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Research article

Waste Plastics Mixture of Polystyrene and Polypropylene into Light Grade Fuel using Fe_2O_3 Catalyst

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Abstract

Polypropylene and polystyrene waste plastic mixture to light grade fuel recover was under laboratory scale at temperature range was 180 - 430 ºC. Light grade fractional fuel collection column temperature was 65 ºC. Pyrex glass reactor and Pyrex fractional column was use in the experiment. Polypropylene 125gm and polystyrene 125 gm waste plastics mixture sample was use in the experiment. For experimental purpose total 250 gm sample was use by weight and Ferric Oxide catalyst was use 5% by weight. Total experiment run time was 5.25 hours. Product fuel density is 0.72 g/ml and fuel color is light yellow and fully transparent. GC/MS and FT-IR analytical tools were use for light grade fuel analysis purpose. GC/MS chromatogram analysis result showed product fuel hydrocarbon compounds range C_4 to C_{15}. FT-IR spectrum 100 analysis results showed product functional group such as C-CH_3, C-C= - C-C= -CH, CH_3, -CH=CH_2 and so on. Product fuel has aromatic related hydrocarbon compounds such as Benzene (C_6H_6), Toluene (C_7H_8), Ethylbenzene (C_8H_{10}), Styrene (C_8H_8), and so on. Light grade fuel can use internal combustion engines and its can produce electricity or feed for refinery industry.

Keywords: polypropylene, polystyrene, fuel, waste plastics, ferric oxide, hydrocarbon

Introduction

Recently recycling of waste plastics have received much attention all over the world because of serious environmental problems caused by waste plastics, as well as their potential for use as resources. Among the various recycling methods of waste plastics, thermal or catalytic degradation of waste plastics to fuel oil and valuable chemicals is regarded as the most promising method to realize commercial use [1-2]. Polyethylene (PE), polypropylene (PP) and polystyrene (PS) are the major plastics in MW, with chlorinated polymers such as poly (vinyl chloride) (PVC) present in small amounts. The pyrolysis of these materials has been carefully studied. Mechanisms for the pyrolysis and decomposition rates of PE [3, 4], PP [3, 5], PS [3, 6] and PVC [7–10] have been reported. The conversion of waste plastics into fuel represents a sustainable way for the recovery of the organic content of the polymeric waste and also preserves valuable petroleum resources in addition to protecting the environment [11]. The worlds limited reserve of coal, crude oil and natural gas places a great pressure on mankind to preserve its existing non-renewable materials. Among the various recycling methods for the waste plastics, the feedstock recycling has been found to be a promising technique. There are a lot of research [11–21] in progress on the pyrolysis and utilization of pyrolysis products for various applications [22]. Uddin et al. reported the thermal and catalytic degradation of high impact polystyrene containing brominated flame retardant (HIPS-Br), which involved simultaneous dehalogenation to produce halogen free liquid products, i.e., a potential fuel oil [23].

Brebu et al. [24–27] reported the thermal and catalytic decomposition of ABS copolymers and the distribution of nitrogen containing compounds in the degradation products. It is well known that N present in coal derived liquids and shale oil can lead to the corrosion of engine parts and the formation of harmful compounds such as HCN or NOx when these oils are used as fuels [28]. Some of these problems could be reduced in the case of synthetic oils obtained from polymer waste if the degradation is conducted under suitable conditions. Currently, the most common densification process to manufacture d-RDF commercially is pelletizing [29]. Pelletizing usually requires heating of the waste materials and accurate control of moisture, making the process energy-intensive, costly and complicated. The density of the products—pellets —is in the range of 0.4–0.7 grcm3 on wet basis [30]. In early 1970s, Wolf and Sosnovsky [31] conducted a study of high-pressure compaction and baling of MSW under the sponsorship of US Environmental Protection Agency. A three-stroke press was used in their tests. The pressure in the press was limited to 24 MPa; the compacts made of many types of waste components including paper were weak and easy to disintegrate [32]. The processing of this waste has become a technological issue that has attracted the attention of researchers. Presently, the most conventional way of handling these waste streams is to incinerate them with energy recovery or to use them for landfill. However, both landfill and incineration cause secondary pollution problems. Novel disposal technologies are in high demand by the industry and the regulators to provide for more energy efficient and environmentally and economically sound solutions. An alternative to landfill and incineration is pyrolysis or gasification. Pyrolysis has been extensively studied to recover feed stocks for the petrochemical industry [33–36], but the production of large amounts of char and tars, which are difficult to handle, limits its application. The gasification process can convert solid or liquid hydrocarbon feed stocks into a synthesis gas that is suitable for use in electricity production or for the manufacture of chemicals, hydrogen or transportation fuels [37-38].

