Supporting Information

Supercritical Water Co-liquefaction of LLDPE and PP into Oil: Properties and Synergy

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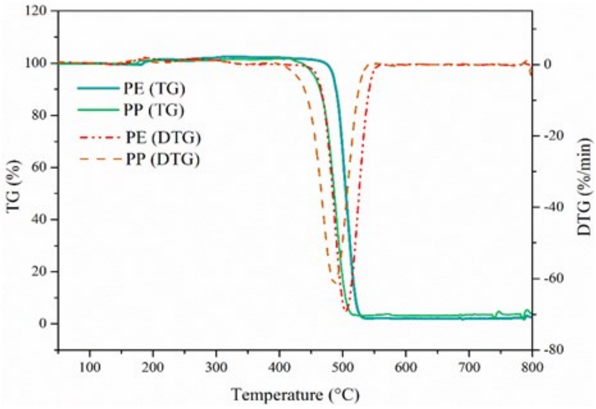

Figure S1. TG/DTG curves of LLDPE and PP (PE represents LLDPE).

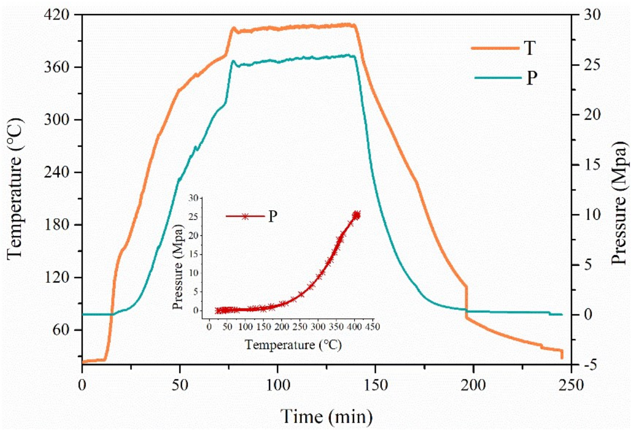

Figure S2. Variation of temperature and pressure with increasing time.

As can be seen from Figure S3, there was much difference in the product shapes when the reaction environment changed. Although the reaction environment reached the supercritical conditions, the viscous liquid product was still observed at a reaction temperature of 380 °C and a reaction pressure of 22 MPa, as shown in Figure 1c. However, the viscous products were decomposed completely under 400 °C and 25 Mpa for 60 min. Therefore, the lower temperature processing of the plastic mixtures is not conducive to the production of oils, especially gasoline and jet fuels. Similarly, higher reaction temperature would result in a higher pressure, especially under supercritical state. Thus, the condition of 400 °C, 25 MPa, and 60 min was a relative milder condition for conversion of plastic mixtures into oil.

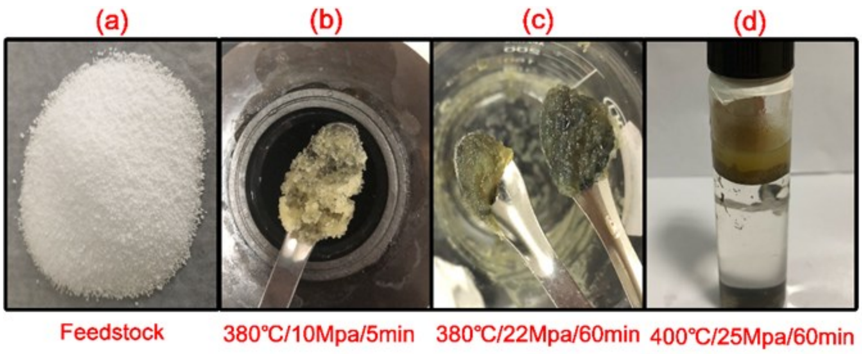

Figure S3. The products from scH_2O co-liquefaction of LLDPE/PP (1:1) under the different reaction conditions a) ambient temperature, b) 380 °C / 10 Mpa/ 5 min, c) 380 °C / 22 Mpa/ 60 min, and d) 400 °C / 25 Mpa/ 60 min.

