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Research Article

Waste Polymer Resin Conversion into Petroleum Oil for Refinery Industry

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Abstract

Polymer waste resin to petroleum oil recovery experiment was performing using thermal degradation process at temperature 25-390 ºC in laboratory scale batch process. Under labconco fume hood experiment was placed with steel reactor. Raw materials were use ten types of variety color and experiment purpose sample was use 1000 gm by weight. Oil density is 0.91 g/ml and experimental oil recovery rate was 49.18%, light gas generated 9.91% and solid black residue was 40.91%. Product oil was analysis by GC/MS and obtains compounds range showed C_3 to C_{37}. Product oil analysis result showed also aromatics group compounds such as Benzene, Toluene, Ethylbenzene, Styrene, α-Methylstyrene, Naphthalene, Phenol etc.. Waste polymer resin to recovery oil can use for feed stock refinery process for further modification and appropriate for internal combustion engines.

Keywords: polymer waste, petroleum oil, refinery, thermal, none coded, GC/MS, recycle plastic

1. Introduction

Plastic waste has recently reached a diffusion of ~75 million tonnes per year globally [1]. Municipal waste is by far the largest source of plastic waste with more than 60% of the total; 7% of plastic waste is subjected to material recovery and 15% to energy recovery; and an average of~80%is disposed of [2]. Waste plastic mainly consists of polyethylene (PE), polypropylene (PP) and polystyrene (PS) with different polymer structure, which is above 70% in waste plastics [3, 4, 5]. Thus, recycling of waste plastic is highly encouraged. With respect to the method of recycling, plastics can be practically recycled either mechanically towards a new plastic with a lower grade application, i.e., physical recycling, or chemically to obtain chemical raw materials or fuel oil, i.e., chemical recycling. However, physical recycling, as a conventional method to treat the waste plastic mixture, is limited by technical problems, difficulties in maintaining the product quality and adequate price [6-7]. Thus, physically recycled plastics should be treated by other procedures such as chemical recycling and energy recovery [8]. The thermal degradation of

plastic wastes is one of the prospective ways to solve this problem. This way the plastic wastes are converted into fuels or other valuable feedstock's for the petrochemical industry. Numerous researchers have contributed to the theory and practice of thermal degradation (with or without catalyst) of polymers. Mainly polyolefin's (polyethylene (PE) and polypropylene (PP) and polystyrene (PS) were the target polymers, because their cracking resulted in products with favorable properties for further application [9–12]. PE derived fuel has very high cetane and octane number, because it is rich in linear paraffins and a-olefins. Linear paraffin content in the gas oil fraction is advantageous, because this hydrocarbon structure has the highest cetane rate, but also has the lowest octane number in the naphtha fraction.

However, PE-derived naphtha-like fraction has high octane number, which comes from the high content of olefins. The liquid products of cracking of PP contain primarily olefins and isoparaffins that resemble the molecular skeleton of PP. Both hydrocarbon structures are advantageous for further utilization [13]. Both hydrocarbon structures are advantageous for further utilization. Neat PS feedstocks will depolymerise in cracking processes to give predominately styrene monomer. Therefore, the fuel made from polystyrene feedstock will be high by aromatic character and have good energy content. The aromatic hydrocarbons have the highest octane number in the naphtha fraction [14]. The degradation of these polymers in their individual form is well described. The literature shows the results of different degradation techniques, the yield and the characteristics of the products and the degradation mechanism and kinetic data were presented [15–22].

2. Materials

Raw materials were collected from one of local recycle company in Stamford. Polymer waste was resin types and it was 10 colors different types of none coded polymer waste. From 10 types of polymer waste to collected 100 gm for each and put together in one container for liquefaction process. All resin was palette types and hard polymer waste with ten types of different colors.

