

# Waste Tyre and Polypropylene Mixture Into Petroleum Fuel using ZnO

Moinuddin Sarker, Mohammad Mamunor Rashid

**Abstract-** Waste tyre and polypropylene waste plastic into petroleum fuel production process with laboratory batch process in present of ZnO catalyst at temperature range 250-430 °C. In this experiment Pyrex glass reactor was use and sample was using total 75 gm. Waste tyre was 25 gm by weight and polypropylene was 50 gm by weight. 5% Zinc Oxide catalyst was use in this experiment to accelerate the reaction. Product fuel density is 0.75gm/ml and fuel color is light yellow. Waste tyre and polypropylene waste plastic to fuel conversion percentage was 63.47 %, light gas percentage was 12.27 %, and solid black residue percentage was 24.26%. Product fuel was analysis by using Perkin Elmer GC/MS and GC/MS chromatogram showed carbon chain range C<sub>3</sub> to C<sub>21</sub>. GC/MS analysis result indicate that product fuel has aliphatic hydrocarbon including alkane, alkene and alkyl group, aromatic group, halogenated group, alcoholic group, nitrogen content and oxygen content compounds. Aromatic group compounds are Toluene, 1-ethyl-3-methyl-Benzene, propyl-Benzene, 1,3,5-trimethyl-Benzene, Limonene and so on. Product fuel can use internal combustion engine and feed for refinery process.

**Keywords:** scrap tire, polypropylene, waste plastic, synthetic fuel, conversion

## I. INTRODUCTION

The disposal of municipal solid waste (MSW) is currently recognized as a major environmental concern arising especially in the industrialized regions. It is also well known that the organic fraction of MSW amounts to much more than half its content (the rest being inorganic material and moisture), and consists primarily of waste plastics, paper and lignocellulosic substances. Hence, it appears that efficient ways of disposing or preferably converting solid wastes must be developed in order to meet the increasingly stringent environmental requirements of tomorrow [1]. Particularly considering post-consumer plastics, it must be noticed that they pose an attractive opportunity for utilization as a valuable and reusable source of hydrocarbons if broken down into lower molecular weight products [2]. In addition to energy considerations, the development of improved methods for converting these low-cost waste polymers in an environmentally favorable way appears to be the best alternative route to plastics pyrolysis or recycling. With respect to present trends in finding cost-effective energy sources, recent research efforts have focused on the utilization of waste polymeric materials in reacting directly with coal [3,4].

This becomes possible since it is well established that waste plastics undergo de-polymerization and degradation above 380 °C by a free radical chain reaction [5]. Although a variety of waste plastics processing methods for obtaining hydrocarbons have been developed in the recent past, there is still a great deal of interest for the mentioned co-liquefaction process due to the fact that coal is an abundant fuel resource [6,7,8]. As an alternative to direct combustion, high volume waste plastics can be converted through high-temperature gasification/ pyrolysis, to a large extent, into a blend of gaseous hydrocarbons. This gaseous fuel, thoroughly mixed with air, may be subsequently burned under premixed homogeneous conditions to minimize the emissions of products of incomplete combustion (PIC), which include gaseous and particulate pollutants. In terms of energy, the heat necessary to pyrolyze the PS (1.5 MJ/kg) is only a small fraction of the internal energy of the polymer itself (heating value of 40.2 MJ/kg) [9, 10].

Thus, the energy balance is largely positive, and very favorable heat integration may be achieved in the production of this waste polymer- derived pyrolyzate fuel [11]. The current methods for dealing with the environmental problems resulting from this solid waste include source reduction, reuse, recycling, landfill, and waste -to- energy conversion. Most solid wastes are disposed through landfilling. However, with the lack of landfill space and with current challenges both in implementing the recycling of plastics and in finding markets for the recyclables, combustion of these materials in waste-to-energy plants offers an alternative of technological and economic interest. Combustion of waste plastics provides a number of advantages, such as destruction of hazardous contaminants, reduction of mass and volume (by more than 90%), and energy recovery, as well as rendering the waste unrecognizable from its original form (which is often a requirement for medical waste) [12, 13]. Different types of reactors have been used for tire pyrolysis, such as autoclaves [14] and fixed bed reactors,[15-19] and for a larger scale operation, bubbling fluidized bed reactors, [18-23] moving beds under vacuum, in one and two steps, [24-26] ablative beds, [27] and rotary ovens [28-30]. Key factors for process viability are high throughput and products with suitable properties for their subsequent valorization toward value added compounds such as high-quality carbon black, active carbon, or chemical compounds, such as benzene, toluene, xylene, limonene, and so on[31].