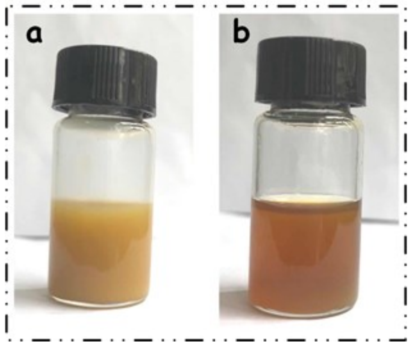

Figure S4. Appearance of oils: a) grease at room temperature (i.e., 25±3 °C), and b) liquid phase at low-grade fever (i.e., 50 °C).

As can be seen from Figure S5, the gas yield obtained from scH_2O reaction of single and mixed plastics varied in the range of 9.05-12.58 wt%. Chen et al.[1], and Jin et al.[2], state that no gas products was generated from PP and HDPE scH_2O reaction respectively under the same reaction condition (i.e., 400 °C, and 60 min), and Seshasayee et al.[3], shows an gas yield of around 68 wt% from scH_2O reaction of PP under the same condition (i.e., 400 °C, and 60 min). The chemical compositions of gas products from thermochemical conversion (including liquefaction and pyrolysis) of PE and PP have been widely reported[1, 4, 5]. Chen et al. [1] studied the liquefaction of PP in scH_2O, and gas products included ethane, propane, propene, butane, and pentane. The similar products from PE were also observed in researches of Zhang et al. [4], and Williams et al [5].

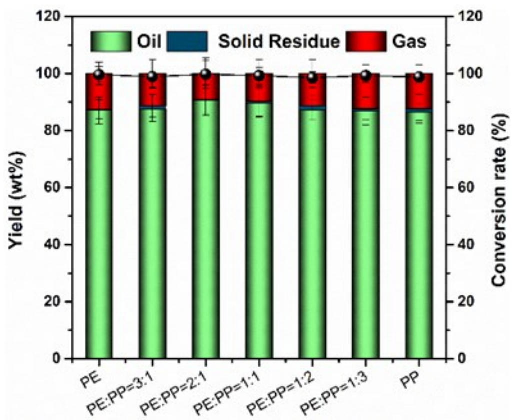

Figure S5. The products distribution of scH_2O co-liquefaction of PE and PP (PE represents LLDPE).

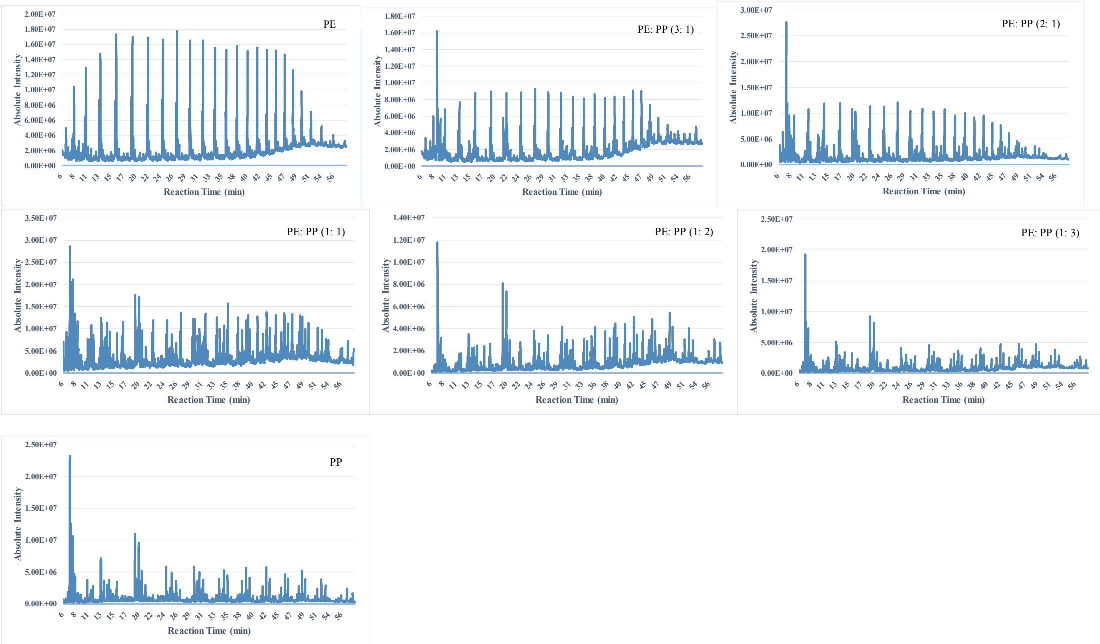

Figure S6. Gas chromatogram of the oil from the liquefaction of LLDPE, PP and their mixtures (PE represents LLDPE).

