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Polypropylene and Polystyrene Waste Plastics Mixture to Diesel Fuel for Truck/Bus Engines

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ABSTRACT:*Polypropylene and polystyrene waste plastics mixture to diesel grade fuel production process was performed in to laboratory scale. Experimental main goal was diesel fuel collection by using fractional distillation process. Experimental temperature was use up to 400 ºC and fractional distillation purposed temperature was used 285 ºC. Under laboratory fume hood and batch process experiment was perform without catalyst and experimental run time was 6 hours. Produced fuel density is 0.81 g/ml. Liquid fuel was analysis by using GC/MS and compounds data table shown below table in result and discussion section.*

KEYWORDS: *Polypropylene, polystyrene, diesel fuel, hydrocarbon, GC/MS*

I. INTRODUCTION

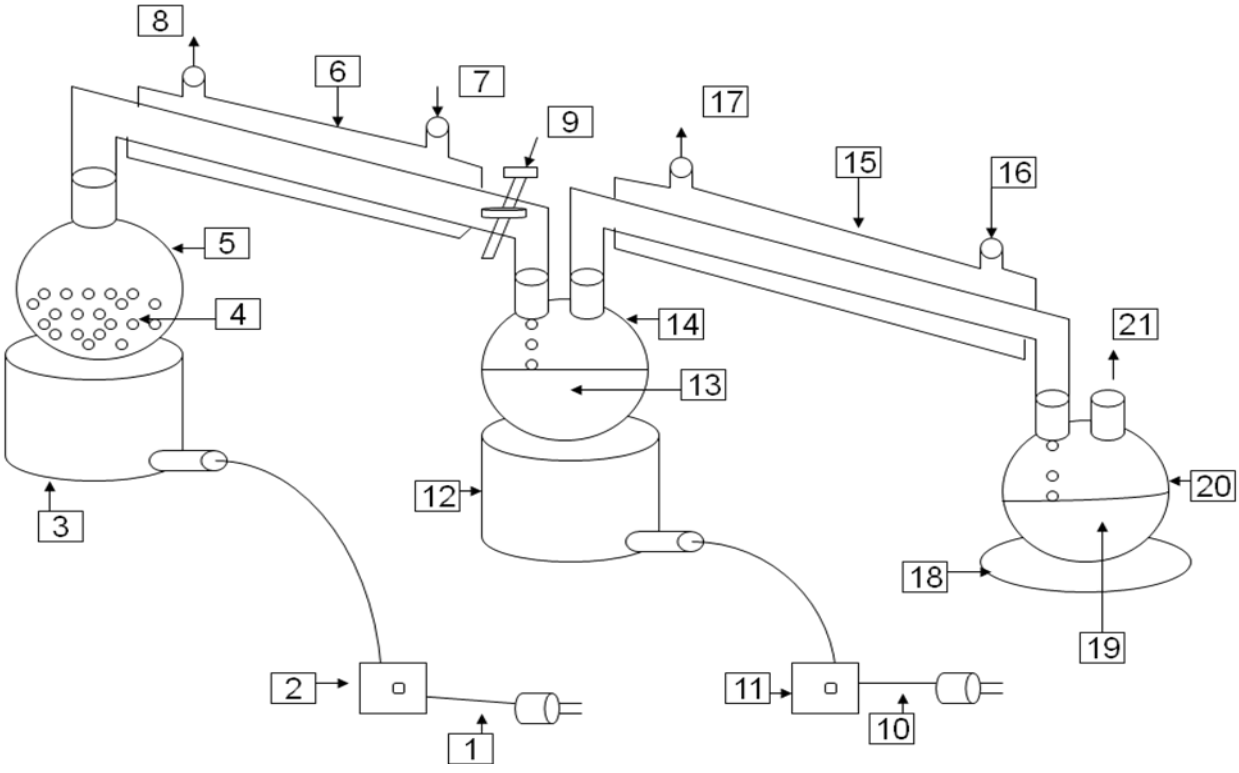
The amount of waste plastics discarded each year is constantly increasing and is causing serious pollution problems. If this material can be chemically recycled, this material will become a cheap and abundant source for useful chemicals and energy. Among various recycling methods, the chemical method which converts waste plastics to useful hydrocarbons, has been recognized as a promising approach.[1] In view of their versatility and relatively low cost, the consumption of plastic materials has been growing steadily, although the disposal of waste plastics constitutes a severe environmental problem due mainly to their chemical inertness. While polymers recycling is a requirement to mitigate their impact on the environment [2], various tertiary recycling processes are attractive, since they produce valuable chemicals or fuels [3, 4]. Considering polyolefins, polyethylene and polypropylene have a massive production and consumption in a large number of applications.[5] Plastic materials production has reached global maximum capacities levelling at 260 million tonnes in 2007, where in 1990 the global production capacity was estimated at an 80 million tonnes [6]. It is estimated that production of plastics worldwide is growing at a rate of about 5% per year [7]. Over the past seventy years, the plastic industry has witnessed a drastic growth, namely in the production of synthetic polymers represented by polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), polyvinyl alcohol (PVA) and polyvinyl chloride (PVC). Plastics also contribute to our daily life functions in many aspects. Household goods nowadays are mainly composed of plastic or plastic reinforced materials, from packaging, clothing, appliances and electrical and vehicle equipments, to insulations, industrial applications, greenhouses, automotive parts, aerospace and mulches.[8]

