	11.82	17.21	12.22	17.84
C_6	5.52	7.13	7.12	6.83
C_7	1.57	2.81	2.76	2.44
C_8	1.19	3.41	3.42	3.36

[a] heating rate

Table A-3 Carbon number distribution in liquid products from co-pyrolysis of tire with various heating rates

Carbon number	Boiling Point	% Mass			
		HT10[a]	HT15	HT20	HT30
6	69.9		3.40	0.20	
7	98.4		3.54	3.08	1.99
8	125.1	4.90	3.77	3.62	2.44
9	150.1	4.99	3.98	3.73	2.91
10	173.6	5.05	4.17	4.03	3.40
11	195.6	5.10	4.34	4.30	3.86
12	216.3	5.13	4.48	4.56	4.29
13	235.8	5.13	4.59	4.78	4.64
14	254.0	5.13	4.66	4.96	4.90
15	271.3	5.11	4.70	5.10	5.05
16	287.5	5.08	4.70	5.17	5.09
17	302.8	5.04	4.65	5.19	5.03
18	317.4	4.99	4.55	5.12	4.87
19	331.1	4.91	4.41	4.99	4.64
20	344.2	4.79	4.21	4.77	4.36
21	356.6	4.61	3.97	4.48	4.05
22	368.5	4.32	3.69	4.13	3.72
23	379.9	3.88	3.38	3.75	3.39
24	390.8	3.26	3.05	3.34	3.06
25	401.2	2.54	2.72	2.93	2.76
26	411.3	1.82	2.40	2.53	2.47
27	421.0	1.21	2.09	2.16	2.21
28	430.5	0.76	1.80	1.83	1.98
29	439.6	0.47	1.54	1.54	1.76
30	448.4	0.28	1.31	1.28	1.57
31	457.0	0.17	1.10	1.07	1.39
32	465.4	0.10	0.93	0.88	1.24
33	473.5	0.06	0.78	0.73	1.10
34	481.3	0.04	0.65	0.60	0.98
35	489.0	0.02	0.54	0.50	0.87
36	496.4	0.01	0.45	0.41	0.77
37	503.5	0.01	0.38	0.34	0.68
38	510.4	0.01	0.31	0.28	0.60
39	517.0	0.00	0.26	0.23	0.53
40	523.2	0.00	0.21	0.19	0.46
41	529.1	0.00	0.18	0.15	0.41
42	534.7	0.00	0.15	0.13	0.35
43	539.8	0.00	0.12	0.10	0.30
44	544.5	0.00	0.10	0.08	0.26
45	548.6	0.00	0.08	0.07	0.22
46	552.2	0.00	0.06	0.05	0.18
47	555.2	0.00	0.05	0.04	0.14
48	557.5	0.00	0.04	0.03	0.11
49	559.1	0.00	0.02	0.02	0.07

[a] heating rate

Table A-4 Oil fractions from co-pyrolysis of tire with various heating rates shown in %Mass

Fraction	Boiling Point (°C)	% Mass			
		HT10[a]	HT15	HT20	HT30
Gasoline	15.5-149	16.85	11.29	9.08	9.11
Kerosene	149-232	20.46	17.36	17.89	17.36
Gas oil	232-343	33.76	32.27	36.05	33.06
Fuel Oil	343-371	8.81	8.31	8.88	8.47
Heavy vacuum gas oil	371-559.1	20.12	30.78	28.09	31.45

[a] heating rate

Table A-5 The product distributions from tire pyrolysis with various oxides

Sample	% Yield		
	Gas	Liquid	Solid
Non-cat	8.73	50.43	40.84
4%Fe2O3	23.23	33.6	43.17
5%Fe2O3	19.89	36.9	43.21
CaO	19.11	41.56	39.33

Table A-6 The gas compositions from tire pyrolysis with various oxides shown in % volume

Gases	% Volume			
	Non-cat	4%Fe2O3	5%Fe2O3	CaO
Methane	34.70	16.961	25.161	27.83
Ethylene	5.63	4.182	6.656	6.99
Ethane	13.60	8.273	11.957	13.98
Propylene	5.52	3.415	5.179	5.75
Propane	6.76	3.447	4.766	5.98
C_4	13.67	29.349	29.284	20.75
C_5	11.82	12.425	7.127	9.19
C_6	5.52	11.008	6.692	7.32
C_7	1.57	8.056	1.854	1.32
C_8	1.19	2.884	1.325	0.91