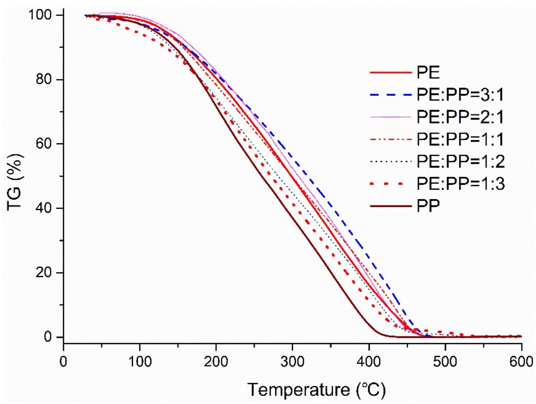

Figure S7. TG curves of oil products from scH_2O liquefaction of LLDPE, PP, and their mixtures (PE represents LLDPE).

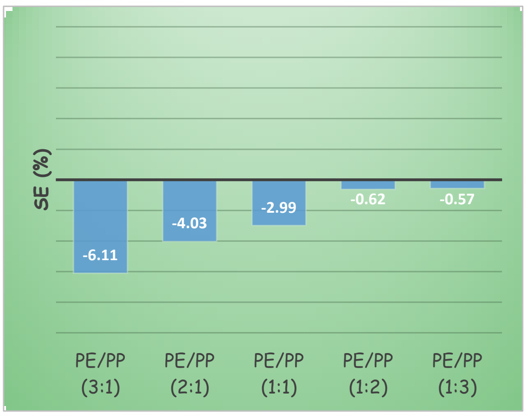

Figure S8. The contents of the carbon numbers (C_5-C_{10}) for various feedstocks (PE=LLDPE).

Table S1. The GC-MS analysis of oil obtained from liquefaction of LLDPE, PP and their mixtures in supercritical water (PE reprents LLDPE).