High temperature pyrolysis and cracking of waste thermoplastic polymers, such as polyolefines, polyethylene (PE), polypropylene (PP) and polystyrene (PS), are well- known and environmentally accepted methods of their utilisation. This group of processes embraces thermal pyrolysis and cracking, catalytic cracking and hydrocracking in the presence of hydrogen. Pyrolysis is the typical chemical recycling process, enabling production of monomers, mainly ethylene, propene and butene from waste plastics. In case of cracking processes, their main products are fuels fractions, gaseous hydrocarbons and liquid mixtures of hydrocarbons boiling in the range of temperatures ~35–360 ºC (gasoline and light gas oils) as well as the solid carbon residues, similar to coke.[9] Some researcher experimental results of application of various acidic catalysts was use for fuel production, such as silica–alumina, zeolites (HY, HZSM-5, mordenite) or alkaline compounds such as ZnO, CaO and K2O [10–13]. In this present technology diesel fuel production was perform without catalyst with fractional distillation process and temperature was use only 285 ºC for diesel fuel collection.

II. MATERIALS AND METHOD

Polypropylene and Polystyrene waste plastics mixture to fuel production process was perform in to laboratory scale. Two step processes experiment was perform without catalyst and waste materials was use for experiment 250 gm. PP and PS waste ratio was 50:50. 1st step process temperature was use up to 400 ºC and 2nd

step process temperature was use 285 ºC. Pyrex glass was using both steps and heat mental, variac meter was use for temperature controller. Figure 1 is shown fuel process diagram for visual understanding. 1st step process waste plastic cut into small pieces and places into pyrex glass inside then setup condensation unit with collection flask. Heat mental was use for waste materials melting purposed and temperature was increased and decreased by using variac meter. Electrical heat was use for sample meting and glass condensation was use for vapor condensation without water flow. Usually water is using for condensation cooling purpose but in this experiment doesn't required water cooling for condensation. When heat rise up gradually then waste plastics start to melt then it become slurry then it become a vapor. Vapors are traveled to condensation inside and due to room temperature inside vapor are become a cool at the end liquid fuel is collected. This product fuel density is 0.89 g/ml. In this process liquid fuel was collected 192.1 g and volume was 217 ml. left over residues was 50.9 gm and light gas was 7 gm. In mass balance calculation percentage showed 76.84 % liquid fuel, residue 20.36% and light gas was 2.8%. Residue percentage is high because polystyrene waste plastic additives percentage is high. After finished 1st step process then start 2nd step process for fractional process. In 2nd fractional process product fuel was fractionation temperature wise and collected diesel grade fuel at 285 ºC. Liquid 1st step product fuel was fractionation at 285 ºC and collected diesel grade fuel but before get diesel grade fuel in this process also produce gasoline grade fuel, naphtha grade fuel and aviation or jet grade fuel. Experimental process main goal was diesel grade fuel collection. 192.1 gm liquid fuel to taken out 12.5 gm for analytical analysis to determine 1st step fuel compounds structure. For 2nd step distillation process liquid fuel was use 179.6 gm for collected diesel grade fuel. Product diesel grade fuel density is 0.81 g/ml. 179.6 gm liquid to diesel grade fuel was 35 gm and volume was 43 ml. During fractional distillation production period other fuel was produced such as gasoline grade, naphtha grade, aviation or jet grade and fuel oil grade. Light gas was produce 32.7 gm and left over residue was 11.0 gm. Other grade fuel was produce 100.9 gm. In percentage calculation 2nd step process diesel grade fuel collection was 19.49%. Fuel was thicker and light yellow color.



