

Supporting information for:

Catalytic pyrolysis of plastic wastes for the production of liquid fuels for engines

Supattra Budsareechai^a, Andrew J. Hunt^b and Yuvarat Ngernyen^{*a}

^a*Department of Chemical Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen, 40002, Thailand. E-mail:nyuvarat@kku.ac.th*

^b*Materials Chemistry Research Center, Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen, 40002, Thailand*



Fig. S1 The process for pelletization of catalyst

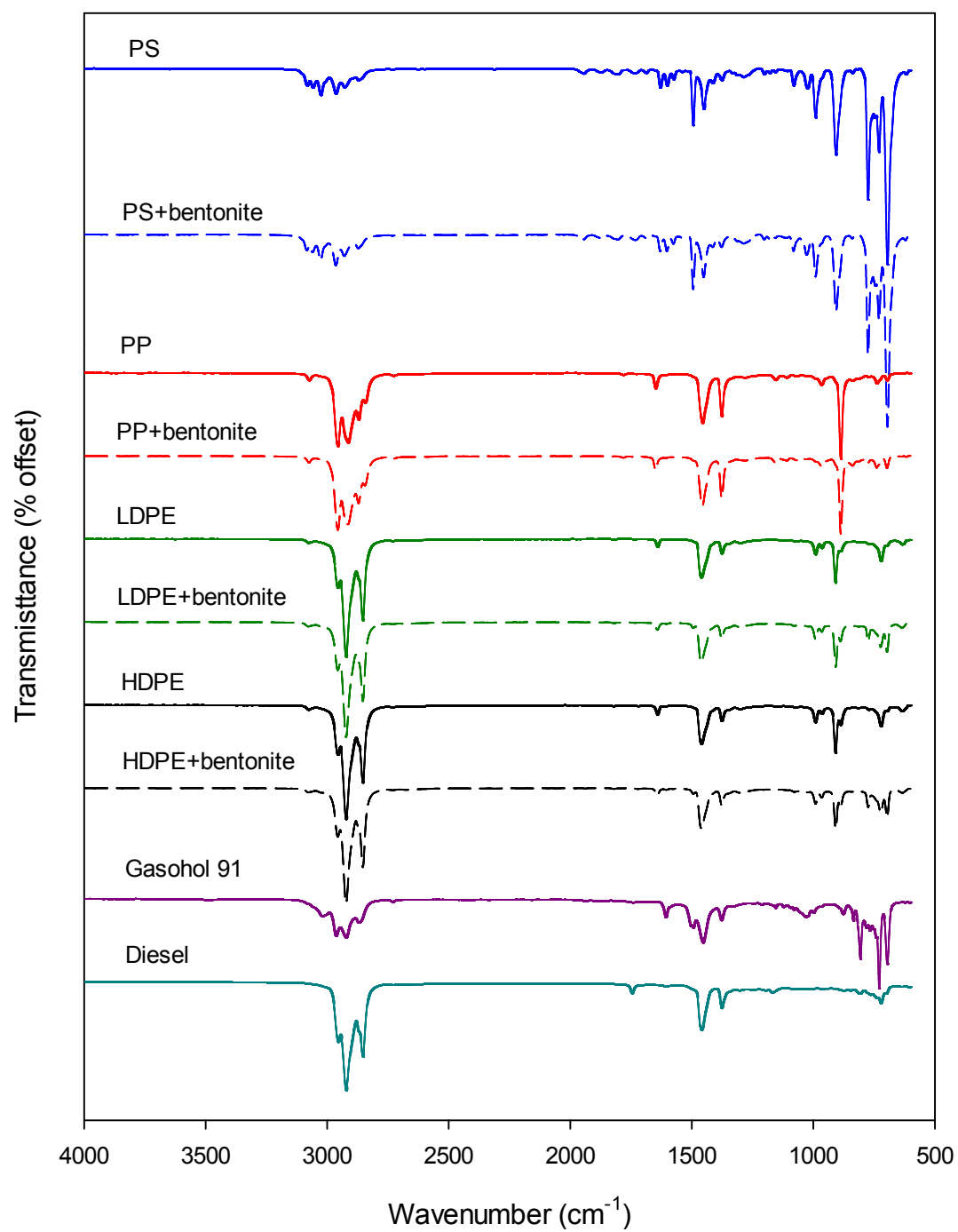


Fig. S2 FTIR spectra of oil from pyrolysis of plastic waste type.