3. Process Description

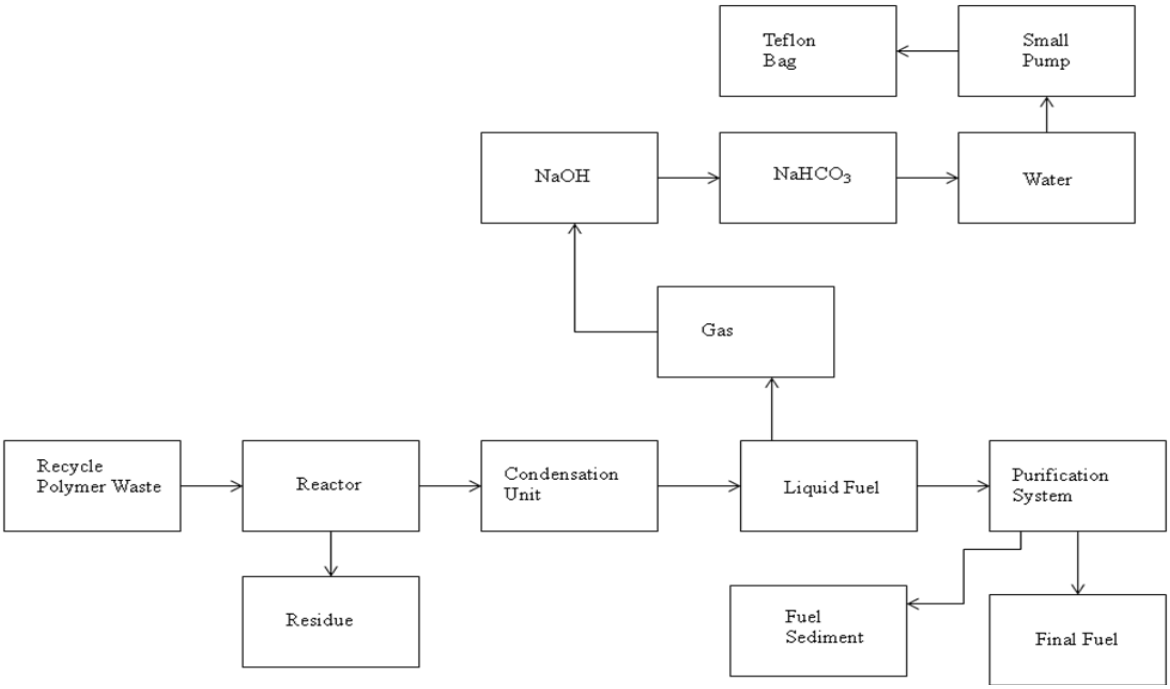

Figure 1: Recycle polymer waste resin to petroleum oil production process

Collected ten types of resin waste polymer put into together steel reactor chamber for liquefaction process without catalyst in batch process. Experimental process setup is showed figure 1 for better understanding. Whole setup was close and it was batch process under laboratory fume hood. Experiment every part connection was enough tilting to prevent gas lose into environment. For this experimental process was need reactor with controller, condensation pipe, fuel collection tank, fuel purification device, fuel sediment container, final fuel collection tank, light gas cleaning device with alkali solution, pump, Teflon bag and residue collection container. Experimental temperature range was 25- 390 ºC and experiment temperature control was using watlow meter. Sample was heated up from 25 ºC to up to 390 ºC and temperature was increase slowly step by step. For experiment purpose initial raw materials was use 1000 gm (1Kg). In this experiment main goal was none coded types resin to refinery feed discover without catalyst. Only thermal degradation process was use for 10 types of polymer resin to oil recovery. Experiment starting heat was 25 ºC, from 25 ºC to heat increase up to 150 ºC gradually that time notice that oil start to come out by condensation unit. Full experiment condensation finished time was 4.45 hours. Collected fuel was filtered by RCI purification filter system and fuel sediment was collected into different another container. Fuel sediment is coming from raw materials additives and during conversion period some ash particle also comes with liquid fuel. RCI filter purification process can remove fuel sediment from liquid fuel and fuel sediment can be reuse for next experiment from waste plastic to fuel production. Polymer resin waste to production oil period some percentage light gas also generated because all hydrocarbon are not condense in normal temperature. Some hydrocarbon compounds have negative boiling point temperature those hydrocarbon compounds comes out as light gas. Lighter gas collected from collection tank and passed through alkali solution with clean water then gas was collected Teflon bag using small pump. Produce light gas can use as a heat source for continues process and this process can reduce production cost. Usually four types of hydrocarbon light gas has negative boiling point and gases are methane, ethane, propane and butane. Product fuel density is 0.91 g/ml and conversion rate was 59.09% including liquid oil and light gas. In this experiment mass balance calculation showed liquid fuel was 491.8 gm (535ml), light gas generated from total sample to 99.1 gm and left over residue was 409.1 gm. Fuel is ignited and color is dark brown.