Table A-7 Carbon number distribution in liquid products from pyrolysis of tire with various oxides

Carbon number	Boiling Point (°C)	%Mass			
		Non-cat	4%Fe2O3	5%Fe2O3	CaO
6	69.9				0.85
7	98.4				2.30
8	125.1	4.90	8.16	7.79	2.97
9	150.1	4.99	2.23	2.01	3.74
10	173.6	5.05	2.80	2.49	4.57
11	195.6	5.10	3.42	3.00	5.42
12	216.3	5.13	4.07	3.54	6.21
13	235.8	5.13	4.70	4.07	6.86
14	254.0	5.13	5.26	4.57	7.27
15	271.3	5.11	5.69	5.00	7.38
16	287.5	5.08	5.95	5.32	7.16
17	302.8	5.04	6.01	5.50	6.67
18	317.4	4.99	5.87	5.54	5.97
19	331.1	4.91	5.55	5.42	5.17
20	344.2	4.79	5.10	5.17	4.36
21	356.6	4.61	4.58	4.81	3.60
22	368.5	4.32	4.02	4.39	2.94
23	379.9	3.88	3.47	3.93	2.37
24	390.8	3.26	2.96	3.47	1.90
25	401.2	2.54	2.50	3.02	1.52
26	411.3	1.82	2.10	2.61	1.22
27	421.0	1.21	1.76	2.24	0.98
28	430.5	0.76	1.47	1.91	0.79
29	439.6	0.47	1.22	1.62	0.64
30	448.4	0.28	1.02	1.38	0.51

Carbon number	Boiling Point (°C)	%Mass			
		Non-cat	4%Fe2O3	5%Fe2O3	CaO
31	457.0	0.17	0.85	1.16	0.42
32	465.4	0.10	0.71	0.98	0.34
33	473.5	0.06	0.59	0.83	0.28
34	481.3	0.04	0.50	0.70	0.23
35	489.0	0.02	0.41	0.59	0.19
36	496.4	0.01	0.35	0.50	0.16
37	503.5	0.01	0.29	0.42	0.13
38	510.4	0.01	0.24	0.36	0.11
39	517.0	0.00	0.20	0.30	0.09
40	523.2	0.00	0.17	0.25	0.07
41	529.1	0.00	0.14	0.21	0.06
42	534.7	0.00	0.12	0.18	0.05
43	539.8	0.00	0.10	0.15	0.04
44	544.5	0.00	0.08	0.12	0.03
45	548.6	0.00	0.07	0.10	0.03
46	552.2	0.00	0.05	0.08	0.02
47	555.2	0.00	0.04	0.06	0.02
48	557.5	0.00	0.03	0.05	0.01
49	559.1	0.00	0.02	0.03	0.01

Table A-8 Oil fractions from tire co-pyrolysis with various oxides shown in %Mass

Fraction	Boiling Point (°C)	% Mass			
		Non-cat	4%Fe2O3	5%Fe2O3	CaO
Gasoline	15.5-149	16.85	7.85	5.98	8.19
Kerosene	149-232	20.46	18.71	10.02	24.08
Gas oil	232-343	33.76	39.19	22.92	43.77
Fuel Oil	343-371	8.81	10.13	5.28	8.15
Heavy vacuum gas oil	371-559.1	20.12	24.13	55.80	15.81

Table A-9 The product distributions from tire pyrolysis with various catalyst : tire ratios

Sample	% Yield		
	Gas	Liquid	Solid
Non-cat	8.73	50.43	40.84
0.10[a]MOR	15.42	40.42	44.16
0.25MOR	17.33	39.71	42.96
0.50MOR	29.44	25.68	44.88

[a] ratio of catalyst to tire

Table A-10 The gas composition from tire pyrolysis with various catalyst: tire ratio shown in %volume