[1. Electric Cord, 2. Variac, 3. Heat Mantle, 4. Sample (Waste Plastic PP and PS), 5. Boiling Flask, 6. Condensation Unit, 7. Water Inlet, 8. Water Outlet, 9. Open & Close System Bulb, 10. Electric Cord, 11. Variac, 12. Heat Mantle, 13. Fuel (For Fraction), 14. Boiling Flask, 15. Condensation Unit, 16. Water Inlet, 17. Water Outlet, 18. Ring Cork, 19. NSR Fuel (Diesel Collection), 20. Collection Flask, 21. Lighter Gas Escape Path]

Figure 1: PP and PS waste plastic fuel to diesel fuel production process.

III. RESULT AND DISCUSSION

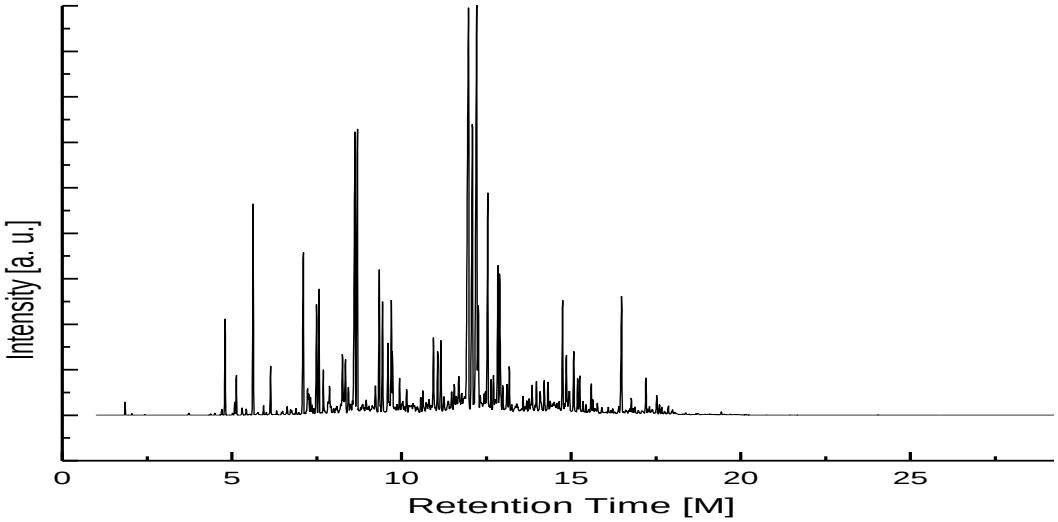


Figure 2: GC/MS chromatogram of PP and PS plastic fuel to Diesel fuel

Table 1: GC/MS chromatogram compounds list of PP and PS plastic fuel to Diesel fuel