4. Result and Discussion

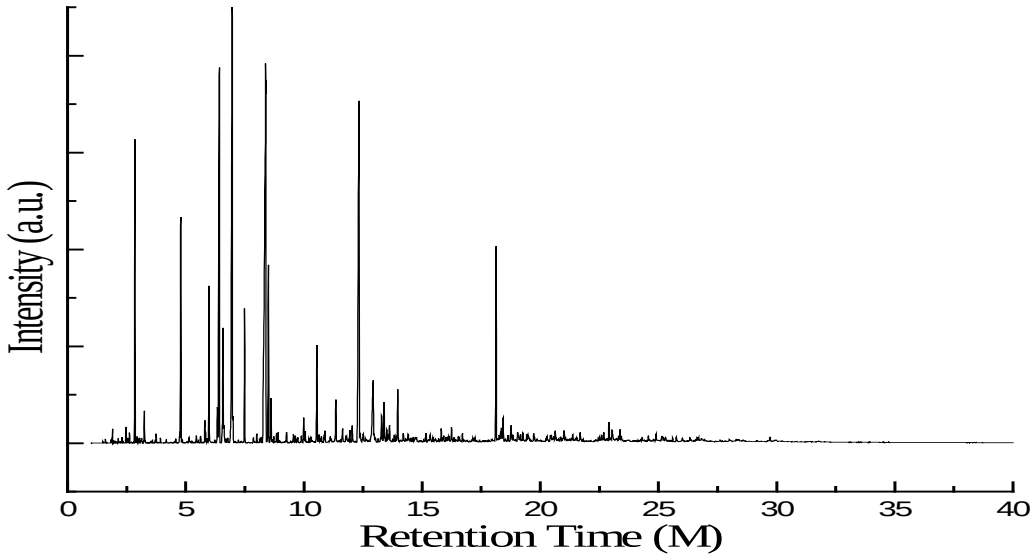

Figure 2: GC/MS Chromatogram of recyclable polymer resin to petroleum oil

Table 1: GC/MS Chromatogram compounds list of recyclable polymer resin to petroleum oil