Gases	% Volume			
	Non-cat	0.10[a]MOR	0.25MOR	0.50MOR
Methane	34.70	23.62	17.51	10.17
Ethylene	5.63	8.90	11.58	12.66
Ethane	13.60	9.78	7.98	4.69
Propylene	5.52	6.38	8.69	10.43
Propane	6.76	8.92	12.22	16.97
C_4	13.67	15.36	15.11	18.55
C_5	11.82	14.00	12.27	10.85
C_6	5.52	7.41	9.25	10.84
C_7	1.57	2.21	2.87	2.60
C_8	1.19	3.43	3.50	2.23

[a] ratio of catalyst to tire

Table A-11 Carbon number distribution in liquid products from pyrolysis of tire with various catalyst : tire ratios

Carbon number	Boiling Point	% Mass			
		Non-cat	0.10[a]MOR	0.25MOR	0.50MOR
6	69.9				3.00
7	98.4		3.25	3.16	3.20
8	125.1	4.90	3.88	3.54	3.95
9	150.1	4.99	4.05	3.86	4.59
10	173.6	5.05	4.20	4.16	5.06
11	195.6	5.10	4.33	4.43	5.36
12	216.3	5.13	4.43	4.65	5.47
13	235.8	5.13	4.52	4.82	5.44
14	254.0	5.13	4.58	4.93	5.29
15	271.3	5.11	4.62	4.98	5.06
16	287.5	5.08	4.63	4.96	4.77
17	302.8	5.04	4.62	4.88	4.46
18	317.4	4.99	4.58	4.75	4.14
19	331.1	4.91	4.50	4.57	3.82
20	344.2	4.79	4.38	4.35	3.52
21	356.6	4.61	4.23	4.10	3.23
22	368.5	4.32	4.04	3.83	2.96
23	379.9	3.88	3.81	3.55	2.72
24	390.8	3.26	3.54	3.27	2.50
25	401.2	2.54	3.24	3.00	2.30
26	411.3	1.82	2.93	2.73	2.12
27	421.0	1.21	2.61	2.48	1.95
28	430.5	0.76	2.29	2.24	1.81
29	439.6	0.47	1.98	2.02	1.67
30	448.4	0.28	1.70	1.81	1.55
31	457.0	0.17	1.44	1.63	1.43
32	465.4	0.10	1.21	1.45	1.33
33	473.5	0.06	1.01	1.30	1.23
34	481.3	0.04	0.83	1.16	1.15
35	489.0	0.02	0.69	1.03	1.06
36	496.4	0.01	0.56	0.91	0.98
37	503.5	0.01	0.46	0.81	0.91
38	510.4	0.01	0.38	0.71	0.84
39	517.0	0.00	0.31	0.63	0.77
40	523.2	0.00	0.25	0.55	0.70
41	529.1	0.00	0.21	0.48	0.64
42	534.7	0.00	0.17	0.42	0.58
43	539.8	0.00	0.13	0.36	0.52
44	544.5	0.00	0.11	0.31	0.46
45	548.6	0.00	0.09	0.26	0.40
46	552.2	0.00	0.07	0.21	0.33
47	555.2	0.00	0.05	0.17	0.27
48	557.5	0.00	0.04	0.12	0.21
49	559.1	0.00	0.02	0.08	0.14

[a] ratio of catalyst to tire

Table A-12 Oil fractions from tire pyrolysis with various catalyst: tire ratios shown in %Mass

Fraction	Boiling Point (°C)	% Mass			
		Non-cat	0.10[a]MOR	0.25MOR	0.50MOR
Gasoline	15.5-149	16.85	10.13	9.81	14.55
Kerosene	149-232	20.46	17.31	18.04	20.52
Gas oil	232-343	33.76	33.02	33.73	31.85
Fuel Oil	343-371	8.81	8.56	8.88	7.45
Heavy vacuum gas oil	371-559.1	20.12	30.98	29.54	25.64

[a] ratio of catalyst to tire

Table A-13 The product distributions from tire co- pyrolysis with various catalysts.