No.	Name	Formula	Relative amount, %						
			PE	3:1	2:1	1:1	1:2	1:3	PP
	Paraffins (C_7-C_{30})		***63.17***	***55.84***	***55.54***	***50.91***	***28.1***	***8.12***	***5.05***
1	Heptane, 4-methyl-	C_7H_{16}	1.57	×	1.82	×	×	×	1.87
2	Octane	C_8H_{18}	2.65	2.64	2.43	×	×	×	1.06
3	Nonane	C_9H_{20}	3.16	2.80	×	1.80	×	×	×
5	Decane	$C_{10}H_{22}$	3.33	3.26	3.75	2.58	1.80	1.74	×
6	Undecane	$C_{11}H_{24}$	3.41	3.32	2.94	1.77	1.01	×	1.11
7	Nonane, 2,6-dimethyl-	$C_{11}H_{24}$	×	×	×	×	1.58	×	1.01
8	Dodecane	$C_{12}H_{26}$	3.61	3.43	3.00	1.95	×	1.72	×
9	Tridecane	$C_{13}H_{28}$	3.49	3.29	2.91	2.09	1.03	×	×
10	Tetradecane	$C_{14}H_{30}$	3.40	2.05	2.86	1.76	1.08	×	×
11	Pentadecane	$C_{15}H_{32}$	3.48	3.28	2.98	2.00	1.29	×	×
12	Hexadecane	$C_{16}H_{34}$	3.21	3.18	2.97	2.09	1.33	1.51	×
13	Heptadecane	$C_{17}H_{36}$	3.32	5.72	2.81	6.31	1.15	×	×
14	Octadecane	$C_{18}H_{38}$	3.16	3.50	2.67	5.8	1.38	×	×
15	Nonadecane	$C_{19}H_{40}$	3.05	2.85	4.13	1.97		×	×
16	Eicosane	$C_{20}H_{42}$	16.73	11.84	10.84	5.00	5.16	1.78	×
17	Heneicosane	$C_{21}H_{44}$	2.86	×	2.36	1.99	4.48	×	×
18	Tricosane	$C_{23}H_{48}$	×	1.98	×	×	×	×	×
19	Tetracosane	$C_{24}H_{50}$	2.73	×	2.71	1.65	×	×	×
20	Z-12-Pentacosene	$C_{25}H_{50}$	×	×	2	1.15	×	×	×
21	Hexacosane	$C_{26}H_{54}$	×	2.70	2.97	1.99	1.18	×	×
22	Heptacosane	$C_{27}H_{56}$	×	×	1.21	1.85	5.63	1.37	×
23	Nonacosane	$C_{29}H_{60}$	×	×	×	2.70	×	×	×
24	Triacontane	$C_{30}H_{62}$	×	×	×	4.46	×	×	×
	Olefins (C_8-C_{35})		***33.19***	***31.72***	***29.39***	***28***	***43.9***	***47.84***	***74.95***
25	1-Octene	C_8H_{16}	0.89	×	×	1.79	3.43	3.16	6.66
26	2,4-Dimethyl-1-heptene	C_9H_{18}	×	2.53	3.60	4.09	9.13	13.50	15.50
27	cis-2-Nonene	C_9H_{18}	×	×	1.20	×	2.66	4.52	×
28	1-Nonene	C_9H_{18}	1.42	1.40	×	×	3.01	×	2.36
29	1-Decene	$C_{10}H_{20}$	2.41	1.77	1.54	1.03	×	2.29	3.54
30	cis-3-Decene	$C_{10}H_{20}$	×	×	×	×	0.9	0.84	1.01
31	4-Decene	$C_{10}H_{20}$	1.07	1.32	×	2.97	1.01	×	×
32	1-Undecene	$C_{11}H_{22}$	1.97	1.01	×	1.28	×	×	2.64
33	3-Undecene, (Z)-	$C_{11}H_{22}$	0.10	×	×	1.52	×	×	×
34	5-Undecene	$C_{11}H_{22}$	0.89	×	×	0.62	×	×	×
35	2-Decene, 2,4-dimethyl-	$C_{12}H_{24}$	×	×	1.38	×	×	2.41	6.59
36	1-Dodecene	$C_{12}H_{24}$	1.97	×	1.87	1.43	×	1.47	×
37	2-Dodecene, (Z)-	$C_{12}H_{24}$	×	×	×	0.71	1.18	1.21	×
38	1-Tridecene	$C_{13}H_{26}$	2.22	1.64	1.69	×	×	2.63	×
39	4-Dodecene, (Z)-	$C_{12}H_{24}$	1.01	1.83	×	×	1.60	×	×
40	2-Tridecene, (Z)-	$C_{13}H_{26}$	0.77	×	×	×	×	×	×
41	3-Tridecene, (E)-	$C_{13}H_{26}$	1.81	×	×	×	×	×	×
42	3-Tridecene, (Z)-	$C_{13}H_{26}$	0.70	×	×	×	×	×	×
43	2-Tetradecene, (E)-	$C_{14}H_{28}$	1.93	1.85	1.73	0.81	×	×	×
44	5-Tetradecene, (E)-	$C_{14}H_{28}$	0.86	×	×	×	0.70	×	×
45	3-Tetradecene, (Z)-	$C_{14}H_{28}$	0.62	×	×	×	×	×	×
46	1-Pentadecene	$C_{15}H_{30}$	1.99	2.02	4.29	1.47	×	4.67	5.33
47	Cetene	$C_{16}H_{32}$	1.46	1.86	1.46	0.50	0.72	×	×
48	3-Hexadecene, (Z)-	$C_{16}H_{32}$	×	×	×	1.51	×	×	6.31
49	1-Heptadecene	$C_{17}H_{34}$	1.74	2.02	1.66	×	×	×	×
50	8-Heptadecene	$C_{17}H_{34}$	0.85	×	×	×	0.73	×	3.76