Peak Number	Retention Time (M.)	Trace Mass (m/z)	Compound Name	Compound Formula	Molecular weight	Probability Percentage	NIST Library Number
1	1.95	43	Pentane, 2-methyl-	C_6H_{14}	86	45.8	61279
2	2.05	56	1-Pentene, 2-methyl-	C_6H_{12}	84	43.2	19326
3	2.43	56	1-Pentene, 2,4-dimethyl-	C_7H_{14}	98	48.8	114435
4	2.94	81	1,3-Pentadiene, 2,4-dimethyl-	C_7H_{12}	96	33.5	114450
5	3.60	41	1-Hexene, 3,3-dimethyl-	C_8H_{16}	112	11.5	113441
6	3.74	91	Toluene	C_7H_8	92	38.2	291301
7	4.15	109	1,3-Hexadiene, 2,3,5-trimethyl-	C_9H_{16}	124	21.9	60994
8	4.25	109	Cyclopentane, 2-ethylidene-1,1-dimethyl-	C_9H_{16}	124	24.8	46420
9	4.33	69	1-Hexene, 3,3-dimethyl-	C_8H_{16}	112	23.2	113441
10	4.38	83	1-Hexene, 3,3,5-trimethyl-	C_9H_{18}	126	7.27	63168
11	4.71	69	Cyclohexane, 1,3,5-trimethyl-	C_9H_{18}	126	44.1	114702
12	4.80	43	2,4-Dimethyl-1-heptene	C_9H_{18}	126	65.2	113516
13	5.09	69	Cyclohexane, 1,3,5-trimethyl-, (1α,3α,5β)-	C_9H_{18}	126	37.0	2480
14	5.13	91	Ethylbenzene	C_8H_{10}	106	63.9	114918
15	5.29	109	Cyclohexene, 3,3,5-trimethyl-	C_9H_{16}	124	32.6	114765
16	5.62	104	2-Butenoic acid, 3-methyl-, 2-phenylethyl ester	$C_{13}H_{16}O_2$	204	17.0	279236
17	5.77	83	Bicyclo[3.1.1]heptan-2-one, 6,6-dimethyl-, (1R)-	$C_9H_{14}O$	138	15.0	108460
18	5.93	82	1,6-Octadiene, 2,5-dimethyl-, (E)-	$C_{10}H_{18}$	138	8.28	62075
19	6.01	95	Cyclohexanemethanol, 4-(1-methylethyl)-, trans-	$C_{10}H_{20}O$	156	9.58	5298
20	6.14	105	Benzene, (1-methylethyl)-	C_9H_{12}	120	51.3	228742