Materials

Polypropylene waste plastic and polystyrene waste plastic were collected from Natural State Research office dining section. Both waste plastics were food container and food was stick with both plastics surface. Food particle was clean with liquid soap and water inside laboratory sink system by manually. Hard shape waste was cut into small pieces using scissor and placed into reactor chamber. Ferric Oxide (Fe_2O_3) catalyst was collected from VWR Company and it was red color powder shape. 250 gm waste plastic was use with 50:50 ratio and 12.5 gm red color Ferric Oxide catalyst was use for the experiment.

Experimental Process

Thermal degradation and catalytically process was applied with polypropylene and polystyrene waste plastics mixture and temperature range was 180 - 430 ºC. Laboratory scale batch process was setup under laboratory fume hood without vacuum system. Experimental process setup is shown figure 1 for visual understanding. For experimental setup purpose accessories, equipment and required materials was waste plastics (PP and PS mixture), ferric oxide catalyst, Pyrex glass reactor, heat mental with temperature controller, Pyrex glass fractional column, vacuum grease for joint, clamp for joint, heating pad, insulator for reactor cover, fraction fuels collation container, sodium hydroxide and sodium bicarbonate solution (0.5 N), small pump, Teflon bag, residue collection container, fuel purification device, sediment container. All accessories and part was connected one to another properly and tighten enough to prevent gas loss during production period. Electrical heat was applied in the experiment and temperature was controlled by variac meter. The experiment main goal was light fraction fuel collection from polypropylene and polystyrene waste plastics mixture and percentage determination in the laboratory scale. Waste plastic mixture and ferric oxide catalyst place into reactor chamber for liquefaction process. Experiment start was 180 ºC to up to 430 ºC until finish the whole materials conversion into fuels. Light grade fraction fuel was collected at 65 ºC and it was low hydrocarbon range compounds. This process was fully close system and it was running under laboratory fume hood. Waste plastics heated up and start to melted then produce liquid slurry, liquid slurry turn into vapor then vapor travel thorough fractional column. Light boiling point compounds vapor collecting as a light grade fraction fuel at 65 º C temperatures. In this experiment other grade fuels also collected but our main goal was light grade fraction fuel collation and percentage determination. Experimental procedure showed up liquid NaOH and $NaHCO_3$ was use for cleaning light gas which was not condensed. All hydrocarbons are not condensed because starting hydrocarbon C_1 to C_4 has negative boiling point temperature which is not condensed normal temperature. Negative boiling point hydrocarbon compounds are methane, ethane, propane and butane. Clean lighter gas was storage into Teflon bag using small pump system. Collected all fuel was separated in to different container and calculated mass balance for light grade fraction fuel percentage was 14%. Rest of other percentage was other grade fuels, residue and light gas. Collected fuel was cleaned by RCI technology provide RCI fuel purification system with micron filter. Cleaned fuel density is 0.72 g/ml and it is crystal clear. 250 g mixture of PP and PS waste plastics to light grade fuel was recovery 35 g. In the laboratory scale process showed 14% light grade fractional fuel produce with 5% ferric oxide catalyst. Total experiment run time was 5.25 hours. Ferric Oxide catalyst recovers under investigation. Light gas and residue analysis is under investigation.

