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Research Article

Crude Oil Production for Refinery Petroleum Industry from All Kind of Polymer Waste Using Ferric Oxide (Fe_2O_3) Catalyst

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Abstract

Thermal degradation was studied as a method to decompose mixtures of all kind of polymer waste including tire and the aim was to produce liquid crude oil. Polymer waste mixture was used randomly with 2% Ferric Oxide catalyst. The experiment was performed at a laboratory scale in batch process under fume hood and the experiment was fully in a closed system. Experimental temperature range was 200-430 ºC and Pyrex glass reactor was also in use. Produce oil's density was 0.78 g/ml. Perkin Elmer GC/MS was use for oil analysis purpose and it produced oil carbon chain detected C_3-C_{28}. In the laboratory experiment crude oil conversion rate was 62.13%, light gas 10%, and solid black residue was 27.87 %. Produced oil color was dark brown and crude oil can be used for petroleum refinery process for further modification.

Keywords: waste plastics, thermal degradation, crude oil, municipal, conversion, GC/MS, polymer waste

1. Introduction

Municipal waste plastic represents about 8 wt% of the municipal solid waste and it generally consists of mixture of different kind of plastics: 40.5 wt% HDPE and L/LDPE, 19.6 wt% PP, 11.9 wt% PS/EPS, 10.7 wt% PVC, 8.1 wt% PET, and about 5 wt% ABS and 4.2 wt% other polymers [1]. Polyethylene terephthalate (PET) is the most important polyester resin currently produced because of its excellent mechanical and chemical properties [2]. Since PET also presents low permeability to gases and solvents, it is a potential corrosion barrier. This polymer is derived commercially from reaction between terephthalic acid and ethyleneglycol [3] and its properties depend on its molecular weight, molecular structure, crystallinity and the presence of impurities [4]. Pyrolysis is one of the best methods to recover the material and energy from polymer waste, as only about 10% of the energy content of the waste plastic is used to convert the scrap into valuable hydrocarbon products [5].

Thermal degradation of ABS gives oils with high content of benzene derivatives (toluene, ethylbenzene, styrene, cumene, and α-methylstyrene) but also containing significant amount of organic nitrogen as aliphatic and aromatic nitriles or nitrogen containing heterocyclic compounds. The amount and distribution of these compounds strongly depends on the thermal or catalytic conditions used for degradation [6, 7]. It was also found that ABS and its brominated flame retardant affect the thermal degradation of PE and PS in mixtures [8]. There have been many reports on the pyrolysis of PVC alone [9–12] or mixed with other polymers [13, 14]. Inorganic and organic compounds are formed during the initial stages of the process [15, 16] but the amount of chlorine in pyrolysis oil can be decreased by catalytic procedures [17]. Generally, the PET is separated from waste plastic and recycled individually by physical methods or chemical (solvolysis) procedures to produce monomers [18]. However, PET is widely used together with PE or PP as laminated sheets in various applications. Separation of PET from laminated sheets is difficult by any separation process therefore this polymer has to be considered as a possible component of complex polymer mixtures that are treated valorised by pyrolysis. Various studies showed that thermal degradation of PET gives mainly gases and carbonaceous residue, with different compounds that are formed depending on the degradation temperature, atmosphere and experimental technique [19–24].

2. Materials

Raw material was collected from local city and collected raw materials was mixture of plastic was such as HDPE, LDPE, PP, PS, PVC, PETE, rubber, gloves, tire, non coded waste plastics etc. All collected polymer waste was cut into small pieces for reactor setup. Collected waste polymer mixture did not wash because experimental main goal was all kind of polymer waste to crude oil production. Mixture polymer waste was randomly mix and it was not proportional or percentage wise. Crude oil production purposed polymer waste doesn't need to wash and without wash polymer waste can convert into crude oil. Ferric Oxide catalyst was collected from VWR.COM Company.