Number of Peak	Retention Time (min.)	Trace Mass (m/z)	Compound Name	Compound Formula	Molecular Weight	Probability %	NIST Library Number
1	1.49	41	Cyclopropane	C_3H_6	42	51.5	18854
2	1.56	43	Isobutane	C_4H_{10}	58	57.4	61289
3	1.60	41	1-Propene, 2-methyl-	C_4H_8	56	23.2	61293
4	1.63	41	2-Butene, (E)-	C_4H_8	56	29.7	105
5	1.75	55	Cyclopropane, 1,2-dimethyl-, trans-	C_5H_{10}	70	51.3	114453
6	1.81	43	Butane, 2-methyl-	C_5H_{12}	72	70.5	61287
7	1.85	41	Acetonitrile	C_2H_3N	41	49.2	228221
8	1.87	42	Cyclopropane, ethyl-	C_5H_{10}	70	23.7	114410
9	1.90	43	Pentane	C_5H_{12}	72	87.2	114462
10	1.94	55	2-Pentene, (E)-	C_5H_{10}	70	15.1	291780
11	1.98	55	1-Butene, 3-methyl-	C_5H_{10}	70	16.3	160477
12	2.05	67	1,4-Pentadiene	C_5H_8	68	22.5	114494
13	2.24	67	Bicyclo[2.1.0]pentane	C_5H_8	68	19.7	192491
14	2.30	43	Pentane, 2-methyl-	C_6H_{14}	86	46.9	61279
15	2.47	56	1-Pentene, 2-methyl-	C_6H_{12}	84	37.9	61283
16	2.62	69	2-Butene, 2,3-dimethyl-	C_6H_{12}	84	13.4	289588
17	2.84	42	Furan, tetrahydro-	C_4H_8O	72	89.1	118704
18	2.94	67	1,3-Pentadiene, 2-methyl-, (E)-	C_6H_{10}	82	11.4	149695
19	2.98	67	2,4-Hexadiene, (Z,Z)-	C_6H_{10}	82	14.1	113646
20	3.04	56	1-Pentene, 2,4-dimethyl-	C_7H_{14}	98	62.4	114435
21	3.14	81	2,4-Dimethyl 1,4-pentadiene	C_7H_{12}	96	40.6	114468
22	3.25	78	Benzene	C_6H_6	78	70.1	114388
23	3.42	67	Cyclopentene, 3-methyl-	C_6H_{10}	82	8.88	19269
24	3.50	67	Cyclopentane, methylene-	C_6H_{10}	82	17.9	19272
25	3.54	56	1-Hexene, 2-methyl-	C_7H_{14}	98	29.6	114433
26	3.59	41	1-Heptene	C_7H_{14}	98	29.2	107734
27	3.71	43	Heptane	C_7H_{16}	100	49.5	61276
28	3.75	81	1,3-Pentadiene, 2,4-dimethyl-	C_7H_{12}	96	38.9	114450
29	3.81	41	2-Heptene	C_7H_{14}	98	24.6	160628
30	3.93	55	1-Butene, 4-bromo-	C_4H_7Br	134	81.3	151755
31	4.14	55	Cyclohexane, methyl-	C_7H_{14}	98	52.8	118503
32	4.18	57	Butane, 1-bromo-	C_4H_9Br	136	67.8	58817
33	4.28	41	Cyclopentane, ethyl-	C_7H_{14}	98	49.9	940
34	4.53	81	3,5-Dimethylcyclopentene	C_7H_{12}	96	10.5	113640
35	4.58	69	4-Methyl-2-heptene	C_8H_{16}	112	11.0	113430
36	4.79	91	Toluene	C_7H_8	92	68.7	291301
37	5.05	56	1-Heptene, 2-methyl-	C_8H_{16}	112	66.7	113675
38	5.13	55	Pentane, 2-cyclopropyl-	C_8H_{16}	112	10.1	113439
39	5.21	95	1,4-Hexadiene, 2,3-dimethyl-	C_8H_{14}	110	16.9	1482
40	5.27	43	Hexane, 2,4-dimethyl-	C_8H_{18}	114	27.1	118871
41	5.37	41	2-Octyn-1-ol	$C_8H_{14}O$	126	4.65	53364