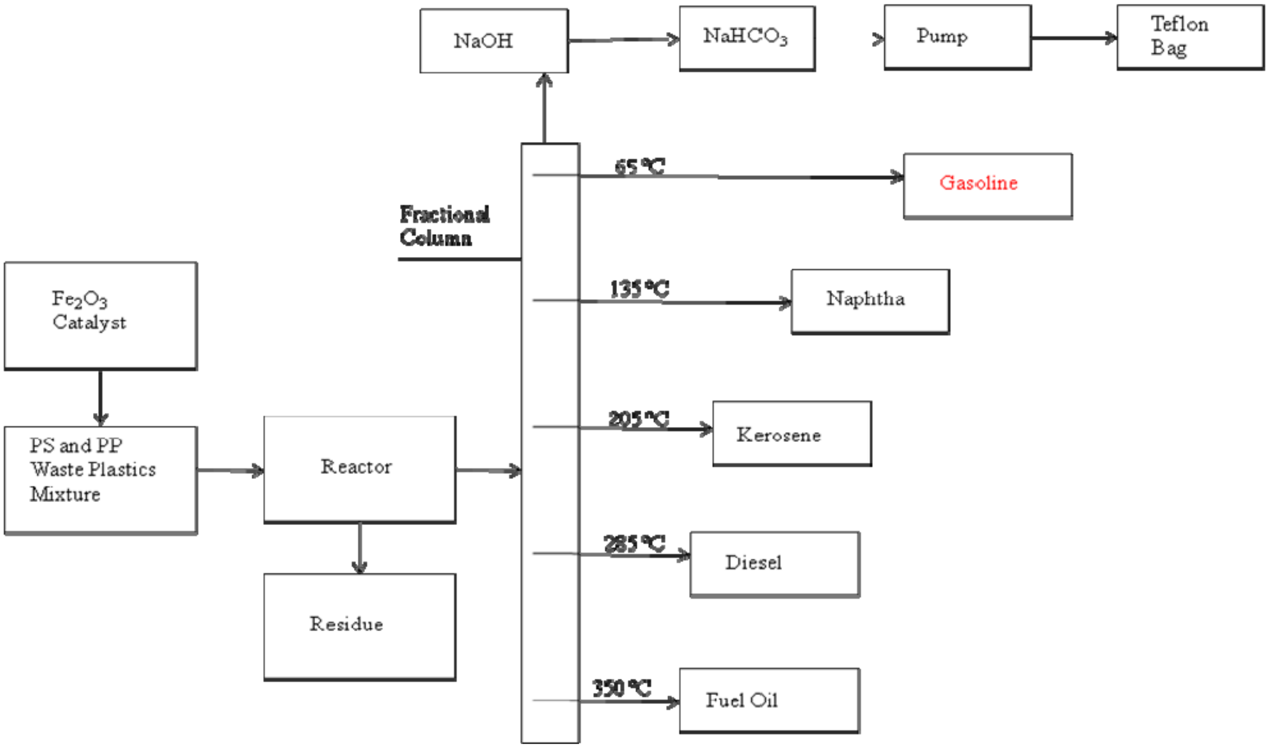

Figure 1: Polypropylene and polystyrene waste plastics mixture to light grade fuel

Result and Discussion

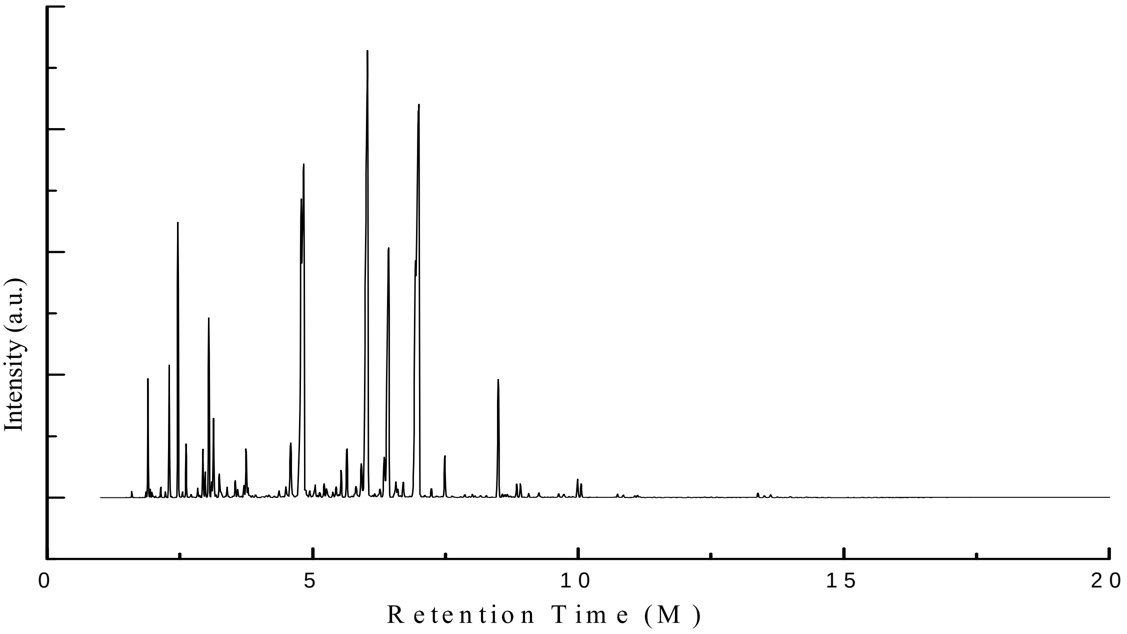

Figure 2: GC/MS chromatogram of polypropylene and polystyrene waste plastics mixture to light grade fuel