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II. MATERIALS

Waste scrap tire and polypropylene waste plastic collected from local city motor collision center and grocery store. Polypropylene waste plastic and waste scrape tire cut into small pieces and wash with liquid soap and water. Polypropylene waste plastic and tyre has additive because manufacturing company adding different types of additive for hard shape and durability. Tyre additives are adding manufacturing company such as rubber tyre additives, Nitro on-road car tire additive (rubber), M(MBT) tyre additive, CPE135B--rubber tyre processing additive, cobalt particle used in tire additive, rubber additives CBS(CZ), rubber additives, rubber accelerator NS/TBBS, rubber additive 6PPD(4020), CBS 80 rubber dispersant additive, CBS rubber accelerator for tyre, carbon black N220 for tyre, tire chemical, silicon dioxide/tire application silica, rubber additives PVI, high reinforcement carbon black N330 for tyre, anti ozone wax for tyre, (poly aluminium chloride) for tyre, chemicals, activated clay/fuller earth for tyre oil with high deodoration power, white carbon black powder for tire, sulfur powder for rubber and tire, tyre rubber C5 petroleum of mixing refining, flame retardants used in polyurethane foam tire, Jiuxiang Brand SP-801 Zinc Oxide for tyre, Additive silane Si 69, silane coupling agent, tyre additive CZ (CBS), plastics additives (EFAME) and etc. Plastics manufacturing company are adding also different types of additive for hard shape and durability and 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, antistatic agent and etc. All additive are remaining as a residue after finished the experiment. Some negligible percentage is coming with fuel and it can remove by filtering or separation process.

III. EXPERIMENTAL PROCESS

Waste tyre and polypropylene waste plastic fuel recovery process was perform in laboratory scale in the batch process. In presence of ZnO catalyst experiment was perform and liquid oil was recover from tyre and polypropylene waste. 5% ZnO catalyst powder was use and total sample was 75 gm by weight. 50 gm of polypropylene and 25 gm of tyre waste was use in this experiment. Without vacuumed system experiment was placed into laboratory fume hood and temperature range was 250 430 °C. Experimental setup was shown into figure 1 and necessary accessories and equipment was reactor, veriac meter for temperature control, condensation unit, fuel container, fuel purifier, final fuel container, sediment container, small pump, liquid alkali solution, water, Teflon Bag, residue collection container. Equipment setup was properly from tyre and PP waste to liquid fuel production. Polypropylene waste plastic and tyre mixture placed into reactor chamber then 5% ZnO catalyst was added into polypropylene and tyre mixture. Plastic, tyre and catalyst mixture heated up from 250 to 430 °C until finished the experiment. Sometimes temperature profiles need to decrease for better quality fuel. Small scale production was monitored properly to prevent gas lose into environment

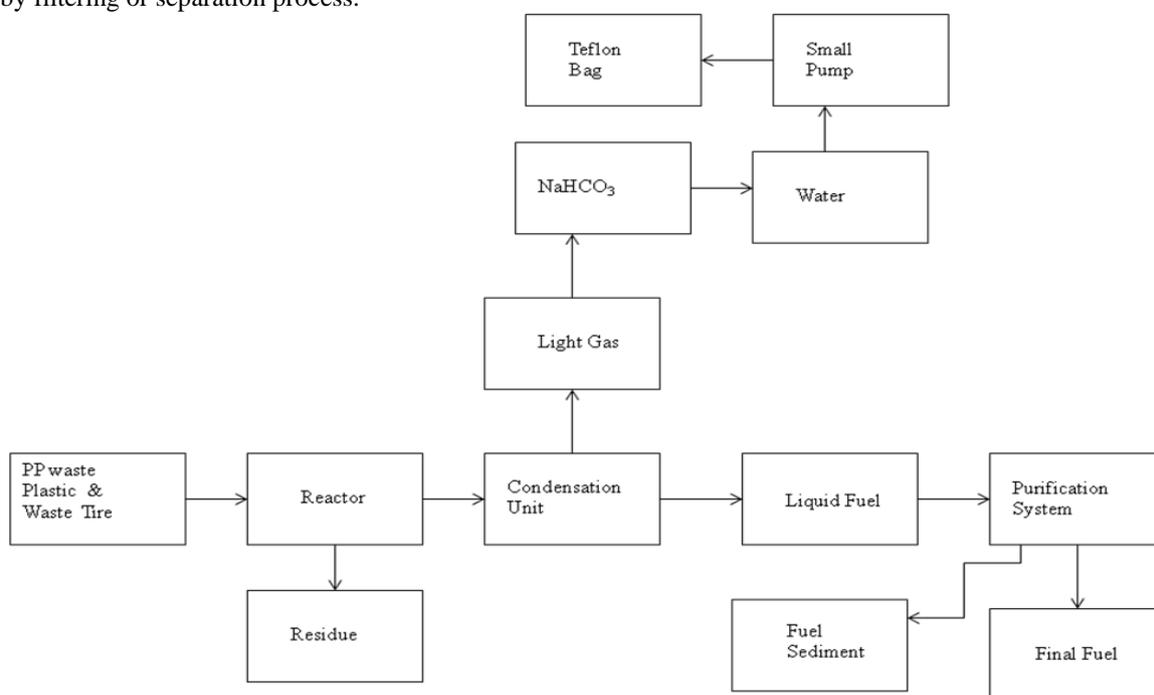


Figure 1: Waste Tyre and Polypropylene Waste Plastic Mixture to Fuel Production Process