3. Process Description

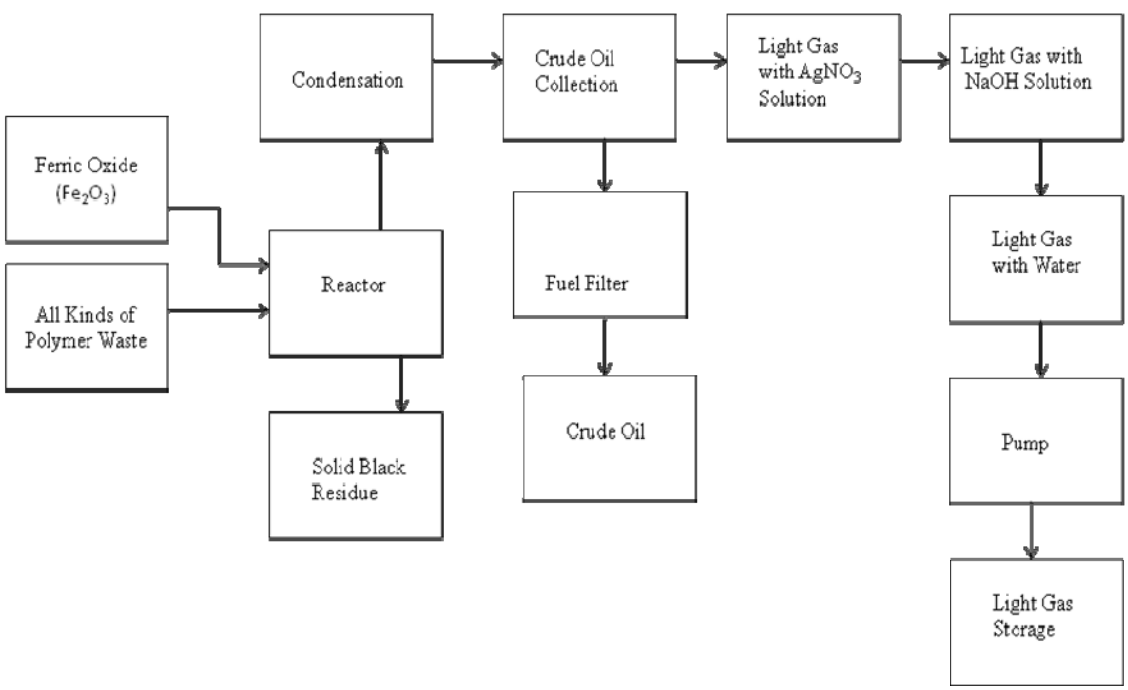

Figure 1: All kind of polymer waste to crude oil production diagram

Mixture of polymer waste and Ferric Oxide mixture transfer into reactor chamber for liquefaction process. For experimental purpose 2% Ferric Oxide was use as a catalyst. Randomly mixture of polymer was low density polyethylene, high density polyethylene, polypropylene, polystyrene, polyvinyl chloride, polyethylene terepthalate, rubber, tire, gloves, non coded waste plastics etc. experiential purpose polymer sample was use 75 gm by weight. Experiment reactor setup (Figure 1) was properly with condensation unit, collection tank, and light gas cleaning with $AgNO_3$ solution, $NaHCO_3$ solution, waste tank, small pump, storage tank for light gas, oil filter system and final crude oil collection tank. Every connection was properly to prevent gas loss during crude oil production. For experimental purpose temperature range was 200-430 ºC and high temperature tolerable vacuum grease was using all connection. Experiment start temperature 200 ºC and temperature was increase slowly step by step based on production until finished the experiment. An initial raw material has PVC, PET and PVC has 56% chlorine content and PET has 34% Oxygen content. Chlorine content are creating hydrochloric acid during conversion time and oxygen content present PET blocking some portion of condensation pipe. Both waste plastics are creating problem during oil production and produce oil has also chlorine content. In this experiment main goal was mixture polymer waste to crude oil production with Ferric Oxide catalyst. During crude oil production period light gas generated from all kind of polymer mixture waste and light gas was cleaned with $AgNO_3$ and solution normality was 0.25(N). Light gas passed through also NaOH solution and solution normality was 0.25 (N) and finally light gas was passed through with waste tank then light gas was store into Teflon bag by using small pump. Produce crude oil was filtered by micron filter then transfer into separate container for analysis purpose. Crude oil density is 0.78 g/ml and crude oil conversion rate was 62.13 %, light gas conversion rate was 10 % and solid black residue was 27.87 %. Mass balance calculation showed 75 gm initial polymer sample to crude oil 46.6 gm, light gas converted 7.5 gm and solid black residue was 20.9 gm. Residue percentage was high because in raw materials was polymer PVC, PETE, rubber and Tire mixture. PVC and PET and tire have high percentage of additives all percentage was not convert into crude oil. Total experiment run time was 4-5 hours and crude oil color was dark brown. Residue was take out from reactor chamber and keep into separate container for analysis purpose.