Table 1: GC/MS chromatogram compounds list of polypropylene and polystyrene waste plastics mixture to light grade fuel

Number of Peak	Retention Time (M)	Trace Mass (m/z)	Compound Name	Compound Formula	Molecular Weight	Probability Percentage (%)	NIST Library Number
1	1.59	41	1-Propene, 2-methyl-	C_4H_8	56	29.1	18910
2	1.86	42	Cyclopropane, ethyl-	C_5H_{10}	70	30.7	114410
3	1.90	43	Pentane	C_5H_{12}	72	81.7	229281
4	1.93	55	Cyclopropane, 1,2-dimethyl-, cis-	C_5H_{10}	70	17.4	19070
5	1.97	55	2-Pentene	C_5H_{10}	70	14.6	230822
6	2.22	43	1-Pentene, 4-methyl-	C_6H_{12}	84	59.7	149350
7	2.30	43	Pentane, 2-methyl-	C_6H_{14}	86	63.8	61279
8	2.46	56	1-Pentene, 2-methyl-	C_6H_{12}	84	14.5	61283
9	2.62	69	2-Pentene, 4-methyl-	C_6H_{12}	84	15.7	231320

10	2.71	67	2,4-Hexadiene, (Z,Z)-	C_6H_{10}	82	10.9	113646
11	2.84	43	Pentane, 2,4-dimethyl-	C_7H_{16}	100	63.7	107685
12	2.93	67	2,4-Hexadiene, (Z,Z)-	C_6H_{10}	82	12.3	113646
13	2.98	67	2,4-Hexadiene, (Z,Z)-	C_6H_{10}	82	13.7	113646
14	3.04	56	1-Pentene, 2,4-dimethyl-	C_7H_{14}	98	48.1	114435
15	3.10	55	2-Pentene, 3,4-dimethyl-, (Z)-	C_7H_{14}	98	18.9	114487
16	3.13	81	2,4-Dimethyl 1,4-pentadiene	C_7H_{12}	96	52.2	114468
17	3.24	78	Benzene	C_6H_6	78	68.3	114388
18	3.38	43	Hexane, 3-methyl-	C_7H_{16}	100	60.1	113081
19	3.54	56	1-Hexene, 2-methyl-	C_7H_{14}	98	36.5	114433
20	3.59	56	1-Heptene	C_7H_{14}	98	19.5	107734
21	3.71	43	Heptane	C_7H_{16}	100	62.6	61276
22	3.74	81	1,3-Pentadiene, 2,4-dimethyl-	C_7H_{12}	96	35.6	114450
23	3.92	81	1,4-Hexadiene, 2-methyl-	C_7H_{12}	96	13.8	840
24	4.17	81	Cyclopentene, 4,4-dimethyl-	C_7H_{12}	96	18.6	38642
25	4.28	69	Cyclopentane, ethyl-	C_7H_{14}	98	13.4	231044
26	4.37	70	Hexane, 2-methyl-4-methylene-	C_8H_{16}	112	12.1	113454
27	4.59	69	2-Hexene, 3,5-dimethyl-	C_8H_{16}	112	13.8	149385
28	4.79	91	2-Butanone, 3-methyl-1-phenyl-	$C_{11}H_{14}O$	162	16.9	221303
29	4.83	91	Toluene	C_7H_8	92	57.6	45321
30	4.95	70	Heptane, 3-methylene-	C_8H_{16}	112	16.0	114011
31	5.05	56	1-Heptene, 2-methyl-	C_8H_{16}	112	51.9	113675