Sample	% Yield		
	Gas	Liquid	Solid
Non-cat	8.73	50.43	40.84
0.25[a]MOR	17.33	39.71	42.96
0.25ITQ-21	12.48	43.11	44.41
0.25ITQ-24	14.86	40.44	44.71
0.50MOR	29.44	25.68	44.88
0.50ITQ-21	30.43	25.85	43.72
0.50ITQ-24	25.75	28.83	45.42

[a] ratio of catalyst to tire

Table A-14 The gas composition from tire co- p yrolysis with various catalysts shown in %volume

Gases	% Volume						
	Non-cat	0.25[a] MOR	0.25 ITQ-21	0.25 ITQ-24	0.50 MOR	0.50 ITQ-21	0.50 ITQ-24
Methane	34.7	17.51	19.65	17.12	10.17	11.42	13.23
Ethylene	5.63	11.58	10.54	9.08	12.66	14.96	9.36
Ethane	13.6	7.98	8.31	8.34	4.69	5.24	5.07
Propylene	5.52	8.69	7.21	7.63	10.43	8.56	8.97
Propane	6.76	12.22	12.56	14.83	16.97	17.00	17.34
C_4	13.67	15.11	14.62	17.15	18.55	17.10	18.69
C_5	11.82	12.27	12.98	12.35	10.85	9.89	10.40
C_6	5.52	9.25	8.21	8.85	10.84	10.47	10.82
C_7	1.57	2.87	2.67	2.37	2.6	2.79	3.00
C_8	1.19	3.5	3.25	2.28	2.23	2.58	3.11

[a] ratio of catalyst to tire

Table A-15 Carbon number distribution in liquid products from tire co- pyrolysis with various catalysts

Carbon number	Boiling Point	% Mass						
		Non-cat	0.25[a] MOR	0.25 ITQ-21	0.25 ITQ-24	0.50 MOR	0.50 ITQ-21	0.50 ITQ-24
6	69.9					3		
7	98.4		3.16	4.30	7.01	3.2	2.15	2.85
8	125.1	4.9	3.54	3.53	3.91	3.95	2.91	3.23
9	150.1	4.99	3.86	3.78	3.97	4.59	3.35	3.96
10	173.6	5.05	4.16	3.99	4.02	5.06	3.77	4.57
11	195.6	5.1	4.43	4.16	4.05	5.36	4.17	5.02
12	216.3	5.13	4.65	4.27	4.07	5.47	4.52	5.28
13	235.8	5.13	4.82	4.33	4.07	5.44	4.80	5.38
14	254	5.13	4.93	4.35	4.05	5.29	5.00	5.35
15	271.3	5.11	4.98	4.32	4.03	5.06	5.11	5.22
16	287.5	5.08	4.96	4.26	3.99	4.77	5.12	5.01
17	302.8	5.04	4.88	4.16	3.93	4.46	5.04	4.75
18	317.4	4.99	4.75	4.05	3.87	4.14	4.88	4.47
19	331.1	4.91	4.57	3.91	3.79	3.82	4.65	4.19
20	344.2	4.79	4.35	3.77	3.70	3.52	4.37	3.90
21	356.6	4.61	4.1	3.61	3.59	3.23	4.06	3.62

Carbon number	Boiling Point	% Mass						
		Non-cat	0.25[a] MOR	0.25 ITQ-21	0.25 ITQ-24	0.50 MOR	0.50 ITQ-21	0.50 ITQ-24
22	368.5	4.32	3.83	3.46	3.46	2.96	3.73	3.36
23	379.9	3.88	3.55	3.30	3.32	2.72	3.40	3.12
24	390.8	3.26	3.27	3.15	3.16	2.5	3.08	2.90
25	401.2	2.54	3	3.00	2.98	2.3	2.77	2.69
26	411.3	1.82	2.73	2.86	2.78	2.12	2.49	2.50
27	421	1.21	2.48	2.72	2.57	1.95	2.22	2.32
28	430.5	0.76	2.24	2.59	2.35	1.81	1.98	2.16
29	439.6	0.47	2.02	2.46	2.12	1.67	1.76	2.02
30	448.4	0.28	1.81	2.34	1.89	1.55	1.56	1.88
31	457	0.17	1.63	2.22	1.67	1.43	1.39	1.76
32	465.4	0.1	1.45	2.10	1.45	1.33	1.23	1.64
33	473.5	0.06	1.3	1.99	1.25	1.23	1.09	1.53
34	481.3	0.04	1.16	1.88	1.07	1.15	0.96	1.43
35	489	0.02	1.03	1.78	0.91	1.06	0.85	1.33
36	496.4	0.01	0.91	1.67	0.77	0.98	0.75	1.24
37	503.5	0.01	0.81	1.57	0.64	0.91	0.66	1.16
38	510.4	0.01	0.71	1.47	0.53	0.84	0.58	1.07
39	517	0	0.63	1.37	0.44	0.77	0.51	0.99
40	523.2	0	0.55	1.27	0.37	0.7	0.45	0.91
41	529.1	0	0.48	1.16	0.30	0.64	0.39	0.83
42	534.7	0	0.42	1.06	0.25	0.58	0.34	0.75
43	539.8	0	0.36	0.96	0.20	0.52	0.29	0.68
44	544.5	0	0.31	0.85	0.16	0.46	0.25	0.60
45	548.6	0	0.26	0.74	0.13	0.4	0.21	0.52
46	552.2	0	0.21	0.63	0.10	0.33	0.17	0.44
47	555.2	0	0.17	0.51	0.08	0.27	0.13	0.36
48	557.5	0	0.12	0.39	0.06	0.21	0.10	0.27
49	559.1	0	0.08	0.26	0.04	0.14	0.07	0.18