21	6.32	43	1-Nonene	C_9H_{18}	126	6.36	229029
22	6.50	117	Tetracyclo[3.3.1.0(2,8).0(4,6)]-non-2-ene	C_9H_{10}	118	15.1	191137
23	6.63	91	Benzene, propyl-	C_9H_{12}	120	60.0	113930
24	6.73	57	Nonane, 4-methyl-	$C_{10}H_{22}$	142	25.0	3834
25	6.76	77	Benzaldehyde	C_7H_6O	106	50.2	291541
26	6.89	105	Benzene, 1,2,3-trimethyl-	C_9H_{12}	120	21.7	228017
27	7.11	118	α-Methylstyrene	C_9H_{10}	118	34.7	2021
28	7.23	69	Nonane, 2-methyl-3-methylene-	$C_{11}H_{22}$	154	8.39	61011
29	7.26	69	Nonane, 2-methyl-3-methylene-	$C_{11}H_{22}$	154	6.08	61011
30	7.37	43	2-Piperidinone, N-[4-bromo-n-butyl]-	$C_9H_{16}BrNO$	233	6.66	251632
31	7.42	43	1-Decene, 4-methyl-	$C_{11}H_{22}$	154	12.5	150275
32	7.50	43	Octane, 3,3-dimethyl-	$C_{10}H_{22}$	142	6.93	61706
33	7.57	71	Octane, 3,3-dimethyl-	$C_{10}H_{22}$	142	12.1	61706
34	7.70	43	4-Decene, 7-methyl-, (E)-	$C_{11}H_{22}$	154	12.4	60846
35	7.88	43	Cyclohexane, 1,1-dimethyl-2-propyl-	$C_{11}H_{22}$	154	8.19	69817
36	7.99	69	Ethanone, 1-(1,2,2,3-tetramethylcyclopentyl)-, (1R-cis)-	$C_{11}H_{20}O$	168	7.24	186082
37	8.05	56	5-Undecene, (E)-	$C_{11}H_{22}$	154	8.37	114227
38	8.10	69	2-Undecanethiol, 2-methyl-	$C_{12}H_{26}S$	202	14.8	9094
39	8.26	43	1-Octanol, 2-butyl-	$C_{12}H_{26}O$	186	5.04	114639
40	8.30	91	Benzene, butyl-	$C_{10}H_{14}$	134	28.0	228741
10	8.35	43	Dodecane, 2,6,10-trimethyl-	$C_{15}H_{32}$	212	6.75	114045
42	8.63	69	Cyclooctane, 1,4-dimethyl-, cis-	$C_{10}H_{20}$	140	4.29	61409
43	8.70	69	Cyclooctane, 1,4-dimethyl-, cis-	$C_{10}H_{20}$	140	4.93	61409
44	8.96	43	1-Nonene, 4,6,8-trimethyl-	$C_{12}H_{24}$	168	7.66	6413
45	9.23	83	(2,4,6-Trimethylcyclohexyl) methanol	$C_{10}H_{20}O$	156	5.82	113757
46	9.34	43	1-Dodecanol, 3,7,11-trimethyl-	$C_{15}H_{32}O$	228	3.16	114065
47	9.60	91	Benzene, (3-methyl-3-butenyl)-	$C_{11}H_{14}$	146	66.5	113578
48	9.94	69	1-Isopropyl-1,4,5-trimethylcyclohexane	$C_{12}H_{24}$	168	37.7	113584
49	10.16	105	Benzene, (1,3-dimethyl-3-butenyl)-	$C_{12}H_{16}$	160	29.4	45481
50	10.22	131	Benzene, (3-methyl-2-butenyl)-	$C_{11}H_{14}$	146	34.5	186387
51	10.24	69	4-Nonene, 5-butyl-	$C_{13}H_{26}$	182	5.36	34734
52	10.30	118	Benzene, (3-methyl-1-methylenebutyl)-	$C_{12}H_{16}$	160	41.4	64019
53	10.34	41	1,12-Tridecadiene	$C_{13}H_{24}$	180	6.47	7380
54	10.38	41	8-Dodecen-1-ol, acetate, (Z)-	$C_{14}H_{26}O_2$	226	4.95	130718
55	10.44	105	1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one	$C_{13}H_{20}O_2$	208	194131	21.7
56	10.47	43	2-Piperidinone, N-[4-bromo-n-butyl]-	$C_9H_{16}BrNO$	233	9.92	251632
57	10.57	69	1-Isopropyl-1,4,5-	$C_{12}H_{24}$	168	40.5	113584