32	5.09	70	Heptane, 3-methylene-	C_8H_{16}	112	51.6	288517
33	5.13	55	3-Octene, (E)-	C_8H_{16}	112	9.04	142580
34	5.21	95	Cyclopentene, 1,2,3-trimethyl-	C_8H_{14}	110	17.1	113461
35	5.26	109	1,2,4,4-Tetramethylcyclopentene	C_9H_{16}	124	30.7	113515
36	5.38	109	Cyclohexene, 3,3,5-trimethyl-	C_9H_{16}	124	33.8	114765
37	5.44	69	3-Heptene, 2,6-dimethyl-	C_9H_{18}	126	24.6	113946
38	5.53	83	Cyclopentane, 1,1,3,4-tetramethyl-, cis-	C_9H_{18}	126	17.4	27589
39	5.65	43	Heptane, 2,4-dimethyl-	C_9H_{20}	128	33.5	155382
40	5.81	83	2,3-Dimethyl-3-heptene	C_9H_{18}	126	26.4	113493
41	5.91	69	Cyclohexane, 1,3,5-trimethyl-	C_9H_{18}	126	46.3	114702
42	6.03	57	2,4-Dimethyl-1-heptene	C_9H_{18}	126	41.9	113516
43	6.27	57	cis-1,4-Dimethyl-2-methylenecyclohexane	C_9H_{16}	124	20.4	113533
44	6.35	69	Cyclohexane, 1,3,5-trimethyl-, (1α,3α,5β)-	C_9H_{18}	126	34.2	2480
45	6.43	91	Ethylbenzene	C_8H_{10}	106	50.4	158804
46	6.56	109	Cyclohexene, 3,3,5-trimethyl-	C_9H_{16}	124	53.7	114765
47	6.70	109	Cyclohexene, 3,3,5-trimethyl-	C_9H_{16}	124	43.1	114765
48	6.94	104	Styrene	C_8H_8	104	33.5	291542
49	7.00	78	1,3,5,7-Cyclooctatetraene	C_8H_8	104	38.3	113230
50	7.49	105	Benzene, (1-methylethyl)-	C_9H_{12}	120	50.4	228742
51	7.78	56	Decane, 4-methylene-	$C_{11}H_{22}$	154	8.05	46777
52	7.86	117	Benzene, 2-propenyl-	C_9H_{10}	118	19.4	231964

53	7.94	43	trans-3-Decene	$C_{10}H_{20}$	140	5.96	113881
54	8.00	91	Benzene, propyl-	C_9H_{12}	120	70.5	113930
55	8.06	57	Nonane, 4-methyl-	$C_{10}H_{22}$	142	19.7	3834
56	8.16	77	Benzaldehyde	C_7H_6O	106	70.5	291541
57	8.27	105	Benzene, 1,3,5-trimethyl-	C_9H_{12}	120	22.1	20470
58	8.49	118	α-Methylstyrene	C_9H_{10}	118	33.8	2021
59	8.84	71	Nonane, 2,6-dimethyl-	$C_{11}H_{24}$	156	7.58	61438
60	8.91	71	Nonane, 2,6-dimethyl-	$C_{11}H_{24}$	156	8.56	61438
61	9.07	43	4-Decene, 7-methyl-, (E)-	$C_{11}H_{22}$	154	8.37	60846
62	9.26	117	1,3-Methanopentalene, 1,2,3,5-tetrahydro-	C_9H_{10}	118	10.1	221371
63	9.63	43	1-Heptanol, 2,4-dimethyl-, (2S,4R)-(-)-	$C_9H_{20}O$	144	13.5	4027
64	9.73	43	Undecane, 2-methyl-	$C_{12}H_{26}$	170	3.70	6605
65	9.83	43	5-Undecene, 5-methyl-, (Z)-	$C_{12}H_{24}$	168	5.12	61876
66	9.89	69	1-Decen-4-yne, 2-nitro-	$C_{10}H_{15}NO_2$	181	10.7	186798
67	9.99	69	1-Decene, 2,4-dimethyl-	$C_{12}H_{24}$	168	3.41	61110
68	10.05	69	1-Octanol, 3,7-dimethyl-	$C_{10}H_{22}O$	158	4.19	232406
69	10.74	43	1-Dodecanol, 3,7,11-trimethyl-	$C_{15}H_{32}O$	228	6.61	114065
70	11.06	91	Benzene, (3-methyl-3-butenyl)-	$C_{11}H_{14}$	146	65.4	113578
71	11.12	69	(2,4,6-Trimethylcyclohexyl) methanol	$C_{10}H_{20}O$	156	21.4	113757
72	11.35	91	1-Phenyl-5-methylheptane	$C_{14}H_{22}$	190	59.4	112837
73	11.43	69	1-Isopropyl-1,4,5-trimethylcyclohexane	$C_{12}H_{24}$	168	26.4	113584