[a] ratio of catalyst to tire

Table A-16 Oil fractions from tire co- pyrolysis with various catalysts shown in %Mass

Fraction	Boiling Point (°C)	% Mass						
		Non-cat	0.25[a] MOR	0.25 ITQ-21	0.25 ITQ-24	0.50 MOR	0.50 ITQ-21	0.50 ITQ-24
Gasoline	15.5-149	16.85	9.81	11.04	14.03	14.55	7.43	9.78
Kerosene	149-232	20.46	18.04	16.45	16.35	20.52	16.92	19.45
Gas oil	232-343	33.76	33.73	29.36	28.12	31.85	33.64	33.15
Fuel Oil	343-371	8.81	8.88	7.96	7.63	7.45	8.32	8.22
Heavy vacuum gas oil	371-559.1	20.12	29.54	35.20	33.86	25.64	33.70	29.41

[a] ratio of catalyst to tire

Table A-17 The product distributions from tirc co-pyrolysis with various %Ge loaded on mordenite.

Sample	% Yield		
	Gas	Liquid	Solid
Non-cat	8.73	50.43	40.84
0.00%Ge	17.3	39.7	42.9
0.50%Ge	21.8	30.9	41.3
1%Ge	28.9	30.8	40.3
3%Ge	32.8	27.1	40.1
5%Ge	28.6	30.1	41.3

Table A-18 The gas compositions from tire co- pyrolysis with various %Ge loaded on mordenite shown in %volume

Gases	% Volume					
	Non-cat	0.00%Ge	0.5%Ge	1%Ge	3%Ge	5%Ge
Methane	34.70	17.51	28.52	27.07	21.01	21.24
Ethylene	5.63	11.58	8.89	7.91	10.13	7.33
Ethane	13.60	7.98	11.88	10.56	10.49	10.52
Propylene	5.52	8.69	7.41	7.14	7.82	6.61
Propane	6.76	12.22	11.56	10.69	19.57	13.25
C_4	13.67	15.11	13.55	15.13	15.77	15.49
C_5	11.82	12.27	10.65	11.51	10.68	18.48
C_6	5.52	9.25	5.50	6.87	3.99	5.56
C_7	1.57	2.87	1.08	1.65	0.00	0.91
C_8	1.19	3.5	0.95	1.45	0.55	0.60

Table A-19 Carbon number distribution in liquid products from tire co-pyroiysis with various %Ge loaded on mordenite analyzed