42	5.45	207	Cyclotrisiloxane, hexamethyl-	$C_6H_{18}O_3Si_3$	222	92.2	238029
43	5.53	69	Cyclopentane, 1,1,3,4-tetramethyl-, cis-	C_9H_{18}	126	9.64	27589
44	5.63	93	1,5-Dimethyl-1,4-cyclohexadiene	C_8H_{12}	108	13.8	113103
45	5.81	83	2,3-Dimethyl-3-heptene	C_9H_{18}	126	19.1	113493
46	5.98	43	2,4-Dimethyl-1-heptene	C_9H_{18}	126	66.3	113516
47	6.34	55	5-Hexenenitrile, 2-methyl-	$C_7H_{11}N$	109	9.60	1454
48	6.42	91	Ethylbenzene	C_8H_{10}	106	51.4	158804
49	6.58	91	Benzene, 1,3-dimethyl-	C_8H_{10}	106	33.9	291455
50	6.96	103	Styrene	C_8H_8	104	52.2	291542
51	7.10	83	Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	$C_{10}H_{18}$	138	10.0	113192
52	7.16	81	2-Decyne	$C_{10}H_{18}$	138	9.99	114180
53	7.23	82	3-Octyne, 2-methyl-	C_9H_{16}	124	5.36	62452
54	7.45	105	Benzene, (1-methylethyl)-	C_9H_{12}	120	54.4	228742
55	7.66	55	1-Decene, 10-bromo-	$C_{10}H_{19}Br$	218	5.38	155034
56	7.86	117	Benzene, 2-propenyl-	C_9H_{10}	118	16.1	231964
57	7.94	41	2-Nonyn-1-ol	$C_9H_{16}O$	140	22.9	114747
58	8.00	91	Benzene, propyl-	C_9H_{12}	120	72.1	113930
59	8.05	57	Heptane, 3-ethyl-	C_9H_{20}	128	6.96	114031
60	8.13	105	Benzene, 1-ethyl-3-methyl-	C_9H_{12}	120	36.6	228743
61	8.19	105	Benzene, 1-ethyl-2-methyl-	C_9H_{12}	120	29.4	228745
62	8.38	94	Phenol	C_6H_6O	94	77.1	291521
63	8.50	118	α-Methylstyrene	C_9H_{10}	118	29.2	2021
64	8.61	103	Benzonitrile	C_7H_5N	103	64.3	291291
65	8.67	117	Benzene, 1-propenyl-	C_9H_{10}	118	10.4	20403
66	8.72	105	Benzene, 1,3,5-trimethyl-	C_9H_{12}	120	11.7	20469
67	8.84	43	Decane, 4-methyl-	$C_{11}H_{24}$	156	8.51	5261
68	8.91	43	Octane, 3,3-dimethyl-	$C_{10}H_{22}$	142	13.7	61706
69	8.98	105	Benzene, (1-methylpropyl)-	$C_{10}H_{14}$	134	32.8	228188
70	9.27	117	Benzene, 2-propenyl-	C_9H_{10}	118	15.0	114744
71	9.45	117	1,3-Methanopentalene, 1,2,3,5-tetrahydro-	C_9H_{10}	118	14.3	221371
72	9.55	108	Phenol, 2-methyl-	C_7H_8O	108	34.2	118461
73	9.63	83	3-Decene, 2,2-dimethyl-, (E)-	$C_{12}H_{24}$	168	4.09	60857
74	9.74	91	1,2,3,4,5,8-Hexahydronaphthalene	$C_{10}H_{14}$	134	17.2	113559
75	9.89	107	Phenol, 3-methyl-	C_7H_8O	108	32.4	53611
76	9.99	69	2,6-Dimethyl-6-trifluoroacetoxyoctane	$C_{12}H_{21}F_3O_2$	254	2.85	215969
77	10.06	43	5-Ethyl-1-nonene	$C_{11}H_{22}$	154	3.26	114896
78	10.22	41	3-Undecene, (E)-	$C_{11}H_{22}$	154	4.76	60565
79	10.30	117	Benzene, 1-isocyano-4-methyl-	C_8H_7N	117	21.3	2002
80	10.56	117	Benzonitrile, 4-methyl-	C_8H_7N	117	33.7	290521
81	10.64	83	trans-3(10)-Caren-2-ol	$C_{10}H_{16}O$	152	7.71	151665
82	10.74	73	Cyclopentasiloxane,	$C_{10}H_{30}O_5Si_5$	370	7.13	236883