4. Result and Discussion

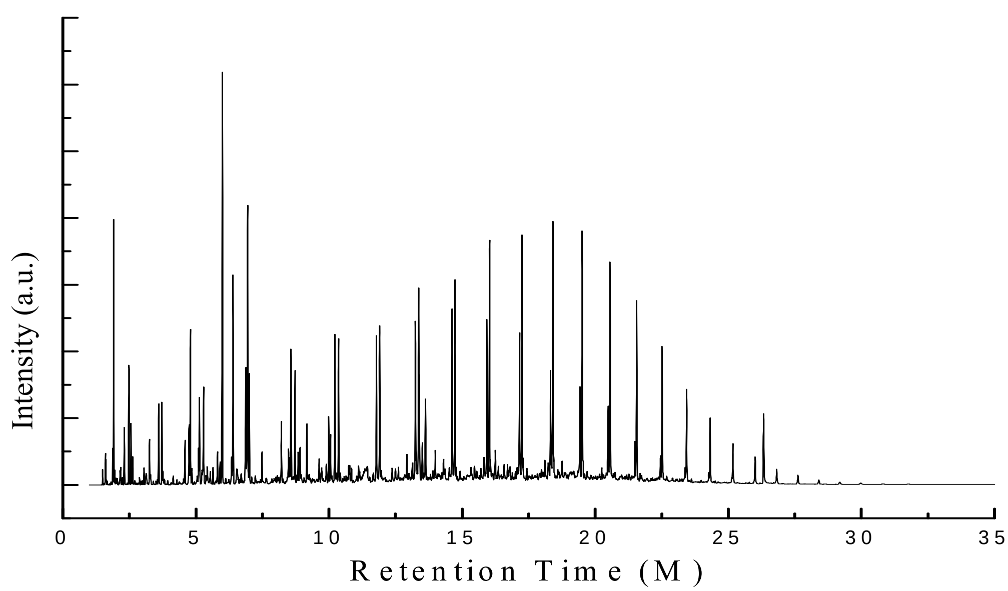

Figure 2: GC/MS Chromatogram of all kind of polymer waste to crude oil

Table 1: GC/MS Chromatogram compounds list of all kind of polymer waste to crude 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	Propene	C_3H_6	42	33.7	50
2	1.56	43	Isobutane	C_4H_{10}	58	74.4	61289
3	1.60	41	1-Propene, 2-methyl-	C_4H_8	56	28.7	61293
4	1.61	43	Butane	C_4H_{10}	58	74.2	18940
5	1.63	41	2-Butene	C_4H_8	56	32.6	61292
6	1.75	55	1-Butene, 3-methyl-	C_5H_{10}	70	23.6	160477
7	1.87	42	Cyclopropane, ethyl-	C_5H_{10}	70	24.7	114410
8	1.91	43	Pentane	C_5H_{12}	72	82.1	229281
9	1.95	55	2-Pentene	C_5H_{10}	70	18.0	19079
10	2.18	57	Propane, 2-chloro-2-methyl-	C_4H_9Cl	92	85.3	107667
11	2.31	43	Pentane, 2-methyl-	C_6H_{14}	86	64.5	61279
12	2.48	56	1-Hexene	1-Hexene	84	24.3	227613
13	2.56	57	Hexane	C_6H_{14}	86	84.3	61280
14	2.63	69	2-Butene, 2,3-dimethyl-	C_6H_{12}	84	16.4	289588
15	2.71	55	3-Hexene, (Z)-	C_6H_{12}	84	30.4	114381
16	2.88	56	Cyclopentane, methyl-	C_6H_{12}	84	52.2	114428
17	2.94	67	1,3-Pentadiene, 2-methyl-, (E)-	C_6H_{10}	82	14.8	113652
18	3.05	56	1-Pentene, 2,4-dimethyl-	C_7H_{14}	98	64.4	114435
19	3.13	67	Cyclopentene, 3-methyl-	C_6H_{10}	82	12.3	114408
20	3.26	78	Benzene	C_6H_6	78	69.4	114388
21	3.30	41	Butane, 2-chloro-2-methyl-	$C_5H_{11}Cl$	106	51.0	58840
22	3.40	43	Hexane, 3-methyl-	C_7H_{16}	100	59.4	231738
23	3.50	67	Cyclohexene	C_6H_{10}	82	24.3	114431
24	3.55	56	1-Hexene, 2-methyl-	C_7H_{14}	98	29.3	114433
25	3.60	56	1-Heptene	C_7H_{14}	98	36.1	107734
26	3.72	43	Heptane	C_7H_{16}	100	74.2	61276
27	3.76	81	1,3-Pentadiene, 2,4-dimethyl-	C_7H_{12}	96	30.2	114450
28	3.82	55	2-Heptene	C_7H_{14}	98	31.5	160628
29	3.94	81	3-Hepten-1-ol	$C_7H_{14}O$	114	10.2	113238
30	4.07	67	1,4-Heptadiene	C_7H_{12}	96	20.3	113639
31	4.14	55	Cyclohexane, methyl-	C_7H_{14}	98	64.6	118503
32	4.20	59	2-Pentanol, 2-methyl-	$C_6H_{14}O$	102	27.9	19883
33	4.29	69	Cyclopentane, ethyl-	C_7H_{14}	98	32.3	940
34	4.37	55	3-Hepten-1-ol	$C_7H_{14}O$	114	13.1	113238
35	4.43	81	Cyclohexane, methylene-	C_7H_{12}	96	16.7	19641
36	4.59	41	Pentane, 2-chloro-2-methyl-	$C_6H_{13}Cl$	120	60.5	114640
37	4.75	43	Heptane, 4-methyl-	C_8H_{18}	114	61.7	113916
38	4.79	91	Toluene	C_7H_8	92	53.5	291301
39	4.85	81	Cyclopropane, trimethylmethylene-	C_7H_{12}	96	14.4	63085
40	5.09	70	Heptane, 3-methylene-	C_8H_{16}	112	57.9	288517
41	5.13	55	1-Octene	C_8H_{16}	112	29.6	1604
42	5.23	55	3-Heptene, 3-methyl-	C_8H_{16}	112	23.9	113088
43	5.29	43	Octane	C_8H_{18}	114	40.7	61242