This experiment main goal was collect liquid oil from polypropylene waste and tyre waste mixture. Polypropylene waste plastic and tyre waste to fuel recover period noticed that when mixture waste was heated up 250 °C to 430 °C glass reactor inside smoke generation was faster. ZnO catalyst help to breakdown polymer chain and form into short chain then produce vapor travel through condensation unit at the end collected liquid hydrocarbon fuel. Tyre has high percentage of additives that additives cannot convert into liquid fuel and an additive comes out as a solid black residue. Residue has good Btu value it can use as substitute coal. When polymer chain breakdown that time it was start C1 to infinitive but C1-C4 light carbon cannot condense and come out as light gas. Light gas compounds mixture of methane, ethane, propane and butane and carbon dioxide. Produced light gas can clean with alkali wash and water wash. Light gas was store with Teflon bag using small

pump. Liquid fuel was filtered with micron filter paper and fuel was collected another container. During fuel filter period some fuel sediment was collected and sediment can reuse for another batch process. Sediment are comes from initial materials label or additives and carbon ash. Residue can collect after finished the experiment and keep into separate container. In mass balance calculation showed 75 gm materials to liquid fuel was 47.6 gm, light gas was generated 9.2 gm, and leftover black residue was 18.2 gm. Polypropylene waste plastic and tyre mixture to fuel conversion percentage was 63.47 %, light gas percentage was 12.27 %, and residue percentage was 24.26%. Product fuel density is 0.75 gm/ml, fuel color light yellow and product fuel is ignited.

#### IV. RESULTS AND DISCUSSIONS

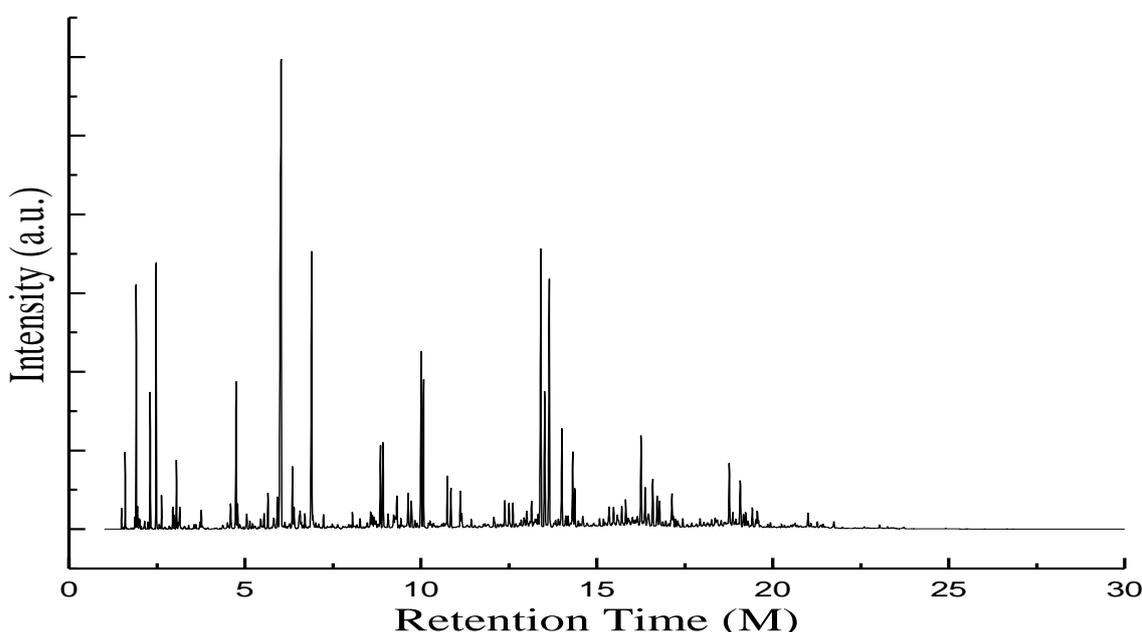


Figure 2: GC/MS Chromatogram of waste Tyre and Polypropylene Waste Plastic Mixture to Fuel

Table 1: GC/MS Chromatogram compound list of waste Tyre and Polypropylene Waste Plastic Mixture to Fuel

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 <sub>3</sub> H <sub>6</sub>	42	44.5	50
2	1.59	41	1-Propene, 2-methyl-	C <sub>4</sub> H <sub>8</sub>	56	28.7	18910
3	1.87	42	1-Pentene	C <sub>5</sub> H <sub>10</sub>	70	17.9	19081
4	1.91	42	Pentane	C <sub>5</sub> H <sub>12</sub>	72	74.2	291244
5	1.95	55	2-Pentene	C <sub>5</sub> H <sub>10</sub>	70	16.4	19079
6	1.99	55	2-Pentene	C <sub>5</sub> H <sub>10</sub>	70	16.1	230822
7	2.31	43	Pentane, 2-methyl-	C <sub>6</sub> H <sub>14</sub>	86	58.2	61279
8	2.48	56	1-Pentene, 2-methyl-	C <sub>6</sub> H <sub>12</sub>	84	29.1	495
9	2.63	69	2-Pentene, 2-methyl-	C <sub>6</sub> H <sub>12</sub>	84	12.5	494
10	2.85	43	Pentane, 2,4-dimethyl-	C <sub>7</sub> H <sub>16</sub>	100	61.0	107685