			decamethyl-				
83	10.85	83	1-Tetradecanol, 14-chloro-	$C_{14}H_{29}ClO$	248	5.29	156095
84	10.89	107	Phenol, 4-ethyl-	$C_8H_{10}O$	122	30.8	113319
85	11.12	69	(2,4,6-Trimethylcyclohexyl) methanol	$C_{10}H_{20}O$	156	9.22	113757
86	11.16	69	1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one	$C_{13}H_{20}O_2$	208	14.0	194131
87	11.35	107	Phenol, 4-ethyl-	$C_8H_{10}O$	122	54.1	113319
88	11.55	94	Benzene, [(1-methyl-2-propenyl)oxy]-	$C_{10}H_{12}O$	148	29.1	62466
89	11.64	41	Hexanedinitrile	$C_6H_8N_2$	108	54.4	290867
90	11.77	41	3-Dodecene, (E)-	$C_{12}H_{24}$	168	6.65	113960
91	11.80	109	(1,3-Dimethyl-2-methylene-cyclopentyl)-methanol	$C_9H_{16}O$	140	9.33	190162
92	11.90	57	Dodecane	$C_{12}H_{26}$	170	7.93	22004
93	11.94	128	Naphthalene	$C_{10}H_8$	128	46.2	114935
94	12.05	116	m-Ethylbenzonitrile	C_9H_9N	131	32.3	118641
95	12.33	121	Phenol, 4-(1-methylethyl)-	$C_9H_{12}O$	136	56.8	229733
96	12.51	44	2H-Azepin-2-one, hexahydro-1-methyl-	$C_7H_{13}NO$	127	33.3	26284
97	12.61	71	Decane, 2,3,5,8-tetramethyl-	$C_{14}H_{30}$	198	7.81	149589
98	12.93	83	Cyclohexanecarboxylic acid, 3-pentadecyl ester	$C_{22}H_{42}O_2$	338	13.3	280600
99	13.29	135	Cyclohexene, 2-ethenyl-1,3,3-trimethyl-	$C_{11}H_{18}$	150	9.42	188124
100	13.39	134	3-(1-Cyclopentenyl)furan	$C_9H_{10}O$	134	8.42	110306
101	13.50	43	2-Undecanethiol, 2-methyl-	$C_{12}H_{26}S$	202	6.34	9094
102	13.57	121	Phenol, 2-(1-methylpropyl)-	$C_{10}H_{14}O$	150	53.8	291506
103	13.62	69	2-Isopropyl-5-methyl-1-heptanol	$C_{11}H_{24}O$	172	7.27	245029
104	13.75	92	Benzene, heptyl-	$C_{13}H_{20}$	176	51.1	118464
105	13.82	142	Naphthalene, 2-methyl-	$C_{11}H_{10}$	142	25.3	291510
106	13.97	91	Benzenebutanenitrile	$C_{10}H_{11}N$	145	83.8	236852
107	14.20	149	Phenol, 2-(1,1-dimethylethyl)-5-methyl-	$C_{11}H_{16}O$	164	16.4	228731
108	14.30	69	1-Dodecanol, 3,7,11-trimethyl-	$C_{15}H_{32}O$	228	4.06	22776
109	14.41	91	8,9-Dimethylbicyclo[4.4.1]undeca-2,4,8-triene	$C_{13}H_{18}$	174	9.12	99687
110	15.07	69	1-Heptatriacotanol	$C_{37}H_{76}O$	536	5.94	127968
111	15.17	121	Cyclopenta[c]pentalen-3(3aH)-one, 1,2,5a,6,7,8-hexahydro-6,6-dimethyl-	$C_{13}H_{18}O$	190	19.7	187653
112	15.28	156	Naphthalene, 1,4-dimethyl-	$C_{12}H_{12}$	156	13.1	39241
113	15.34	121	4'-Butoxyacetophenone	$C_{12}H_{16}O_2$	192	12.5	187579
114	15.46	43	Octadecane, 1-chloro-	$C_{18}H_{37}Cl$	288	7.34	23181
115	15.57	43	5,8,11-Heptadecatriynoic acid, methyl ester	$C_{18}H_{24}O_2$	272	25.4	36076
116	15.81	83	Trichloroacetic acid,	$C_{18}H_{33}Cl_3O_2$	386	5.34	280518