			trimethylcyclohexane				
58	10.63	69	Cyclohexane, 2-propyl-1,1,3-trimethyl-	$C_{12}H_{24}$	168	5.79	69818
59	10.72	69	5-Tetradecene, (Z)-	$C_{14}H_{28}$	196	5.03	142626
60	10.81	69	7-Tetradecene	$C_{14}H_{28}$	196	3.98	70643
61	10.94	43	Dodecane, 4,6-dimethyl-	$C_{14}H_{30}$	198	11.1	45335
62	11.16	43	Dodecane, 4,6-dimethyl-	$C_{14}H_{30}$	198	14.3	45335
63	11.25	69	1-Tetradecanol, 14-chloro-	$C_{14}H_{29}ClO$	248	4.46	156095
64	11.48	83	E-2-Hexadecacen-1-ol	$C_{16}H_{32}O$	240	3.63	131101
65	11.56	43	Heptadecane, 2,6,10,15-tetramethyl	$C_{21}H_{44}$	296	5.71	14103
66	11.61	69	1,12-Tridecadiene	$C_{13}H_{24}$	180	6.96	7380
67	11.63	43	2-Hexyl-1-octanol	$C_{14}H_{30}O$	214	3.64	113807
68	11.98	69	2-Isopropyl-5-methyl-1-heptanol	$C_{11}H_{24}O$	172	4.66	245029
69	12.08	69	1-Octanol, 2-butyl-	$C_{12}H_{26}O$	186	3.08	114639
70	12.22	69	2-Isopropyl-5-methyl-1-heptanol	$C_{11}H_{24}O$	172	4.15	245029
71	12.27	92	Benzene, heptyl-	$C_{13}H_{20}$	176	73.9	118464
72	12.55	43	3-Hexadecene, (Z)-	$C_{16}H_{32}$	224	3.73	62797
73	12.85	43	1-Octanol, 2-butyl-	$C_{12}H_{26}O$	186	4.05	114639
74	12.89	55	1,9-Tetradecadiene	$C_{14}H_{26}$	194	3.98	187543
75	12.99	55	Cyclododecanemethanol	$C_{13}H_{26}O$	198	4.96	108275
76	13.11	55	1,9-Tetradecadiene	$C_{14}H_{26}$	194	4.77	187543
77	13.18	91	Cyclooctane, phenyl-	$C_{14}H_{20}$	188	29.0	155843
78	13.36	69	2-Dodecen-1-yl(-)succinic anhydride	$C_{16}H_{26}O_3$	266	5.21	76110
79	13.39	145	2,5,5-Trimethyl-3-phenyl-cyclohexanone	$C_{15}H_{20}O$	216	27.8	190828
80	13.58	69	Isotridecanol-	$C_{13}H_{28}O$	200	7.37	298499
81	13.63	69	2-Butyl-5-methyl-3-(2-methylprop-2-enyl)cyclohexanone	$C_{15}H_{26}O$	222	5.47	281106
82	13.76	167	Diphenylmethane	$C_{13}H_{12}$	168	34.5	114004
83	13.85	43	Decane, 2,3,5,8-tetramethyl-	$C_{14}H_{30}$	198	11.9	149589
84	13.93	69	7-Heptadecene, 1-chloro-	$C_{17}H_{33}Cl$	272	8.25	36331
85	14.21	43	Decane, 2,3,5,8-tetramethyl-	$C_{14}H_{30}$	198	9.15	149589
86	14.38	43	Heptadecane, 2,6,10,15-tetramethyl-	$C_{21}H_{44}$	296	6.22	14103
87	14.64	83	1-Nonadecanol	$C_{19}H_{40}O$	284	3.43	232931
88	14.75	69	Acetic acid, 3,7,11,15-tetramethyl-hexadecyl ester	$C_{22}H_{44}O_2$	340	4.39	193630
89	14.86	43	Trichloroacetic acid, hexadecyl ester	$C_{18}H_{33}Cl_3O_2$	386	3.69	280518
90	15.35	92	Benzene, [6-cyclopentyl-3-(3-cyclopentylpropyl)hexyl]-	$C_{25}H_{40}$	340	11.3	15643
91	15.90	69	1,19-Eicosadiene	$C_{20}H_{38}$	278	5.79	241604
92	16.09	91	Benzene, 1,1'-[3-(3-cyclopentylpropyl)-1,5-pentanediyl]bis-	$C_{25}H_{34}$	334	19.4	23398
93	16.41	43	Tetradecane, 2,6,10-trimethyl-	$C_{17}H_{36}$	240	7.38	11556
94	16.49	92	Benzene, 1,1'-(1,3-propanediyl)bis-	$C_{15}H_{16}$	196	91.6	133399
95	16.77	105	Benzene, 1,1'-(1-methyl-1,3-propanediyl)bis-	$C_{16}H_{18}$	210	82.0	149665
96	17.21	69	Trichloroacetic acid, hexadecyl ester	$C_{18}H_{33}Cl_3O$	386	11.6	280518