Table S1 Compounds in oils (%Area) from the pyrolysis of plastic wastes as detected by

GC–MS analysis

PS			PP			LDPE			HDPE			Gasohol 91	Diesel
Compound	NC	C	Compound	NC	C	Compound	NC	C	Compound	NC	C		
1-Tetradecene	0	0.15	Pentane	1.13	1.29	n-Hexane	0.71	0.73	n-Hexane	0.65	0.64	Butane, 2-methyl- : 2.60	Octane : 0.32
Toluene	7.93	7.56	Cyclohexane	2.28	2.51	1-Hexene	1.05	1.10	1-Hexene	1.15	1.16	Pentane : 1.95	Nonane : 0.83
Ethylbenzene	15.07	11.29	Heptane, 4-methyl-	1.81	1.68	Heptane	1.26	1.35	Heptane	1.22	1.23	Butane, 2,2-dimethyl- : 0.47	Decane : 1.34
1-Tridecene	0	0.14	2,2-Dimethyl-3-heptene trans	0.63	0	1-Heptene	1.37	1.46	1-Heptene	1.32	1.35	Pentane, 3-ethyl- : 3.75	Undecane : 1.72
Styrene	20.12	24.49	Cyclohexane, 1,3,5-trimethyl-	1.55	0	2,4-Hexadiene	0	0.61	Octane	1.79	1.82	Pentane,2,2,4,4-tetramethyl : 3.78	Benzene, 1,3-dimethyl-m-xylene C ₈ H ₁₀ : 0.58
Naphthalene, 2-phenyl-	1.65	0	3-Hexene, 2,5-dimethyl-, (E)-	0	0.69	Cyclohexane, methyl-	0	0.55	1-Octene	1.68	1.71	n-Hexane : 2.71	trans-2-Dodecen-1-ol : 0.57
Benzene	0.77	0.42	2-Hexene, 4,4,5-trimethyl-	0	0.99	Octane	1.53	1.93	Cyclopentane, ethylidene-	0.60	0.61	3,4,5-trimethyl-Heptane, : 0.96	Dodecane CH ₃ (CH ₂) ₁₀ CH ₃ : 3.17
1-Undecene	0	0.16	2,4-Dimethyl-1-heptene	15.08	15.71	1-Octene	1.51	1.68	2,4-Dimethyl-1-heptene	1.58	1.72	Cyclopentane : 0.46	Nonane, 3-methyl- : 0.75
Benzene, (1-methylethyl)-	5.75	4.09	Cyclohexane, 1,3,5-trimethyl-	2.43	3.49	2,4-Dimethyl-1-heptene	0	0.50	Cyclohexene, 1-methyl-	0.75	0.78	1-Hexene : 0.47	Dodecane, 2-methyl- : 0.48
Benzene, propyl-	0.2	0.20	Cyclopentane, 1,2,3,4,5-pentamethyl-	0.93	1.44	Cyclohexene, 1-methyl-	0	0.52	Nonane	1.87	1.88	Hexane, 2-methyl- : 3.52	Dodecane, 3-methyl- : 0.36
1-Dodecene	0	0.15	3-Ethyl-3-methylheptane	0	1.04	Nonane	1.75	1.96	1-Nonene	1.89	1.97	Pentane, 2,3-dimethyl- : 4.83	Benzene, 1,2,4-trimethyl- : 0.72