44	5.38	55	2-Octene, (Z)-	C_8H_{16}	112	18.8	113889
45	5.43	70	2-Hexene, 3,5-dimethyl-	C_8H_{16}	112	13.4	149385
46	5.54	83	Cyclopentane, 1,1,3,4-tetramethyl-, cis-	C_9H_{18}	126	8.54	27589
47	5.64	43	Heptane, 2,4-dimethyl-	C_9H_{20}	128	25.1	155382
48	5.81	83	2,3-Dimethyl-3-heptene	C_9H_{18}	126	21.7	113493
49	5.91	69	Cyclohexane, 1,3,5-trimethyl-	C_9H_{18}	126	25.2	114702
50	5.99	43	2,4-Dimethyl-1-heptene	C_9H_{18}	126	60.1	113516
51	6.34	69	Cyclohexane, 1,3,5-trimethyl-, (1α,3α,5β)-	C_9H_{18}	126	31.0	2480
52	6.40	91	Ethylbenzene	C_8H_{10}	106	62.1	158804
53	6.54	91	Cyclohexanol, 1-ethynyl-, carbamate	$C_9H_{13}NO_2$	167	31.6	313023
54	6.88	43	2,3,3-Trimethyl-1-hexene	C_9H_{18}	126	4.88	113521
55	6.94	104	Styrene	C_8H_8	104	43.4	291542
56	7.01	43	Nonane	C_9H_{20}	128	34.4	228006
57	7.10	55	4-Nonene	C_9H_{18}	126	13.6	113904
58	7.23	55	3-Octyne, 2-methyl-	C_9H_{16}	124	4.55	62452
59	7.33	95	Cyclohexene, 3-methyl-6-(1-methylethyl)-	$C_{10}H_{18}$	138	17.3	150127
60	7.42	95	2-Methylbicyclo[3.2.1]octane	C_9H_{16}	124	6.13	215280
61	7.48	105	Benzene, (1-methylethyl)-	C_9H_{12}	120	50.5	228742
62	7.64	55	Cyclohexane, propyl-	C_9H_{18}	126	18.5	249350
63	7.86	67	1,3-Methanopentalene, 1,2,3,5-tetrahydro-	C_9H_{10}	118	16.8	221371
64	8.21	55	Heptane, 3-chloro-3-methyl-	$C_8H_{17}Cl$	148	66.9	114670
65	8.26	105	Benzene, 1-ethyl-3-methyl-	C_9H_{12}	120	12.2	228743
66	8.48	118	α-Methylstyrene	C_9H_{10}	118	34.6	30236
67	8.53	103	Benzonitrile	C_7H_5N	103	42.1	118644
68	8.57	41	1-Decene	$C_{10}H_{20}$	140	12.0	107686
69	8.72	57	Decane	$C_{10}H_{22}$	142	32.0	291484
70	8.80	55	cis-3-Decene	$C_{10}H_{20}$	140	14.2	113558
71	8.84	71	Octane, 3,3-dimethyl-	$C_{10}H_{22}$	142	12.1	61706
72	8.91	43	Decane, 4-methyl-	$C_{11}H_{24}$	156	10.8	5261
73	9.17	57	1-Hexanol, 2-ethyl-	$C_8H_{18}O$	130	68.2	114109
74	9.63	83	2-Undecanethiol, 2-methyl-	$C_{12}H_{26}S$	202	6.18	9094
75	9.73	43	Benzeneacetic acid, 3-tetradecyl ester	$C_{22}H_{36}O_2$	332	7.33	282025
76	9.90	105	Benzene, 1-(chloromethyl)-2-methyl-	C_8H_9Cl	140	37.1	125059
77	9.99	69	Cyclooctane, 1,4-dimethyl-, trans-	$C_{10}H_{20}$	140	3.39	61408
78	10.22	41	Cyclopropane, 1-heptyl-2-methyl-	$C_{11}H_{22}$	154	6.19	62622
79	10.29	55	2,4-Pentadien-1-ol, 3-pentyl-, (2Z)-	$C_{10}H_{18}O$	154	3.85	142197
80	10.36	57	Undecane	$C_{11}H_{24}$	156	32.0	114185
81	10.42	55	3-Undecene, (Z)-	$C_{11}H_{22}$	154	14.1	142598
82	10.78	119	Benzene, (1-azido-1-	$C_9H_{11}N_3$	161	51.7	31549