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11	2.95	67	2,4-Hexadiene, (Z,Z)-	C <sub>6</sub> H <sub>10</sub>	82	12.9	113646
12	2.99	67	2,4-Hexadiene, (Z,Z)-	C <sub>6</sub> H <sub>10</sub>	82	14.6	113646
13	3.06	56	1-Pentene, 2,4-dimethyl-	C <sub>7</sub> H <sub>14</sub>	98	65.2	114435
14	3.11	55	2-Pentene, 3,4-dimethyl-, (Z)-	C <sub>7</sub> H <sub>14</sub>	98	17.3	114487
15	3.15	81	2,4-Dimethyl 1,4-pentadiene	C <sub>7</sub> H <sub>12</sub>	96	48.2	114468
16	3.28	41	1-Pentanol, 2-ethyl-	C <sub>7</sub> H <sub>16</sub> O	116	26.2	114889
17	3.40	43	Hexane, 3-methyl-	C <sub>7</sub> H <sub>16</sub>	100	59.2	113081
18	3.56	56	1-Hexene, 2-methyl-	C <sub>7</sub> H <sub>14</sub>	98	31.6	114433
19	3.60	41	1-Heptene	C <sub>7</sub> H <sub>14</sub>	98	27.7	19704
20	3.72	43	Heptane	C <sub>7</sub> H <sub>16</sub>	100	51.7	61276
21	3.76	81	1,3-Pentadiene, 2,4-dimethyl-	C <sub>7</sub> H <sub>12</sub>	96	32.7	114450
22	3.80	81	Cyclopentene, 4,4-dimethyl-	C <sub>7</sub> H <sub>12</sub>	96	13.3	38642
23	3.88	41	2-Hexene, 3-methyl-, (Z)-	C <sub>7</sub> H <sub>14</sub>	98	11.6	927
24	3.94	81	Cyclopropane, trimethylmethylene-	C <sub>7</sub> H <sub>12</sub>	96	17.2	63085
25	4.19	81	1,4-Hexadiene, 2-methyl-	C <sub>7</sub> H <sub>12</sub>	96	9.82	840
26	4.29	43	Pentanal, 2,3-dimethyl-	C <sub>7</sub> H <sub>14</sub> O	114	7.84	118167
27	4.37	79	2,4-Heptadien-1-ol, (E,E)-	C <sub>7</sub> H <sub>12</sub> O	112	19.6	1645
28	4.51	56	2,4-Dimethyl-1-hexene	C <sub>8</sub> H <sub>16</sub>	112	56.1	113443
29	4.59	69	2-Hexene, 3,5-dimethyl-	C <sub>8</sub> H <sub>16</sub>	112	16.1	149385
30	4.75	43	Heptane, 4-methyl-	C <sub>8</sub> H <sub>18</sub>	114	62.0	113916
31	4.79	91	Toluene	C <sub>7</sub> H <sub>8</sub>	92	42.5	291301
32	5.05	56	1-Heptene, 2-methyl-	C <sub>8</sub> H <sub>16</sub>	112	58.5	113675
33	5.14	55	Cyclobutane, 1,2-diethyl-	C <sub>8</sub> H <sub>16</sub>	112	7.62	61213
34	5.22	95	1,4-Hexadiene, 2,3-dimethyl-	C <sub>8</sub> H <sub>14</sub>	110	13.0	1482
35	5.45	69	3-Heptene, 2,6-dimethyl-	C <sub>9</sub> H <sub>18</sub>	126	16.9	113946
36	5.55	83	Cyclopentane, 1,1,3,4-tetramethyl-, cis-	C <sub>9</sub> H <sub>18</sub>	126	14.2	27589
37	5.65	43	Heptane, 2,4-dimethyl-	C <sub>9</sub> H <sub>20</sub>	128	34.0	155382
38	5.92	69	Cyclohexane, 1,3,5-trimethyl-	C <sub>9</sub> H <sub>18</sub>	126	48.0	114702
39	6.03	70	2,4-Dimethyl-1-heptene	C <sub>9</sub> H <sub>18</sub>	126	48.6	113516
40	6.18	95	1,3-Heptadiene, 5,5-dimethyl-	C <sub>9</sub> H <sub>16</sub>	124	39.2	142726
41	6.27	67	cis-1,4-Dimethyl-2-methylenecyclohexane	C <sub>9</sub> H <sub>16</sub>	124	18.1	113533
42	6.35	69	Cyclohexane, 1,3,5-trimethyl-, (1 $\alpha$ ,3 $\alpha$ ,5 $\beta$ )-	C <sub>9</sub> H <sub>18</sub>	126	32.7	2480
43	6.40	91	Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	106	66.1	114918
44	6.57	109	Cyclohexene, 3,3,5-trimethyl-	C <sub>9</sub> H <sub>16</sub>	124	47.4	114765
45	6.60	67	cis-1,4-Dimethyl-2-methylenecyclohexane	C <sub>9</sub> H <sub>16</sub>	124	16.8	113533
46	6.66	83	2,4,6-Trimethyl-3-heptene	C <sub>10</sub> H <sub>20</sub>	140	58.9	113569
47	6.71	109	Cyclohexene, 3,3,5-trimethyl-	C <sub>9</sub> H <sub>16</sub>	124	41.0	114765
48	6.90	43	Cyclopentane, 1,2,3,4,5-pentamethyl-	C <sub>10</sub> H <sub>20</sub>	140	6.61	152797
49	7.01	43	Dodecane, 1-chloro-	C <sub>12</sub> H <sub>25</sub> Cl	204	4.76	125095
50	7.06	57	Cyclopentane, 1-isobutylidene-3-methyl-	C <sub>10</sub> H <sub>18</sub>	138	8.23	150621