Benzene, 2-propenyl-	0	0.25	Cyclopentene, 1,2,3,4,5-pentamethyl-	0.62	0	1-Nonene	1.77	2.02	Decane	2.20	2.29	1-Hexene, 3-methyl- : 1.34	Tridecane : 3.41
α-Methylstyrene	10.38	12.28	Nonane, 2,6-dimethyl-	2.45	1.02	Decane	1.97	2.26	Toluene	0.64	0	Heptane : 3.31	Benzene, 1,2,3-trimethyl- : 0.88
Benzene, 1-propenyl-	0	0.47	Cyclohexene, 3,3,5-trimethyl-	0	1.09	Toluene	0.99	0	1-Decene	2.69	2.82	Cyclopentane, 1,3-dimethyl-, trans- : 1.41	Dodecane, 2,6,10-trimethyl- : 1.65
Benzaldehyde	0	0.25	1-Decene, 2,4-dimethyl-	4.33	3.00	1-Decene	2.58	2.87	Undecane	2.55	2.54	1-Heptene, 5-methyl- : 1.10	Tetradecane : 5.02
Hexadecane	0	0.15	1-Tetradecene	3.59	0	Undecane	2.44	2.79	Ethylbenzene	0.52	0	Cyclohexane : 2.65	Pentadecane, 7-methyl- : 1.63
Acetophenone	0.43	0.44	1,13-Tetradecadiene	1.51	1.43	Ethylbenzene	1.23	0	1-Undecene	2.72	2.82	3-Heptene : 0.63	Tetradecane, 2-methyl- : 0.86
Eicosane	0	0.15	1-Isopropyl-1,4,5-trimethylcyclohexane	0.65	0	1-Undecene	2.44	2.92	Dodecane	2.68	2.63	Cyclopentane, 1,2,4-trimethyl- : 0.52	Tetradecane, 3-methyl- : 0.55
Diphenylmethane	0.48	0.40	2-Decene, 2,4-dimethyl-	0.98	0	Dodecane	2.55	2.91	1-Dodecene	2.75	2.79	Octane, 2,3-dimethyl- : 3.90	Pentadecane : 5.79
Benzene, 1,1'-ethylidenebis-	0	0.20	3-Octadecene, (E)-	7.78	0	1-Dodecene	2.38	2.85	Styrene	0.65	0.65	Heptane, 4-methyl- : 1.26	Pentadecane, 2-methyl- : 0.67
Heneicosane	0	0.17	Toluene	0	1.22	Styrene	1.23	0.52	Tridecane	2.79	2.77	Heptane, 4-ethyl- : 4.44	Pentadecane, 3-methyl- : 0.43
Benzene, 1,1'-(1-methyl-1,2-ethanediyl)bis-	0.48	0.20	Styrene	0	1.86	Tridecane	2.55	3.02	1-Tridecene	2.85	2.77	Heptane, 3-methyl- : 0.80	Hexadecane : 5.53
Bibenzyl	0.65	0.65	1-Undecene, 5-methyl-	0	3.85	1-Tridecene	2.48	2.66	Tetradecane	2.83	2.85	Cyclopentane, ethyl- : 0.96	Pentadecane, 2,6,10-trimethyl- :