			methylethyl)-				
83	10.91	55	1-Cyclohexylheptene	$C_{13}H_{24}$	180	5.24	214976
84	11.04	55	2-Undecenal	$C_{11}H_{20}O$	168	4.01	6431
85	11.12	69	(2,4,6-Trimethylcyclohexyl) methanol	$C_{10}H_{20}O$	156	14.0	113757
86	11.45	105	Heptanediamide, N,N'-di-benzoyloxy-	$C_{21}H_{22}N_2O_6$	398	12.1	253264
87	11.53	105	Benzenepropanoic acid, 10-undecenyl ester	$C_{20}H_{30}O_2$	302	27.1	281790
88	11.78	41	1-Dodecene	$C_{12}H_{24}$	168	9.60	107688
89	11.91	57	Dodecane	$C_{12}H_{26}$	170	35.7	291499
90	11.96	55	3-Dodecene, (E)-	$C_{12}H_{24}$	168	11.2	70642
91	12.50	57	Decane, 2,3,5,8-tetramethyl-	$C_{14}H_{30}$	198	9.19	149589
92	12.60	43	2-Hexyl-1-octanol	$C_{14}H_{30}O$	214	6.54	113807
93	12.93	83	E-2-Hexadecacen-1-ol	$C_{16}H_{32}O$	240	4.58	131101
94	13.14	55	4-Tetradecene, (Z)-	$C_{14}H_{28}$	196	3.36	142624
95	13.25	55	1-Tridecene	$C_{13}H_{26}$	182	11.3	107768
96	13.37	57	Tridecane	$C_{13}H_{28}$	184	15.3	107767
97	13.99	69	Trichloroacetic acid, hexadecyl ester	$C_{18}H_{33}Cl_3O_2$	386	2.60	280518
98	14.63	55	3-Tetradecene, (Z)-	$C_{14}H_{28}$	196	5.63	62806
99	14.73	57	Tetradecane	$C_{14}H_{30}$	198	42.0	113925
100	15.93	55	1-Pentadecene	$C_{15}H_{30}$	210	8.85	69726
101	16.03	57	Pentadecane	$C_{15}H_{32}$	212	28.0	107761
102	17.16	55	1-Hexadecene	$C_{16}H_{32}$	224	10.2	69727
103	17.25	57	Hexadecane	$C_{16}H_{34}$	226	39.6	114191
104	18.32	55	8-Heptadecene	$C_{17}H_{34}$	238	6.26	107001
105	18.41	57	Heptadecane	$C_{17}H_{36}$	240	27.1	107308
106	19.43	55	E-15-Heptadecenal	$C_{17}H_{32}O$	252	6.48	130979
107	19.51	57	Nonadecane	$C_{19}H_{40}$	268	15.9	114098
108	20.48	55	9-Nonadecene	$C_{19}H_{38}$	266	8.36	113627
109	20.56	57	Nonadecane	$C_{19}H_{40}$	268	30.2	114098
110	21.49	55	1-Nonadecene	$C_{19}H_{38}$	266	5.38	113626
111	21.56	57	Eicosane	$C_{20}H_{42}$	282	23.3	290513
112	22.45	55	10-Heneicosene (c,t)	$C_{21}H_{42}$	294	9.10	113073
113	22.51	57	Heneicosane	$C_{21}H_{44}$	296	31.9	107569
114	23.38	55	1-Docosene	$C_{22}H_{44}$	308	14.7	113878
115	23.43	57	Heneicosane	$C_{21}H_{44}$	296	14.1	107569
116	24.27	55	1-Docosene	$C_{22}H_{44}$	308	11.6	113878
117	24.32	57	Heneicosane	$C_{21}H_{44}$	296	9.63	107569
118	25.17	57	Tetracosane	$C_{24}H_{50}$	338	11.4	248196
119	26.01	57	Heneicosane	$C_{21}H_{44}$	296	9.11	107569
120	26.33	149	1,2-Benzenedicarboxylic acid, diisooctyl ester	$C_{24}H_{38}O_4$	390	42.6	113206
121	26.82	57	Octacosane	$C_{28}H_{58}$	394	10.6	149865