Carbon number	Boiling Point (°C)	%Mass					
		Non-cat	0.00%Ge	0.50%Ge	1%Ge	3%Ge	5%Ge
6	69.9					6.41	6.10
7	98.4		3.16	9.42	10.37	6.44	4.34
8	125.1	4.9	3.54	4.33	4.59	6.73	4.45
9	150.1	4.99	3.86	4.49	4.84	6.98	4.54
10	173.6	5.05	4.16	4.64	5.07	7.21	4.60
11	195.6	5.1	4.43	4.76	5.26	7.39	4.65
12	216.3	5.13	4.65	4.86	5.41	7.53	4.68
13	235.8	5.13	4.82	4.93	5.51	7.60	4.70
14	254	5.13	4.93	4.97	5.54	7.57	4.69
15	271.3	5.11	4.98	4.99	5.51	7.35	4.68
16	287.5	5.08	4.96	4.97	5.40	6.81	4.65
17	302.8	5.04	4.88	4.91	5.20	5.83	4.61
18	317.4	4.99	4.75	4.79	4.93	4.47	4.55
19	331.1	4.91	4.57	4.62	4.59	3.03	4.46
20	344.2	4.79	4.35	4.38	4.19	1.85	4.34
21	356.6	4.61	4.1	4.07	3.75	1.06	4.17
22	368.5	4.32	3.83	3.70	3.30	0.59	3.93
23	379.9	3.88	3.55	3.27	2.86	0.32	3.61
24	390.8	3.26	3.27	2.82	2.44	0.18	3.21

Carbon number	Boiling Point (°C)	%Mass					
		Non-cat	0.00%Ge	0.50%Ge	1%Ge	3%Ge	5%Ge
25	401.2	2.54	3	2.38	2.06	0.10	2.74
26	411.3	1.82	2.73	1.95	1.72	0.06	2.24
27	421	1.21	2.48	1.58	1.43	0.03	1.75
28	430.5	0.76	2.24	1.25	1.18	0.02	1.32
29	439.6	0.47	2.02	0.98	0.97	0.01	0.97
30	448.4	0.28	1.81	0.76	0.80	0.01	0.69
31	457	0.17	1.63	0.59	0.66	0.00	0.49
32	465.4	0.1	1.45	0.46	0.54	0.00	0.34
33	473.5	0.06	1.3	0.35	0.44	0.00	0.24
34	481.3	0.04	1.16	0.27	0.36	0.00	0.17
35	489	0.02	1.03	0.21	0.30	0.00	0.12
36	496.4	0.01	0.91	0.16	0.25	0.00	0.08
37	503.5	0.01	0.81	0.13	0.20	0.00	0.06
38	510.4	0.01	0.71	0.10	0.17	0.00	0.04
39	517	0	0.63	0.08	0.14	0.00	0.03
40	523.2	0	0.55	0.06	0.11	0.00	0.02
41	529.1	0	0.48	0.05	0.09	0.00	0.02
42	534.7	0	0.42	0.04	0.08	0.00	0.01
43	539.8	0	0.36	0.03	0.06	0.00	0.01
44	544.5	0	0.31	0.02	0.05	0.00	0.01
45	548.6	0	0.26	0.02	0.04	0.00	0.00
46	552.2	0	0.21	0.01	0.03	0.00	0.00
47	555.2	0	0.17	0.01	0.03	0.00	0.00
48	557.5	0	0.12	0.01	0.02	0.00	0.00
49	559.1	0	0.08	0.00	0.01	0.00	0.00

Table A-20 Oil fractions from tire co-pyrolysis with %Ge loaded on mordenite shown in %Mass

Fraction	Boiling Point (°C)	% Mass					
		Non-cat	0.0%Ge	0.5%Ge	1%Ge	3%Ge	5%Ge
Gasoline	69.6-149	16.85	9.81	16.20	18.86	25.00	17.76
Kerosene	149-232	20.46	18.04	20.55	21.77	31.77	19.91
Gas oil	232-343	33.76	33.73	32.27	34.52	36.56	31.86
Fuel Oil	343-371	8.81	8.88	7.28	8.47	4.09	7.77
Heavy vacuum gas oil	371-559	20.12	29.54	23.71	16.39	2.58	22.69

Table A-21 The curve fitting and equation of % CUT-OFF: Effect of heating rate.

$y = y_o + \frac{a}{\left[\left(1+e^{-\left(\frac{x-x_o}{b}\right)}\right)\right]}c$	Parameter	Coefficient	R^2
HT10[a]	a	143.914	0.9983837
	b	17.0373	
	c	0.054422	
	x_o	399.541	
	y_o	-46.9545	
HT15	a	118.772	0.9982683
	b	42.5707	
	c	0.197548	
	x_o	405.092	
	y_o	-21.6696	
HT20	a	114.63	0.99846841
	b	41.1657	
	c	0.24196	
	x_o	394.077	
	y_o	-16.8721	
HT30	a	104.173	0.99907948
	b	68.7858	
	c	0.715779	
	x_o	344.307	
	y_o	-2.44037	

[a] heating rate

Table A-15 The curve fitting and equation of % CUT-OFF of tire co-pyrolysis with various oxides.