51	7.10	43	Bicyclo[3.1.1]heptan-2-one, 6,6-dimethyl-, (1R)-	C <sub>9</sub> H <sub>14</sub> O	138	15.6	108460
52	7.17	81	1-Nonyne, 7-methyl-	C <sub>10</sub> H <sub>18</sub>	138	7.04	114524
53	7.23	82	1,6-Octadiene, 2,5-dimethyl-, (E)-	C <sub>10</sub> H <sub>18</sub>	138	7.79	62075
54	7.34	95	1-(1,2-Dimethyl-cyclopent-2-enyl)-ethanone	C <sub>9</sub> H <sub>14</sub> O	138	16.6	190582
55	7.43	57	1-Tetradecyne	C <sub>14</sub> H <sub>26</sub>	194	5.26	142648
56	7.48	105	Benzene, (1-methylethyl)-	C <sub>9</sub> H <sub>12</sub>	120	45.5	228742
57	7.52	107	Bicyclo[3.1.0]hexane, 6-isopropylidene-	C <sub>9</sub> H <sub>14</sub>	122	10.7	2225
58	7.63	43	4-Tridecene, (Z)-	C <sub>13</sub> H <sub>26</sub>	182	8.21	142617
59	7.79	56	3-Nonyl-1-ol	C <sub>9</sub> H <sub>16</sub> O	140	6.71	114743
60	7.84	56	Cyclohexanol, 5-methyl-2-(1-methylethenyl)-, [1R-(1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )]-	C <sub>10</sub> H <sub>18</sub> O	154	10.5	114829
61	7.94	70	cis-3-Decene	C <sub>10</sub> H <sub>20</sub>	140	14.4	113558
62	8.01	91	Benzene, propyl-	C <sub>9</sub> H <sub>12</sub>	120	34.0	113930
63	8.06	57	Nonane, 4-methyl-	C <sub>10</sub> H <sub>22</sub>	142	38.1	3834
64	8.13	105	Benzene, 1-ethyl-3-methyl-	C <sub>9</sub> H <sub>12</sub>	120	13.6	228743
65	8.18	105	Benzene, 1-ethyl-3-methyl-	C <sub>9</sub> H <sub>12</sub>	120	19.5	228743
66	8.27	105	Benzene, 1,3,5-trimethyl-	C <sub>9</sub> H <sub>12</sub>	120	16.0	228343
67	8.37	93	Bicyclo[4.1.0]heptane, 3,7,7-trimethyl-, [1S-(1 $\alpha$ ,3 $\beta$ ,6 $\alpha$ )]-	C <sub>10</sub> H <sub>18</sub>	138	10.8	38894
68	8.48	118	Azetidine, 3-methyl-3-phenyl-	C <sub>10</sub> H <sub>13</sub> N	147	22.6	4393
69	8.57	69	Nonane, 2-methyl-3-methylene-	C <sub>11</sub> H <sub>22</sub>	154	7.28	61011
70	8.63	69	3-Undecene, (Z)-	C <sub>11</sub> H <sub>22</sub>	154	6.94	142598
71	8.67	69	4-Undecene, (Z)-	C <sub>11</sub> H <sub>22</sub>	154	6.65	142600
72	8.85	71	Octane, 3,3-dimethyl-	C <sub>10</sub> H <sub>22</sub>	142	10.1	61706
73	8.93	71	Octane, 3,3-dimethyl-	C <sub>10</sub> H <sub>22</sub>	142	8.80	61706
74	9.07	43	4-Decene, 7-methyl-, (E)-	C <sub>11</sub> H <sub>22</sub>	154	7.56	60846
75	9.23	119	2,3-Epoxy-carane, (E)-	C <sub>10</sub> H <sub>16</sub> O	152	33.3	156146
76	9.27	55	3-Undecene, (E)-	C <sub>11</sub> H <sub>22</sub>	154	4.87	60565
77	9.32	68	Limonene	C <sub>10</sub> H <sub>16</sub>	136	21.4	57640
78	9.37	69	2,4-Pentadien-1-ol, 3-pentyl-, (2Z)-	C <sub>10</sub> H <sub>18</sub> O	154	30.2	142197
79	9.43	56	Nonane, 2-methyl-3-methylene-	C <sub>11</sub> H <sub>22</sub>	154	6.36	61011
80	9.64	83	1-Octanol, 2-butyl-	C <sub>12</sub> H <sub>26</sub> O	186	4.34	22280
81	9.73	473	Dodecane, 2,7,10-trimethyl-	C <sub>15</sub> H <sub>32</sub>	212	5.11	62131
82	9.83	43	Cyclohexane, 2-propyl-1,1,3-trimethyl-	C <sub>12</sub> H <sub>24</sub>	168	7.52	69818
83	10.01	69	2-Undecanethiol, 2-methyl-	C <sub>12</sub> H <sub>26</sub> S	202	5.00	9094
84	10.07	69	1-Decene, 2,4-dimethyl-	C <sub>12</sub> H <sub>24</sub>	168	3.80	61110
85	10.22	41	2-Undecanethiol, 2-methyl-	C <sub>12</sub> H <sub>26</sub> S	202	11.9	47373
86	10.26	57	Nonane, 2,8-dimethyl-4-methylene-	C <sub>12</sub> H <sub>24</sub>	168	4.66	6412
87	10.36	57	Undecane	C <sub>11</sub> H <sub>24</sub>	156	13.1	114185
88	10.46	105	11-Hexadecyn-1-ol	C <sub>16</sub> H <sub>30</sub> O	238	10.4	130909
89	10.60	55	6-Octen-1-ol, 3,7-dimethyl-, formate	C <sub>11</sub> H <sub>20</sub> O	184	3.66	157900