Polymer waste to crude oil (Figure 2 and Table 1) was analyzed by Perkin Elmer Gas Chromatography and Mass Spectrometer with auto sampler system. GC/MS Chromatogram was analyzed with Turbo mass softer and compounds library followed NIST. Compounds was detected from chromatogram based on peak retention time (t) and peak intensity trace mass (m/z). Analyzing crude oil compounds showed produce has chlorine containing compounds or halogenated compounds, aromatic group, aliphatic group, alcoholic group, oxygen containing compounds, sulfur containing compounds and nitrogen containing compounds. Some compounds are described from the table above in this analysis section and showed initial compounds were Propene (C_3H_6) (t=1.49, m/z=41) compound molecular weight is 42 and compound probability percentage is 33.7 %, then rest of compounds was appeared base on retention time and trace mass such as Butane (C_4H_{10}) (t=1.61, m/z=43) compound molecular weight is 58 and compound probability percentage is 74.2%, Pentane (C_5H_{12}) (t=1.91, m/z=43) compound molecular weight is 72 and compound probability percentage is 82.1 %, Hexane (C_6H_{14}) (t=2.56, m/z=57) compound molecular weight is 86 and compound probability percentage is 84.3 %, 2,4-dimethyl-1-Pentene (C_7H_{14}) (t=3.05, m/z=56) compound molecular weight is 98 and compound probability percentage is 64.4 %, 2-chloro-2-methyl- Butane ($C_5H_{11}Cl$) (t=3.30, m/z=41) compound molecular weight is 106 and compound probability percentage is 51.0 %, Heptane (C_7H_{16}) (t=3.72, m/z=43) compound molecular weight is 100 and compound probability percentage is 74.2 %, 3-Hepten-1-ol ($C_7H_{14}O$) (t=3.94, m/z=81) compound molecular weight is 114 and compound probability percentage is 10.2 %, ethyl-Cyclopentane (C_7H_{14}) (t=4.29, m/z=69) compound molecular weight is 98 and compound probability percentage is 32.3 %, 2-chloro-2-methyl- Pentane ($C_6H_{13}Cl$) (t=4.59, m/z=41) compound molecular weight is 120 and compound probability percentage is 60.5 %, Toluene (C_7H_8) (t=4.79, m/z=91) compound molecular weight is 92 and compound probability percentage is 53.5 %, Octane (C_8H_{18}) (t=5.29, m/z=43) compound molecular weight is 114 and compound probability percentage is 40.7 %, 2,4-dimethyl-Heptane (C_9H_{20}) (t=5.64, m/z=43) compound molecular weight is 128 and compound probability percentage is 25.1 %, 2,4-Dimethyl-1-heptene (C_9H_{18}) (t=5.99, m/z=43) compound molecular weight is 126 and compound probability percentage is 60.1 %, Ethylbenzene (C_8H_{10}) (t=6.40, m/z=91) compound molecular weight is 106 and compound probability percentage is 62.1 %, Styrene (C_8H_8) (t=6.94, m/z=104) compound molecular weight is 104 and compound probability percentage is 43.4 %, 1-methylethyl-Benzene (C_9H_{12}) (t=7.48, m/z=105) compound molecular weight is 120 and compound probability percentage is 50.5 %, α-Methylstyrene (C_9H_{10}) (t=8.48, m/z=118) compound molecular weight is 118 and compound probability percentage is 34.6 %, Benzonitrile (C_7H_5N) (t=8.53, m/z=103) compound molecular weight is 103 and compound probability percentage is 42.1 %, 2-ethyl-1-Hexanol ($C_8H_{18}O$) (t=9.17, m/z=57) compound molecular weight is 130 and compound probability percentage