74	11.52	44	Benzene, (3-methyl-2-butenyl)-	$C_{11}H_{14}$	146	26.8	186387
75	12.38	43	Dodecane, 4,6-dimethyl-	$C_{14}H_{30}$	198	10.8	61041
76	12.51	43	Undecane	$C_{11}H_{24}$	156	6.53	249213
77	13.38	69	1-Nonene, 4,6,8-trimethyl-	$C_{12}H_{24}$	168	8.22	6413

Polystyrene waste plastics and polypropylene waste plastic mixture to fractional fuel 1st grade fuel (light grade gasoline) was analysis by GC/MS. GC/MS purpose liquid solvent was use carbon disulfide and Perkin Elmer elite capillary column. 1st fractional fuel or light grade fuel GC/MS chromatogram analysis result showed hydrocarbon range C_4 to C_{15}. In this category fuel was collected light fraction hydrocarbon at temperature range was 65 ºC. 1st fractional light grade fuel has hydrocarbon compounds including aromatic group compounds, alcoholic compounds, oxygen content, and nitrogen content compounds. GC/MS analysis chromatogram and compounds table showed figure 2 and table 1. In this fuel chromatogram analysis was performed also retention time (m) versus trace mass (m/z). 1st fractional fuel or light grade fuel starting compound is 2-methyl-1-Propene (C_4H_8) (t=1.59, m/z=41) compounds molecular weight 56 and compound probability percentage is 29.1%, 4-methyl-1-Pentene (C_6H_{12}) (t=2.22, m/z=43) compounds molecular weight 84 and compound probability percentage is 59.7%, 4-methyl-2-Pentene (C_6H_{12}) (t=2.62, m/z=69) compounds molecular weight 84 and compound probability percentage is 15.5%, (Z,Z)-2,4-Hexadiene (C_6H_{10}) (t=2.93, m/z=67) compounds molecular weight 84 and compound probability percentage is 15.7%, (Z)-3,4-dimethyl-2-Pentene (C_6H_{10}) (t=2.93, m/z=67) compounds molecular weight 82 and compound probability percentage is 12.3%, Benzene (C_6H_6) (t=3.24, m/z=78) compounds molecular weight 78 and compound probability percentage is 68.3 %, Heptane (C_7H_{16}) (t=3.71, m/z=43) compounds molecular weight 100 and compound probability percentage is 62.6%, 4,4-dimethyl-Cyclopentene (C_7H_{12}) (t=4.17, m/z=81) compounds molecular weight 96 and compound probability percentage is 18.6%, 3-methyl-1-phenyl-2-Butanone ($C_{11}H_{14}O$) (t=4.79, m/z=91) compounds molecular weight 162 and compound probability percentage is 16.9 %, (E)-3-Octene (C_8H_{16}) (t=5.13, m/z=55) compounds molecular weight 112 and compound probability percentage is 9.04%, 3,3,5-trimethyl-Cyclohexene (C_9H_{16}) (t=5.38, m/z=109) compounds molecular weight 125 and compound probability percentage is 33.8%, 2,4-dimethyl-Heptane (C_9H_{20}) (t=5.65, m/z=43) compounds molecular weight 128 and compound probability percentage is 33.5%, 2,4-Dimethyl-1-heptene (C_9H_{18}) (t=6.03, m/z=57) compounds molecular weight 126 and compound probability percentage is 41.9%, Ethylbenzene (C_8H_{10}) (t=6.43, m/z=91) compounds molecular weight 106 and compound probability percentage is 50.4 %, 3,3,5-trimethyl-Cyclohexene (C_9H_{16}) (t=6.70, m/z=109) compounds molecular weight 124 and compound probability percentage is 43.1%, propyl- Benzene (C_9H_{12}) (t=8.00, m/z=91) compounds molecular weight 120 and compound probability percentage is 70.5%, 1,3,5-trimethyl- Benzene (C_9H_{12}) (t=8.27, m/z=105) compounds molecular weight 120 and compound probability percentage is 22.1 %, 2,6-dimethyl- nonane ($C_{11}H_{24}$) (t=8.91, m/z=71) compounds molecular weight 156 and compound probability percentage is 8.56%, 2-methyl-Undecane ($C_{12}H_{26}$) (t=9.73, m/z=43) compounds molecular weight 170 and compound probability percentage is 3.70%, 3,7-dimethyl-1-Octanol ($C_{10}H_{22}O$) (t=10.5, m/z=69) compounds molecular weight 158 and compound probability percentage is 4.19%, 1-Phenyl-5-methylheptane ($C_{14}H_{22}$) (t=11.35, m/z=91) compounds molecular weight 190 and compound probability percentage is 59.4 %, 4,6-dimethyl-Dodecane ($C_{14}H_{30}$) (t=12.38, m/z=43) compounds molecular weight 198 and compound probability percentage is 10.8%. 1st fractional light grade product fuel has aromatic group compounds also and all aromatic group compounds appeared from polystyrene plastic because polystyrene plastic has benzene group compounds. Light grade fraction fuel is ignitable and color was light yellow and it is crystal clear.