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90	10.65	83	Hexane, 1-(isopropylidene-cyclopropyl)-	C <sub>12</sub> H <sub>22</sub>	166	9.24	6216
91	10.75	69	1-Undecene, 8-methyl-	C <sub>12</sub> H <sub>24</sub>	168	2.89	61823
92	10.86	69	1-Dodecanol, 3,7,11-trimethyl-	C <sub>15</sub> H <sub>32</sub> O	228	6.14	114065
93	11.12	69	(2,4,6-Trimethylcyclohexyl) methanol	C <sub>10</sub> H <sub>20</sub> O	156	17.0	113757
94	11.43	69	1-Isopropyl-1,4,5-trimethylcyclohexane	C <sub>12</sub> H <sub>24</sub>	168	25.4	113584
95	12.07	69	1-Dodecanol, 3,7,11-trimethyl-	C <sub>15</sub> H <sub>32</sub> O	228	6.78	114065
96	12.17	69	7-Tetradecene	C <sub>14</sub> H <sub>28</sub>	196	4.37	70643
97	12.26	69	5-Tetradecene, (Z)-	C <sub>14</sub> H <sub>28</sub>	196	5.18	142626
98	12.33	43	2-Piperidinone, N-[4-bromo-n-butyl]-	C <sub>9</sub> H <sub>16</sub> BrN	233	12.3	251632
99	12.39	71	Dodecane, 4,6-dimethyl-	C <sub>14</sub> H <sub>30</sub>	198	10.7	45335
100	12.51	71	Dodecane, 4,6-dimethyl-	C <sub>14</sub> H <sub>30</sub>	198	15.1	45335
101	12.61	71	Decane, 2,3,5,8-tetramethyl-	C <sub>14</sub> H <sub>30</sub>	198	11.3	149589
102	12.93	83	E-2-Hexadecan-1-ol	C <sub>16</sub> H <sub>32</sub> O	240	4.53	131101
103	13.01	57	Dodecane, 2,6,10-trimethyl-	C <sub>15</sub> H <sub>32</sub>	212	7.01	114045
104	13.15	43	2-Hexyl-1-octanol	C <sub>14</sub> H <sub>30</sub> O	214	4.38	113807
105	13.33	57	1-Iodo-2-methylundecane	C <sub>12</sub> H <sub>25</sub> I	296	5.99	101485
106	13.41	69	1-Nonene, 4,6,8-trimethyl-	C <sub>12</sub> H <sub>24</sub>	168	3.98	6413
107	13.52	69	1-Nonene, 4,6,8-trimethyl-	C <sub>12</sub> H <sub>24</sub>	168	4.45	6413
108	13.65	69	1-Nonene, 4,6,8-trimethyl-	C <sub>12</sub> H <sub>24</sub>	168	4.91	6413
109	13.83	57	4-Nonene, 5-butyl-	C <sub>13</sub> H <sub>26</sub>	182	3.94	34734
110	14.01	69	1-Octanol, 2-butyl-	C <sub>12</sub> H <sub>26</sub> O	186	3.66	114639
111	14.38	69	7-Octadecyne, 2-methyl-	C <sub>19</sub> H <sub>36</sub>	264	4.52	114518
112	14.48	55	E-2-Octadecadecan-1-ol	C <sub>18</sub> H <sub>36</sub> O	268	4.23	131102
113	14.16	55	1,9-Tetradecadiene	C <sub>14</sub> H <sub>26</sub>	194	4.21	187543
114	15.08	69	Trichloroacetic acid, hexadecyl ester	C <sub>18</sub> H <sub>33</sub> Cl <sub>3</sub>	386	5.28	280518
115	15.35	71	Tetradecane, 2,6,10-trimethyl-	C <sub>17</sub> H <sub>36</sub>	240	8.48	11556
116	15.47	71	Decane, 2,3,5,8-tetramethyl-	C <sub>14</sub> H <sub>30</sub>	198	11.1	149589
117	15.71	71	Heptadecane, 2,6,10,15-tetramethyl-	C <sub>21</sub> H <sub>44</sub>	296	7.27	14103
118	16.15	83	Isotridecanol-	C <sub>13</sub> H <sub>28</sub> O	200	2.92	298499
119	16.26	69	Acetic acid, 3,7,11,15-tetramethyl-hexadecyl ester	C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	340	6.05	193630
120	17.13	69	Cyclododecanemethanol	C <sub>13</sub> H <sub>26</sub> O	198	5.34	108275
121	18.26	71	Tetradecane, 2,6,10-trimethyl-	C <sub>17</sub> H <sub>36</sub>	240	8.85	11556
122	18.76	69	1-Nonadecene	C <sub>19</sub> H <sub>38</sub>	266	4.92	107568
123	21.01	69	1-Hexadecanol, 3,7,11,15-tetramethyl-	C <sub>20</sub> H <sub>42</sub> O	298	7.17	194527
124	21.73	69	Oxirane, tetradecyl-	C <sub>16</sub> H <sub>32</sub> O	240	6.71	75831
125	23.04	69	-Hexadecanol, 3,7,11,15-tetramethyl-	C <sub>20</sub> H <sub>42</sub> O	298	5.04	194527
126	24.91	69	Oxalic acid, allyl hexadecyl ester	C <sub>21</sub> H <sub>38</sub> O <sub>4</sub>	354	3.84	309244