													1.44
Methane, di- p-tolyl-	0.76	0.78	Ethylbenzene	0	1.86	Tetradecane	2.69	2.92	1- Tetradecene	2.96	2.85	Octane : 2.45	Naphthalene, 1,2,3,4- tetrahydro-5- methyl- : 0.77
1,1'- Biphenyl, 4- (1- methylethyl) -	0	0.14	1-Pentadecene	7.76	0	1-Tetradecene	2.82	3.13	Pentadecane	3.18	3.14	Octane, 4- methyl- : 2.24	Hexadecane, 2-methyl- : 0.59
1,1'- Biphenyl, 2,2',5,5'- tetramethyl-	0	0.69	1-Hexadecene	0	7.27	Pentadecane	2.98	3.43	1- Pentadecene	2.83	2.94	Octane, 3- methyl- : 1.25	Pentadecane, 2,6,10,14- tetramethyl- : 4.00
Naphthalene , 2- (phenylmeth yl)-	1.77	0	1- Heptadecane	4.95	0	1-Pentadecene	2.75	3.17	Hexadecane	3.32	3.21	Cyclohexane, ethyl- : 0.53	Heptadecane : 6.04
Benzenamin e, N-[[2-(1- methylethyl) phenyl]phen ylmethylene]	0	0.36	1-Heptadecene	6.42	0	Hexadecane	3.12	3.47	1- Hexadecene	2.61	2.61	Nonane : 0.78	Hexadecane, 2,6,10,14- tetramethyl- : 2.17
p- Ethylidiphen ylmethane	0	0.37	1-Octadecene	1.79	0.65	1-Hexadecene	2.42	2.81	Heptadecane	3.27	3.19	Benzene : 1.87	(1,4- Dimethylpent -2- enyl)benzene : 0.63
1-Propene, 3-(2- cyclopenten yl)-2- methyl-1,1- diphenyl-	0.62	0.22	1,15- Hexadecadiene	1.40	0	Heptadecane	3.06	3.33	1- Heptadecene	2.44	2.39	Ethanol : 2.66	Octadecane : 5.15
Benzene, 1,1'-(1- methyl-1,3- propanediyl) bis-	4.04	3.20	3-Eicosene, (E)-	3.99	0	1-Heptadecene	2.48	2.55	Octadecane	3.43	3.38	Nonane, 4- methyl- : 0.81	Octadecane, 2-methyl- : 0.72
Benzene, 1,1'-(1,3- propanediyl) bis-	11.17	10.88	1-Octadecane	1.69	0	Octadecane	3.33	3.46	1-Octadecene	2.18	2.24	Nonane, 3- methyl- : 0.38	Nonadecane : 5.10
Benzene, 1,1',1'',1'''- (1,5- hexadiene- 1,3,4,6- tetrayl	0	1.25	1,19- Eicosadiene	1.86	2.91	1-Octadecene	2.31	2.31	Nonadecane	3.43	3.39	Decane : 0.34	Naphthalene, 1,7-dimethyl- : 0.44
Benzene, 1,1'-(2- methyl-1- propenyliden e)bis-	0.52	0.88	1,21- Docosadiene	0.57	0	Nonadecane	3.11	3.45	1- Nonadecene	1.98	2.07	Toluene : 13.28	Eicosane : 4.44
1,1- Diphenylcyc lopropane	0	0.42	1-Tricosene	14.98	7.87	1-Nonadecene	2.08	2.09	Eicosane	3.31	3.31	Ethylbenzene : 1.92	Naphthalene, 2,6-dimethyl- : 0.67
Benzene, 1,1'-(3- methyl-1- propene-1,3- diyl)bis-	1.50	0.27	9-Tricosene, (Z)-	0	0.84	Eicosane	3.14	3.25	1-Eicosene	1.68	1.74	p-Xylene : 2.01	Heneicosane : 3.66
Benzene, 1,1'-(1,4- butanediyl)b is-	1.14	0	Cyclotetracos ane	0	1.36	1-Eicosene	1.99	1.78	Heneicosane	2.92	3.05	Benzene, 1,3- dimethyl- : 4.23	Docosane : 3.27
Benzene, (1-methyl-3- butenyl)-	0	0.58	1-Docosene	1.19	0	Heneicosane	2.84	2.80	1- Heneicosene	1.72	1.55	o-Xylene : 2.48	Hexadecanoic acid, methyl ester : 7.07
1,2- Diphenylcyc lopropane	0.70	0.64	1,21- Docosadiene	3.14	1.70	1-Heneicosene	1.83	1.57	Docosane	2.58	2.59	Benzene, propyl- : 0.76	4,4'- Dimethylbip henyl : 0.50
Benzene, 1,1'-(1,4- butanediyl)b is	0	1.40	3-Eicosene, (E)-	1.45	7.11	Docosane	2.66	2.51	1-Docosene	1.22	1.29	Benzene, 1- ethyl-4- methyl- : 1.15	Tricosane : 2.81
1,3- Pentadiene, 1,1- diphenyl-, (Z)- (2,3-	1.01	0.79	1-Eicosene	1.17	1.11	1-Docosene	1.46	1.25	Tricosane	2.30	2.33	Benzene, 1- ethyl-3- methyl- : 2.52	Tetracosane : 2.10
	0.86	0	1-Nonadecene	0	7.38	Tricosane	2.45	2.22	1-Tricosene	1.10	1.06	Mesitylene : -	Octadecanoic

Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-												1.17	acid, methyl ester : 1.04
1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-	0	0.82	1-Octacosene	0.75	0	1-Tricosene	1.17	0.95	Tetracosane	2.08	2.13	Benzene, 1-ethyl-2-methyl- : 0.99	9-Octadecenoic acid, methyl ester, (E)- : 5.58
Bicyclo[4.2.1]nona-2,4,7-triene, 7-phenyl-	3.69	3.43	Cyclopentane, 1,1'-[4-(3-cyclopentylpropyl)-1,7-heptanediyl]bis-	1.91	0	Tetracosane	2.23	1.99	Tetracosane	0.87	0.92	Benzene, 1,2,4-trimethyl- : 3.49	Pentacosane : 1.58
Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-	0	1.34	9-Hexacosene	1.29	1.93	Tetracosane	1.04	0.77	Pentacosane	1.91	1.96	Benzene, 1-methyl-3-propyl- : 0.62	9,12-Octadecadienoic acid (Z,Z)-, methyl ester : 1.41
Benzene, 1,1'-(1,2-dimethyl-1,2-ethenediyl)bis-, (Z)-	1.02	0	Cyclohexane, 1,2,3,4,5,6-hexaethyl-	0	3.7	Pentacosane	2.14	1.80	Pentacosane	0.55	0.64	Benzene, 1-ethyl-3,5-dimethyl- : 0.60	Hexacosane : 0.97
1,2-Diphenylethylene	0	0.49	Heptacosene	1.28	0	Pentacosane	0.74	0.53	Hexacosane	1.64	1.70	Benzene, 1,2,3-trimethyl- : 1.16	Heptacosane : 0.58
9-Ethyl-10-methylanthracene	1.50	1.21	1-Hexacosene	0.61	0	Hexacosane	1.83	1.52	Hexacosane	0.51	0.56	Benzene, 2-ethyl-1,4-dimethyl- : 0.43	
Dibenzo[a,e]cyclooctene	0	0.73	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	1.84	4.01	Hexacosane	0.69	0.47	Heptacosane	1.45	1.53	Benzene, 1-ethyl-2,4-dimethyl- : 0.41	
3-Methyl-1-phenyl-1H-indene	0.68	0.47	Benzene, 1,1'-(1,3-propanediyl)bis-	0	1.05	Heptacosane	1.66	1.33	Octacosane	1.21	1.29	Benzene, 4-ethyl-1,2-dimethyl- : 0.67	
Naphthalene, 1-phenyl-	1.12	0				Octacosane	1.37	1.08	Nonacosane	0.94	1.13	Indane : 0.54	
Benzonitrile, m-phenethyl-	0	0.88				Nonacosane	1.14	0.85				Benzene, 1,2,3,5-tetramethyl- : 0.46	
9-Phenyl-5H-benzocycloheptene	0	0.55				Naphthalene, 2-phenyl-	0.96	0					
Naphthalene, 1-(phenylmethyl)-	0	1.76				Triacontane	0.89	0					
(4-Acetylphenyl)phenylmethane	0.77	0				Hentriacontane	0.80	0					
1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-	0.77	0											
Silane, dimethyl(3-ethylphenoxy)ethoxy-	0.52	0											
2-Ethyl-5-methyl-3,3-diphenylpyrrolidine	1.05	0											
1,1-Diphenylcyclopropane	0.69	0											

NC = No catalyst, C = Catalyst