			hexadecyl ester				
117	16.25	83	11-Dodecen-1-ol, 2,4,6-trimethyl-, (R,R,R)-	$C_{15}H_{30}O$	226	4.83	10749
118	16.71	83	Cyclopropanol, 1-(3,7-dimethyl-1-octenyl)-	$C_{13}H_{24}O$	196	5.44	55804
119	18.13	92	Benzene, 1,1'-(1,3-propanediyl)bis-	$C_{15}H_{16}$	196	94.2	133399
120	18.43	105	Benzene, 1,1'-(1-methyl-1,3-propanediyl)bis-	$C_{16}H_{18}$	210	83.2	149665
121	18.76	83	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	$C_{25}H_{48}$	348	3.85	15853
122	21.01	83	tert-Hexadecanethiol	$C_{16}H_{34}S$	258	6.54	234966
123	21.49	55	1-Eicosene	$C_{20}H_{40}$	280	5.25	13488
124	21.69	204	2-Phenylnaphthalene	$C_{16}H_{12}$	204	32.5	113420
125	22.69	83	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	$C_{25}H_{48}$	348	5.98	15853
126	22.90	218	9-Phenyl-5H-benzocycloheptene	$C_{17}H_{14}$	218	30.6	200996
127	24.90	83	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	$C_{25}H_{48}$	348	7.74	15853
128	29.72	306	1,1':3',1''-Terphenyl, 5'-phenyl-	$C_{24}H_{18}$	306	47.5	113345

Mixture of waste none coded polymer resin to oil was analysis by using Perkin Elmer (Model Clarus 500) Gas Chromatography and Mass Spectrometer (GC/MS) and compounds table and chromatogram shown Table 1 and Figure 2. An oil compound was detected from GC/MS chromatogram to compounds retention time (min.) and trace mass (m/z), compounds formula, molecular weight, probability percentage and NIST library number. From product oil to GC/MS detected compounds range shown C_3H_6 to $C_{37}H_{76}O$. GC/MS analysis result showed us product oil has hydrocarbon compounds including alcoholic group, halogenated, oxygen contain, nitrogen content, ester group and aromatics groups. In this analysis result showed some compounds also generated as an ester group which is coming out from additives because polymer manufacturer are adding additives for plastics hard shape or color. Plastics additives are reinforcing fiber, fillers, coupling agent, plasticizers, colorants, stabilizers (halogen stabilizers, antioxidants, ultraviolet absorbers and biological preservatives), processing aids (lubricants, and flow control), flame retardants, peroxide and antistatic agent [23]. Product oil has chlorine content its can use only petroleum refinery process for feed. Analysis data table 1 starting compound is hydrocarbon and compound name is Cyclopropane (C_3H_6) (t= 51.5, m/z=41) and compounds GC/MS probability percentage is 51.5%. Highest number of compounds detected from GC/MS 1-Heptatriacotanol ($C_{37}H_{76}O$) (t=15.07, m/z=69) compound probability percentage is 5.94% and peak intensity is small. In this analysis section some compounds are elaborated base on their retention time, trace mass and GC/MS compounds probability percentage such as Isobutane (C_4H_{10}) (t=1.56, m/z=43) and compound probability percentage is 57.4%, 2-methyl-Butane (C_5H_{12}) (t=1.81, m/z=43) and compound probability percentage is 70.5 %, 3-methyl- 1-Butene (C_5H_{10}) (t=1.98, m/z=55) and compound probability percentage is 16.3 %, tetrahydro-Furan (C_4H_8O) (t=2.84, m/z=42) and compound probability percentage is 89.1%, 2,4-Dimethyl 1,4-pentadiene (C_7H_{12}) (t=3.14, m/z=81) and compound probability percentage is 40.6 %, Heptane (C_7H_{16}) (t=3.71, m/z=43) and compound probability percentage is 49.5 %, 1-bromo- Butane (C_4H_9Br) (t=4.18, m/z=57) and compound probability percentage is 67.8 %, 2-methyl-1-Heptene (C_8H_{16}) (t=5.05, m/z=56) and compound probability percentage is 66.7 %, 2-Octyn-1-ol ($C_8H_{14}O$) (t=5.37, m/z=41) and compound probability percentage is 4.65 %, 2-methyl-5-Hexenenitrile ($C_7H_{11}N$) (t=6.34, m/z=55) and compound probability percentage is 9.60 %, (1-methylethyl)- Benzene (C_9H_{12}) (t=7.45, m/z=105) and compound probability percentage is 54.4 %, propyl- Benzene (C_9H_{12}) (t=8.00, m/z=91) and compound probability percentage is 72.1 %, Phenol (C_6H_6O) (t=8.38, m/z=94) and compound probability percentage is 77.1 %, 4-methyl-