Polypropylene waste plastic and waste tyre to fuel was analysis by Perkin Elmer GC/MS (Model Clarus 500) and chromatogram and compounds showed figure 2 and table 1. For GC/MS analysis purpose capillary column was use and solvent was use carbon disulfide ( $C_2S$ ). GC/MS chromatogram to fuel compounds traced from NIST library and all compounds was detected based on fragmentation trace mass ( $m/z$ ) and retention time ( $t$ ). Polypropylene has long chain hydrocarbon with methyl group and tyre has carbon hydrogen combination with different types of additives. Fuel analysis result showed fuel compounds have aliphatic hydrocarbon, aromatics group, halogen group, nitrogen content, oxygen content, alcoholic group, sulfur content. Polystyrene waste plastic and tyre to fuel carbon chain start  $C_3$  to  $C_{22}$ . All compounds showed into table 1 with peak number, retention time, compounds name, compounds formula, compounds molecular weight, compound probability percentage, and NIST library number. Starting compound is Propene ( $C_3H_6$ ) ( $t=1.49$ ,  $m/z=41$ ) Compound probability percentage 44.5 %, then rest of compounds are followed lower carbon number to higher carbon number such as Pentane ( $C_5H_{12}$ ) ( $t=1.91$ ,  $m/z=42$ ) Compound probability percentage 74.2%, 2-methyl- Pentane ( $C_6H_{14}$ ) ( $t=2.31$ ,  $m/z=43$ ) Compound probability percentage 58.2 %, 2,4-dimethyl- Pentane ( $C_7H_{16}$ ) ( $t=2.85$ ,  $m/z=43$ ) Compound probability percentage 61.0 %, 2,4-Dimethyl 1,4-pentadiene ( $C_7H_{12}$ ) ( $t=3.15$ ,  $m/z=81$ ) Compound probability percentage 48.2 %, 2-methyl-1-Hexene ( $C_7H_{14}$ ) ( $t=3.56$ ,  $m/z=56$ ) Compound probability percentage 31.6 %, Heptane ( $C_7H_{16}$ ) ( $t=3.72$ ,  $m/z=43$ ) Compound probability percentage 51.7 %, 4,4-dimethyl-Cyclopentene ( $C_7H_{12}$ ) ( $t=3.80$ ,  $m/z=81$ ) Compound probability percentage 13.3 %, 2,3-dimethyl-Pentanal ( $C_7H_{14}O$ ) ( $t=4.29$ ,  $m/z=43$ ) Compound probability percentage 7.84 %, 2,4-Dimethyl-1-hexene ( $C_8H_{16}$ ) ( $t=4.51$ ,  $m/z=56$ ) Compound probability percentage 56.1 %, 4-methyl-Heptane ( $C_8H_{18}$ ) ( $t=4.75$ ,  $m/z=43$ ) Compound probability percentage 62.0 %, 2,3-dimethyl-1,4-Hexadiene ( $C_8H_{14}$ ) ( $t=5.22$ ,  $m/z=95$ ) Compound probability percentage 13.0 %, 1,3,5-trimethyl-Cyclohexane ( $C_9H_{18}$ ) ( $t=5.92$ ,  $m/z=69$ ) Compound probability percentage 48.0 %, cis-1,4-Dimethyl-2-methylenecyclohexane ( $C_9H_{16}$ ) ( $t=6.27$ ,  $m/z=67$ ) Compound probability percentage 18.1%, 3,3,5-trimethyl-Cyclohexene ( $C_9H_{16}$ ) ( $t=6.57$ ,  $m/z=109$ ) Compound probability percentage 47.4 %, 1,2,3,4,5-pentamethyl-Cyclopentane ( $C_{10}H_{20}$ ) ( $t=6.90$ ,  $m/z=43$ ) Compound probability percentage 6.61 %, 7-methyl-1-Nonyne ( $C_{10}H_{18}$ ) ( $t=7.17$ ,  $m/z=81$ ) Compound probability percentage 7.04 %, (1-methylethyl)- Benzene ( $C_9H_{12}$ ) ( $t=7.48$ ,  $m/z=105$ ) Compound probability percentage 45.5 %, 3-Nonyl-1-ol ( $C_9H_{16}O$ ) ( $t=7.79$ ,  $m/z=56$ ) Compound