$y = y_o + \frac{a}{\left[\left(1+e^{-\left(\frac{x-x_o}{b}\right)}\right)\right]}c$	Parameter	Coefficient	R^2
Non-cat	a	143.914	0.9983837
	b	17.0373	
	c	0.054422	
	x_o	399.541	
	y_o	-46.9545	
4%Fe2O3	a	93.3814	0.9965000
	b	48.3515	
	c	0.615117	
	x_o	339.696	
	y_o	2.11324	
5%Fe2O3	a	94.9773	0.9959000
	b	49.2674	
	c	0.582196	
	x_o	359.504	
	y_o	1.86882	
CaO	a	100.733	0.99909924
	b	45.5165	
	c	0.543988	
	x_o	309.584	
	y_o	-4.87751	

Table A-16 The curve fitting and equation of % CUT-OFF of tire co-pyrolysis with various catalysts to tire ratios.

$y = y_o + \frac{a}{\left[\left(1+e^{-\left(\frac{x-x_o}{b}\right)}\right)\right]}c$	Parameter	Coefficient	R^2
Non-cat	a	143.914	0.9983837
	b	17.0373	
	c	0.054422	
	x_o	399.541	
	y_o	-46.9545	
0.10[a]MOR	a	129.215	0.9985982
	b	37.4462	
	c	0.156029	
	x_o	426.314	
	y_o	-29.7028	
0.25MOR	a	123.89	0.99963226
	b	64.3239	
	c	0.399807	
	x_o	392.034	
	y_o	-16.7286	
0.50MOR	a	119.456	0.9994826
	b	130.051	
	c	3.31015	
	x_o	115.805	
	y_o	-3.38011	

[a] ratio of catalyst to tire

Table A-17 The curve fitting and equation of % CUT-OFF of tire co-pyrolysis with various catalysts to tire ratios.

$y = y_o + \frac{a}{\left[\left(1+e^{-\left(\frac{x-x_o}{b}\right)}\right)\right]}c$	Parameter	Coefficient	R^2
Non-cat	a	143.914	0.9983837
	b	17.0373	
	c	0.054422	
	x_o	399.541	
	y_o	-46.9545	
0.25[a]MOR	a	123.89	0.99963226
	b	64.3239	
	c	0.399807	
	x_o	392.034	
	y_o	-16.7286	
0.25ITQ-21	a	150.816	0.9996199
	b	120.67	
	c	0.807657	
	x_o	389.947	
	y_o	-15.6911	
0.25ITQ-24	a	135.412	0.99942476
	b	37.6647	
	c	0.11888	
	x_o	451.477	
	y_o	-37.4132	
0.50MOR	a	119.456	0.9994826
	b	130.051	
	c	3.31015	
	x_o	115.805	
	y_o	-3.38011	
0.50ITQ-21	a	109.655	0.999752
	b	65.7194	
	c	0.561979	
	x_o	359.392	
	y_o	-9.49625	
0.50ITQ-24	a	128.57	0.99906661
	b	140.279	
	c	5.61777	
	x_o	52.0613	
	y_o	-3.27977	

[a] ratio of catalyst to tire

Table A-18 The curve fitting and equation of % CUT-OFF of tire co-pyrolysis with various %Ge loaded on mordenite.