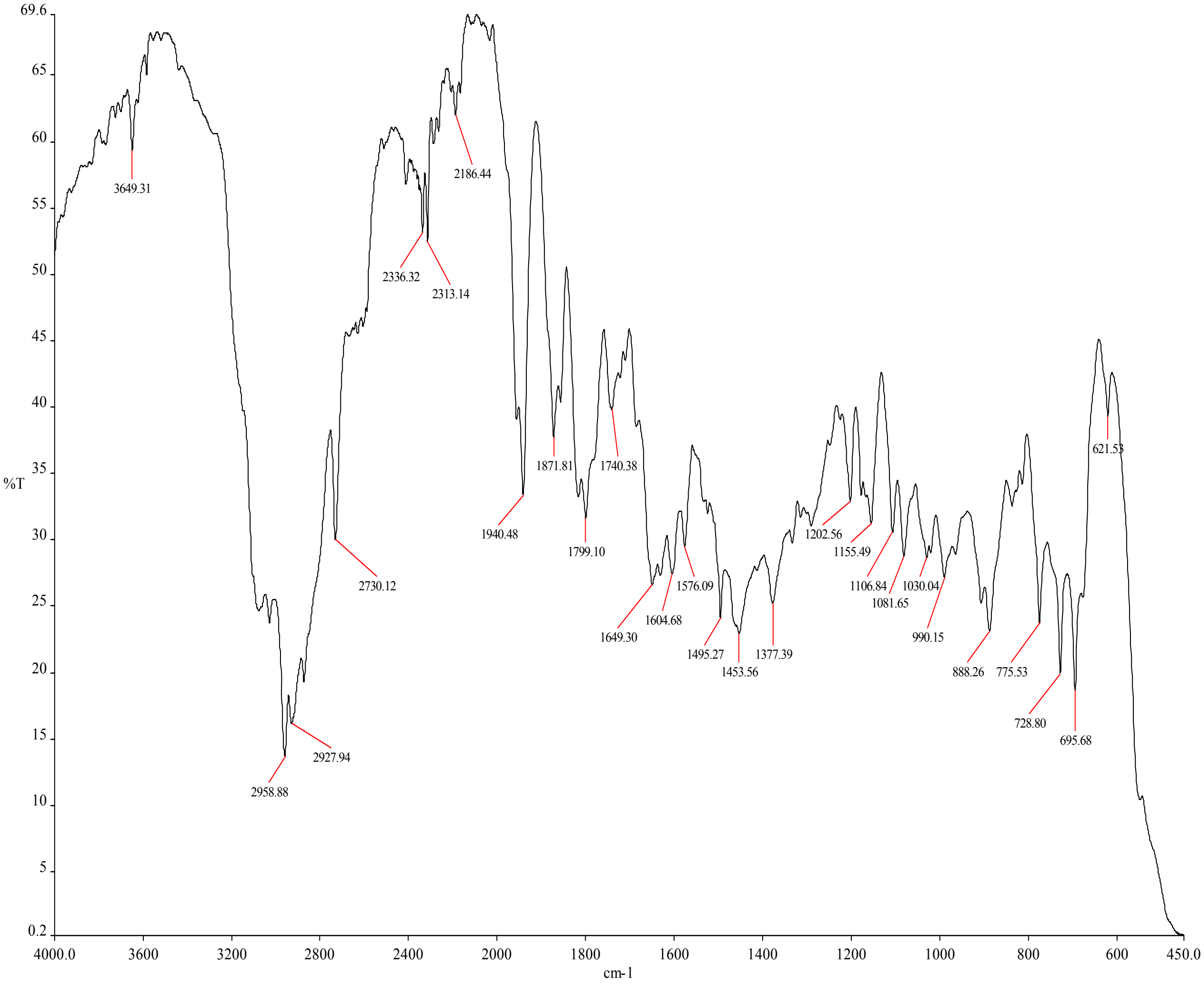

Figure 3: FT-IR spectrum of polypropylene and polystyrene waste plastics mixture to light grade fuel