51	3-Heptadecene, (Z)-	$C_{17}H_{34}$	×	×	×	0.74		×	×
52	1-Octadecene	$C_{18}H_{36}$	×	×	0.56	1.36	1.63	×	1.88
53	5-Octadecene, (E)-	$C_{18}H_{36}$	1.15	1.65	×	0.95	×	2.21	2.11
54	1-Nonadecene	$C_{19}H_{38}$	0.49	×	0.46	×	×	×	×
55	Z-5-Nonadecene	$C_{19}H_{38}$	1.16	3.15	1.21	2.59	×	×	×
56	5-Eicosene, (E)-	$C_{20}H_{40}$	1.31	1.65	1.45	×	2.25	2.00	1.63
57	10-Heneicosene (c,t)	$C_{21}H_{42}$	×	×	×	1.20	×	3.92	2.16
58	1-Docosene	$C_{22}H_{44}$	×	1.46	1.22	×	×	×	×
59	9-Tricosene, (Z)-	$C_{23}H_{46}$	3.12	1.74	1.07	1.28	2.17	×	×
60	1-Tetracosene	$C_{24}H_{48}$	×	1.00	×	×	1.89	×	×
61	Pentacos-1-ene	$C_{25}H_{50}$	×	×	×	1.15	×	1.54	2.16
62	1-Hexacosene	$C_{26}H_{52}$	×	×	×	1.99	2.66	×	7.32
63	Heptacos-1-ene	$C_{27}H_{54}$	×	×	×	×	1.29	1.48	3.99
64	13-Methyl-Z-14-nonacosene	$C_{30}H_{60}$	×	1.82	×	×	2.3	×	×
65	17-Pentatriacontene	$C_{35}H_{70}$	×	×	×	×	4.64	×	4,35
	Cyclics (C_7-C_{25})		***2.11***	***12.44***	***12.88***	***18.2***	***28***	***44.04***	***14.89***
66	Cyclohexene, 1-methyl-	C_7H_{12}	0.53	×	1.98	×	×	×	×
67	Cyclopropane, 1-methyl-2-pentyl-	C_9H_{18}	×	×	1.56	4.78	6.61	7.84	×
68	1,2,4,4-Tetramethylcyclopentene	C_9H_{16}	×	×	1.43	2.24	×	2.29	×
69	Cyclohexane, 1,3,5-trimethyl-	C_9H_{18}	×	2.32	2.54	1.83	2.48	×	5.16
70	Cyclopentene, 1,2,3,4,5-pentamethyl-	$C_{10}H_{18}$	×	×	×	1.45	×	×	0.79
71	Cyclohexane, hexyl-	$C_{12}H_{24}$	×	1.02	×	2.01	×	×	×
72	Cyclohexane, 1,4-dimethyl-2-(2-methylpropyl)-, (1α,2β,4α)-	$C_{12}H_{24}$	×	×	×	×	0.91	1.24	2.55
73	Cyclotetradecane	$C_{14}H_{28}$	0.47	0.89	×	×	×	×	×
74	Cyclohexane, 1,1,3-trimethyl-2-(3-methylpentyl)-	$C_{15}H_{30}$	×	×	×	×	3.30	4.75	1.42
75	Cyclopropane, 1-methyl-1-(2-methylpropyl)-2-nonyl-	$C_{17}H_{34}$	×	1.76	3.14	×	×	×	×
76	Cyclohexane, 1,2,3,4,5,6-hexaethyl-	$C_{18}H_{36}$	×	2.22	×	×	4.50	6.73	×
77	Cyclopentane, 1,1'-[3-(2-cyclopentylethyl)-1,5-pentanediyl]bis-	$C_{22}H_{40}$	×	×	×	×	×	2.04	×
78	Cyclotetracosane	$C_{24}H_{48}$	1.11	2.12	2.23	1.52	1.22	×	4.97
79	Cyclohexane, [6-cyclopentyl-3-(3-cyclopentylpropyl)hexyl]-	$C_{25}H_{46}$	×	×	×	2.95	×	×	×
80	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	$C_{25}H_{48}$	×	2.11	×	×	8.98	19.15	×
	Aramatics (C_8-C_9)		***0.81***	***0.00***	***2.19***	***2.90***	***0.00***	***0.00***	***5.11***
81	Benzene, 1,3-dimethyl-	C_8H_{10}	0.81	×	2.19	×	×	×	2.77
82	p-Xylene	C_8H_{10}	×	×	×	×	×	×	×
83	o-Xylene	C_8H_{10}	×	×	×	1.95	×	×	×
84	Mesitylene	C_9H_{12}	×	×	×	0.95	×	×	2.34

×: not be detected

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