$y = y_o + \frac{a}{\left[\left(1+e^{-\left(\frac{x-x_o}{b}\right)}\right)\right]^c}$	Parameter	Coefficient	R^2
Non-cat	a	143.914	0.9983837
	b	17.0373	
	c	0.054422	
	x_o	399.541	
	y_o	-46.9545	
0.00%Ge	a	123.89	0.99963226
	b	64.3239	
	c	0.399807	
	x_o	392.034	
	y_o	-16.7286	
0.5%Ge	a	125.867	0.9978671
	b	31.5519	
	c	0.124918	
	x_o	395.529	
	y_o	-29.3922	
1%Ge	a	124.843	0.9990228
	b	42.8746	
	c	0.201499	
	x_o	372.735	
	y_o	-24.0008	
3%Ge	a	143.349	0.9975179
	b	19.4622	
	c	0.0767277	
	x_o	316.787	
	y_o	-47.7435	
5%Ge	a	134.812	0.9975559
	b	22.7872	
	c	0.074224	
	x_o	409.475	
	y_o	-38.5028	

Appendix B Standard for gas chromatography

Table B-1 Standard Refinery Gas Compositions for gas chromatography calibration

Approximate concentration % volume/volume

Compositions	% volume/volume
Hydrogen	15
Nitrogen	15
Carbon dioxide	5
Carbon monoxide	5
Methane	5
Ethane	1
Ethylene	10
Propane	1
Propylene	5
Iso-butane	10
N-butane	5
Butane	10
Trans-2-butene	5
Cis-2-butene	5
N-pentane	1
Iso-pentane	2

Table B-2 Liquid for gas chromatography calibration

Liquid standard	Density @ 20°C
N-pentane	0.626
N-hexane	0.659
N-heptane	0.684
Iso-octane	0.6919

Table B-3 ASTM Method D2887 Column Test Mixture

This ULTRA standard (TM) solution was gravimetrically prepared, and the analyte concentrations were verified using high resolution gas chromatography.

Components	Carbon number	% By weight
N-hexane	6	6.0
N-heptane	7	6.0
N-octane	8	8.0
N-nonane	9	8.0
N-decane	10	12.0
N-undecane	11	12.0
N-dodecane	12	12.0
N-tetradecane	14	12.0
N-hexadecane	16	10.0
N-octadecane	18	5.0
N-eicosane	20	2.0
N-tetracosane	24	2.0
N-octacosane	28	1.0
N-dotriacontane	32	1.0
N-hexatriacontane	36	1.0
N-tetracontane	40	1.0
N-tetratetracontane	44	1.0

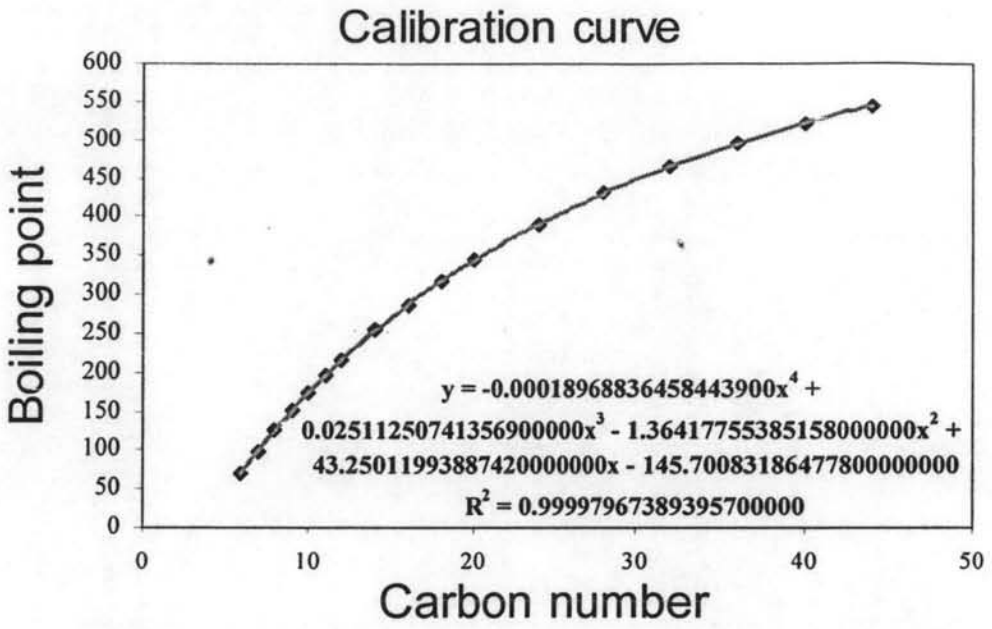

Figure B-1 GC calibration curve of ASTM D2887 Column Test Mixture with the equation of fitted curve.

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