Table 2: FT-IR spectrum functional group of polypropylene and polystyrene waste plastics mixture to light grade fuel

Number of Wave	Wave Number in cm^{-1}	Functional Group Name	Number of Wave	Wave Number in cm^{-1}	Functional Group Name
2	2936.92	C-CH$_3$	15	1630.80	Conjugated
3	2728.23	C-CH$_3$	16	1603.13	Conjugated
8	2186.02	C-C= - C-C= -CH	17	1576.14	Conjugated

10	1871.83	Non-Conjugated	18	1433.92	CH_3
11	1816.60	Non-Conjugated	24	1020.59	Acetates
12	1799.08	Non-Conjugated	25	987.68	$-CH=CH_2$
13	1744.80	Non-Conjugated	27	739.06	-CH=CH-(cis)
14	1685.05	Conjugated			

FT-IR (spectrum 100) analysis of PP and PS waste plastics mixture light grade fuel (figure 3 and table 2) in accordance with the wave number following types of functional groups are appeared in the analysis such as at the initially wave number 2958.88 cm^{-1} and 2927.94 cm^{-1} functional group is $C-CH_3$, wave number 2730.12 cm^{-1}, functional group is CH_2, wave number 2186.44 cm^{-1}, functional group is C-C= - C-C= -CH, wave number 1871.81 cm^{-1}, 1799.10 cm^{-1}, 1740.38 cm^{-1}, 1649.30 cm^{-1} functional group is Non-Conjugated, wave number 1649.30 cm^{-1}, functional group is Amides, wave number 1604.68 cm^{-1} functional group is Conjugated etc. As well as at the end of the analysis index wave number 1453.56 cm^{-1} and 1377.39 cm^{-1} functional group is CH_3, wave number 1030.04 cm^{-1} and 990.15 cm^{-1} functional group is Secondary Cyclic Alcohol, wave number 888.26 cm^{-1}, functional group is $C=CH_2$ and ultimately wave number 728.80 cm^{-1} and 695.68 cm^{-1} functional group is -CH=CH-(cis) as well. Some groups are emerged single and double bonded functional groups. Non-Conjugated groups are available in the spectrum analysis of fuel such as several wave numbers are in range of that boundaries. On the other hand methyl and methylene groups are seen in the same analysis spectrum. Carbon-carbon bond functional groups are cis alkane etc.

PP and PS waste plastics mixture to light grade fuel Euclidean Search Hit List from Perkin Elmer FT-IR library 0.216 F65156 3-METHOXYPHENYLACETONITRILE, 0.212 F35038 1,1-DICHLOROACETONE, 0.172 F00570 ACETONE ABS. AND RESISTANT AGAINST OXIDATION, 0.168 F22813 ETHYL 4-CHLOROACETOACETATE, 0.162 F00508 ETHYL ACETOHYDROXAMATE, 0.158 F95075 VINYLTRIACETOXYSILANE, 0.139 F88302 2-THENOYLTRIFLUOROACETONE, 0.134 F06640 4-AMINO-ACETOPHENONE, 0.132 F79176 PHENYLSULFONYLACETONITRILE, 0.128 F11960 BENZALACETONE.

Conclusion

Polystyrene and polypropylene waste plastic mixture to light grade fraction fuel was recovery with 5% ferric oxide catalyst and 65 º C fractional tower temperatures. Two types of temperature was use in the experiment one was solid waste plastics liquefaction and another temperature profile was light grade fraction fuel collection. Collected light grade fraction fuel recover percentage was 14% and fuel density is 0.72 g/ml. fuel color is light yellow, fuel is transparent and ignite able. Fuel was analysis by GC/MS (Perkin Elmer model Cluras 500) and fuel analysis chromatogram showed carbon chain length C_4 to C_{15}. Product fuel has short chain hydrocarbon including alkane, alkene, alkyl, aromatic group, oxygen content, and alcoholic group. Light grade fraction fuel has aromatic group compounds because initial raw materials have benzene compounds. Fuel can use internal combustion engines and its can produce electricity using gasoline generator. This technology can convert all PP and PS waste plastic into grading fuels. Using the technology can remove all waste plastics problem from environment and convert into valuable hydrocarbon fuels.

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