Decane ($C_{11}H_{24}$) (t=8.84, m/z=43) and compound probability percentage is 8.51 %, 1,2,3,5-tetrahydro-1,3-Methanopentalene (C_9H_{10}) (t=9.45, m/z=117) and compound probability percentage is 14.3 %, 5-Ethyl-1-nonene ($C_{11}H_{22}$) (t=10.06, m/z=43) and compound probability percentage is 3.26 %, 4-ethyl-Phenol ($C_8H_{10}O$) (t=10.89, m/z=107) and compound probability percentage is 30.8 %, [(1-methyl-2-propenyl)oxy]- Benzene ($C_{10}H_{12}O$) (t=11.55, m/z=94) and compound probability percentage is 29.1 %, Naphthalene ($C_{10}H_8$) (t=11.94, m/z=128) and compound probability percentage is 46.2 %, 2,3,5,8-tetramethyl- Decane ($C_{14}H_{30}$) (t=12.61, m/z=71) and compound probability percentage is 7.81 %, 2-Isopropyl-5-methyl-1-heptanol ($C_{11}H_{24}O$) (t=13.62, m/z=69) and compound probability percentage is 7.27 %, 3,7,11-trimethyl-1-Dodecanol ($C_{15}H_{32}O$) (t=14.30, m/z=69) and compound probability percentage is 4.06 %, 1,4-dimethyl- Naphthalene ($C_{12}H_{12}$) (t=15.28, m/z=156) and compound probability percentage is 13.1 %, hexadecyl ester Trichloroacetic acid ($C_{18}H_{33}Cl_3O_2$) (t=15.81, m/z=83) and compound probability percentage is 5.34 %, bis-1,1'-(1,3-propanediyl) Benzene ($C_{15}H_{16}$) (t=18.13, m/z=92) and compound probability percentage is 94.2 %, 1-Eicosene ($C_{20}H_{40}$) (t=21.49, m/z=55) and compound probability percentage is 5.25 %, 1-cyclopentyl-4-(3-cyclopentylpropyl)-Dodecane ($C_{25}H_{48}$) (t=22.69, m/z=83) and compound probability percentage is 5.98 %, 5'-phenyl-1,1':3',1''-Terphenyl ($C_{24}H_{18}$) (t=29.72, m/z=306) and compound probability percentage is 47.5 % respectively. Product fuel has phenol group compounds, furan, chlorinated, brominates groups compound this types compounds need remove or separate by refinery process for that reason this appropriate for petroleum refinery feed.

5. Conclusion

Thermal degradation process and petroleum oil recover from 10 types of waste polymer resin experiment was performing without catalyst. Experiment mass balance analysis result showed liquid fuel percentage is 49.18 % and gas percentage is 9.91 % and solid black residue percentage is 40.91 %. Conversion rate is 59.09% by weight and rest of percentage are coming out as a residue. From this experiment conclude that recycling company provided waste polymer resin has high percentage of additives. Because polymer additives are coming out as a residue after finish the experiment. Residue can be use as roof carpeting because collected solid residue is hard and black color. Product oil density is 0.91 g/ml and oil is ignited and outlook was little thick. Fuel has aliphatic group, aromatics group, halogen content, oxygen content, nitrogen content compounds. Aromatics groups are Benzene, Toluene, Ethylbenzene, Styrene, 1,3-dimethyl-Benzene, 1-ethyl-3-methyl-Benzene, 1-ethyl-2-methyl-Benzene, Phenol, α-Methylstyrene, 3-methyl- Phenol, 1,4-dimethyl-Naphthalene etc. Some toxic compounds also present in this oil for that reason fuel can use only refinery process for further modification and make it appropriated for combustion engines. By using this technology polymer waste resin can convert into valuable oil for petroleum refinery feed and save environmental problem.

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