97	17.61	91	Benzeneacetic acid, 4-pentadecyl ester	$C_{23}H_{38}O_2$	346	47.7	282028
98	17.99	69	Cyclopentane, 1,1'-[3-(2-cyclopentylethyl)-1,5-pentanediyl]bis-	$C_{22}H_{40}$	304	4.51	14492
99	18.10	92	Benzene, [6-cyclopentyl-3-(3-cyclopentylpropyl)hexyl]-	$C_{25}H_{40}$	340	20.0	15643
100	18.56	91	9-Octadecenoic acid (Z)-, phenylmethyl ester	$C_{25}H_{40}O_2$	372	15.3	67841
101	18.64	69	Benzene, [3-(2-cyclohexylethyl)-6-cyclopentylhexyl]-	$C_{25}H_{40}$	340	8.93	23414
102	19.92	204	Indeno[2,1-a]indene, 5,10-dihydro-	$C_{16}H_{12}$	204	21.6	36963
103	24.05	91	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-	$C_{22}H_{20}OS$	332	40.4	142947
104	24.81	44	Benzene, 1,1'-[2-methyl-2-(phenylthio)cyclopropylidene]bis-	$C_{22}H_{20}S$	316	21.3	36978

A PP and PS mixture waste plastic to diesel fuel production was fractional distillation process. Product fuel was analysis by GC/MS to determine compound structure and carbon range present into fuel. GC/MS fuel chromatogram analysis result graph shown figure 2, and carbon range compounds data table shown into table 1. Product fuel carbon range showed C_6 to C_{25}. Product fuel has hydrocarbon compounds including aromatic group, oxygenated, alcoholic group, and halogenated group because waste plastic has additives. During production period some negligible percentage of additive are comes out with fuel. All compounds were traced from chromatogram based on NIST library with retention time (t) and trace mass (m/z). All compounds peak intensity is not same some compounds peak intensity is small, some compounds peak intensity is medium and some compounds peak intensity is large. Starting compounds peak intensity is small and end compounds peak intensity is small. Benzene group compounds are present in this fuel because raw materials were used polystyrene waste plastic. Polystyrene waste plastic has benzene group compounds. Diesel grade fuel production purposed temperature was used 285 ºC. GC/MS analysis compounds are appeared small number carbon to large number carbon wise. GC/MS analysis compounds data table 1 showed 104 compounds determined with retention time, trace mass, compounds formula, molecular weight, probability percentage and NIST library number. Initial compounds is 2-methyl-Pentane (C_6H_{14}) (t=1.95, m/z=43) molecular weight is 86 and probability percentage is 45.8%, then 2,4-dimethyl-1-Pentene (C_7H_{14}) (t=2.43, m/z=56) molecular weight is 98 and probability percentage is 48.8%, Toluene (C_7H_8) (t=3.74, m/z=91) molecular weight is 92 and probability percentage is 38.2%, 1,3,5-trimethyl-Cyclohexane (C_9H_{18}) (t=4.71, m/z=69) molecular weight is 126 and probability percentage is 44.1%, 3,3,5-trimethyl-Cyclohexene (C_9H_{16}) (t=5.29, m/z=109) molecular weight is 124 and probability percentage is 32.6%, 1-Nonene (C_9H_{18}) (t=6.32, m/z=43) molecular weight is 126 and probability percentage is 6.36 %, 4-methyl-Nonane ($C_{10}H_{22}$) (t=6.73, m/z=57) molecular weight is 142 and probability percentage is 25.0%, 2-methyl-3-methylene-Nonane ($C_{11}H_{22}$) (t=7.23, m/z=69) molecular weight is 154 and probability percentage is 8.39%, 3,3-dimethyl-Octane ($C_{10}H_{22}$) (t=7.50, m/z=43) molecular weight is 142 and probability percentage is 6.93%, (E)- 5-Undecene ($C_{11}H_{22}$) (t=8.05, m/z=56) molecular weight is 154 and probability percentage is 8.37%, 2-butyl-1-Octanol ($C_{12}H_{26}O$) (t=8.26, m/z=43) molecular weight is 186 and probability percentage is 5.04%, 4,6,8-trimethyl-1-Nonene ($C_{12}H_{24}$) (t=8.96, m/z=43) molecular weight is 168 and probability percentage is 7.66%, (1,3-dimethyl-3-butenyl)-Benzene ($C_{12}H_{16}$) (t=10.16, m/z=105) molecular weight is 160 and probability percentage is 29.4%, 5-butyl-4-Nonene ($C_{13}H_{26}$) (t=10.24, m/z=69) molecular weight is 182 and probability percentage is 6.47%, 4,6-dimethyl-Dodecane ($C_{14}H_{30}$) (t=10.94, m/z=43) molecular weight is 198 and probability percentage is 11.1%, E-2-Hexadecacen-1-ol ($C_{16}H_{32}O$) (t=11.48, m/z=83) molecular weight is 240 and probability percentage is 3.63 %, (Z)-3-Hexadecene ($C_{16}H_{32}$) (t=12.55, m/z=43) molecular weight is 224 and probability percentage is 3.73%, 2,5,5-Trimethyl-3-phenyl-cyclohexanone ($C_{15}H_{20}O$) (t=13.39, m/z=145) molecular weight is 216 and probability percentage is 27.8%, 2,3,5,8-tetramethyl- Decane ($C_{14}H_{30}$) (t=14.21, m/z=43) molecular weight is 198 and probability percentage is