is 68.2 %, 2-methyl-2-Undecanethiol ($C_{12}H_{26}S$) (t=9.63, m/z=83) compound molecular weight is 202 and compound probability percentage is 6.18%, (2Z)-3-pentyl-2,4-Pentadien-1-ol ($C_{10}H_{18}O$) (t=10.29, m/z=55) compound molecular weight is 154 and compound probability percentage is 3.85 %, 1-azido-1-methylethyl- Benzene ($C_9H_{11}N_3$) (t=10.78, m/z=119) compound molecular weight is 161 and compound probability percentage is 51.7 %, Dodecane ($C_{12}H_{26}$) (t=11.91, m/z=57) compound molecular weight is 170 and compound probability percentage is 35.7 %, E-2-Hexadecacen-1-ol ($C_{16}H_{32}O$) (t=12.93, m/z=83) compound molecular weight is 240 and compound probability percentage is 4.58 %, Tetradecane ($C_{14}H_{30}$) (t=14.73, m/z=57) compound molecular weight is 198 and compound probability percentage is 42.0%, Pentadecane ($C_{15}H_{32}$) (t=16.03, m/z=57) compound molecular weight is 212 and compound probability percentage is 28.0 %, Hexadecane ($C_{16}H_{34}$) (t=17.25, m/z=57) compound molecular weight is 226 and compound probability percentage is 39.6 %, Nonadecane ($C_{19}H_{40}$) (t=19.51, m/z=57) compound molecular weight is 268 and compound probability percentage is 15.9 %, Eicosane ($C_{20}H_{42}$) (t=21.56, m/z=57) compound molecular weight is 282 and compound probability percentage is 23.3 %, 1-Docosene ($C_{22}H_{44}$) (t=24.27, m/z=55) compound molecular weight is 308 and compound probability percentage is 11.6 %, Tetracosane ($C_{24}H_{50}$) (t=25.17, m/z=57) compound molecular weight is 338 and compound probability percentage is 11.4 %, Octacosane ($C_{28}H_{58}$) (t=26.82, m/z=57) compound molecular weight is 394 and compound probability percentage is10.6 % respectively. Produce light gas and black residue analysis under investigation. Crude oil has chlorine compounds for that reason before use any internal combustion engines oil need to be modified by using petroleum refinery process. This oil can be use for internal combustion engine and electricity generation or feed power plant.

5. Conclusion

Polymer waste and tire mixture to crude oil production was a process with Ferric Oxide at temperature range was 200-430 ºC. All kind of polymer waste and motor vehicle tire, rubber, gloves etc was as an initial raw materials but raw materials was not proportional. Produced crude oil was dark brown in color and it was ignite. Conversion rate was 72.13% including light gas and rest of percentage was residue. GC/MS analysis result showed hydrocarbon chain range C_3-C_{28} including other types of compounds. An aromatic compound was detected from produce oil because initial materials were mix with PS, PVC and tire. Produced oil presented aromatics groups were Benzene, Toluene, Ethylbenzene, Styrene, α-Methylstyrene, 1-methylethyl-Benzene, 1-chloromethyl-2-methyl-Benzene, 1-azido-1-methylethyl-Benzene and so on. Produce oil has chlorine compounds and chlorine compounds need to be removed by using refinery process for internal combustion engine. Crude oil can use petroleum refinery process as feed stock. All kinds of polymer waste and tire can convert into crude oil using the technology and reduce land fill problem.

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