9.15%, 1-Nonadecanol ($C_{19}H_{40}O$) (t=14.64, m/z=83) molecular weight is 284 and probability percentage is 3.43%, bis-1,1'-[3-(3-cyclopentylpropyl)-1,5-pentanediyl] Benzene ($C_{25}H_{34}$) (t=16.09, m/z=91) molecular weight is 334 and probability percentage is 19.4%, 2,6,10-trimethyl-Tetradecane ($C_{17}H_{36}$) (t=16.41, m/z=43) molecular weight is 240 and probability percentage is 7.38%, bis-1,1'-[3-(2-cyclopentylethyl)-1,5-pentanediyl]Cyclopentane ($C_{22}H_{40}$) (t=17.99, m/z=69) molecular weight is 304 and probability percentage is 4.51%, [3-(2-cyclohexylethyl)-6-cyclopentylhexyl]- Benzene ($C_{25}H_{40}$) (t=18.64, m/z=69) molecular weight is 340 and probability percentage is 8.93%, and so on. Product fuel has large number of hydrocarbon compounds for that reason this can use only bus, truck.

IV. CONCLUSION

Polystyrene waste plastic and polypropylene waste plastic mixture to diesel fuel production process was two stem processes. 1st step process PP and PS waste plastic mixture to produce fuel, and produce fuel further fractional distillation process was separated diesel grade fuel without using catalyst. Product fuel was analysis by GC/MS and compounds start is C_6 to C_{25} and product fuel has hydrocarbon compounds including aromatic group. Aromatic compounds are present such as Toluene (C_7H_8), Ethylbenzene (C_8H_{10}), (1-methylethyl)-Benzene (C_9H_{12}), 1,2,3-trimethyl-Benzene (C_9H_{12}), butyl-Benzene ($C_{10}H_{14}$), (3-methyl-1-methylenebutyl)-Benzene ($C_{12}H_{16}$), [6-cyclopentyl-3-(3-cyclopentylpropyl)hexyl]-Benzene ($C_{25}H_{40}$) and many more. Product fuel is not igniting because product fuel hydrocarbon compounds heaver compounds mixture. Heavy hydrocarbon compounds can use heavy engine such as truck or bus.

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