probability percentage 6.71 %, propyl-Benzene ( $C_9H_{12}$ ) ( $t=8.01$ ,  $m/z=91$ ) Compound probability percentage 34.0 %, 1,3,5-trimethyl-Benzene ( $C_9H_{12}$ ) ( $t=8.27$ ,  $m/z=105$ ) Compound probability percentage 16.0 %, 3-methyl-3-phenyl-Azetidine ( $C_{10}H_{13}N$ ) ( $t=8.48$ ,  $m/z=118$ ) Compound

probability percentage 22.6 %, 3,3-dimethyl-Octane ( $C_{10}H_{22}$ ) ( $t=8.85$ ,  $m/z=71$ ) Compound probability percentage 10.1 %, Limonene ( $C_{10}H_{16}$ ) ( $t=9.32$ ,  $m/z=68$ ) Compound probability percentage 21.4 %, 2-methyl-3-methylene-Nonane ( $C_{11}H_{22}$ ) ( $t=9.43$ ,  $m/z=56$ ) Compound probability percentage 6.36 %, 2-propyl-1,1,3-trimethyl-Cyclohexane ( $C_{12}H_{24}$ ) ( $t=9.83$ ,  $m/z=43$ ) Compound probability percentage 7.52 %, 2,8-dimethyl-4-methylene-Nonane ( $C_{12}H_{24}$ ) ( $t=10.26$ ,  $m/z=57$ ) Compound probability percentage 4.66 %, 1-Isopropyl-1,4,5-trimethylcyclohexane ( $C_{12}H_{24}$ ) ( $t=11.43$ ,  $m/z=69$ ) Compound probability percentage 25.4 %, 4,6-dimethyl-Dodecane ( $C_{14}H_{30}$ ) ( $t=12.51$ ,  $m/z=71$ ) Compound probability percentage 15.1 %, 2-Hexyl-1-octanol ( $C_{14}H_{30}O$ ) ( $t=13.15$ ,  $m/z=43$ ) Compound probability percentage 4.38 %, 1,9-Tetradecadiene ( $C_{14}H_{26}$ ) ( $t=14.16$ ,  $m/z=55$ ) Compound probability percentage 4.21 %, 2,6,10-trimethyl-tetradecane ( $C_{17}H_{36}$ ) ( $t=15.35$ ,  $m/z=71$ ) Compound probability percentage 8.48 %, 2,6,10,15-tetramethyl-Heptadecane ( $C_{21}H_{44}$ ) ( $t=15.71$ ,  $m/z=71$ ) Compound probability percentage 7.27 %, 2,6,10-trimethyl-Tetradecane ( $C_{17}H_{36}$ ) ( $t=18.26$ ,  $m/z=71$ ) Compound probability percentage 8.85 %, 3,7,11,15-tetramethyl-1-Hexadecanol ( $C_{20}H_{42}O$ ) ( $t=21.01$ ,  $m/z=69$ ) Compound probability percentage 7.17 %, and so on.

## V. CONCLUSION

Polypropylene waste plastic and waste tyre to fuel recovery experiment with ZnO catalyst was successfully. Fuel production temperature range was 250 to 430 °C. Fuel conversion rate was 63.47 % and fuel color is light yellow. Density is 0.75 gm/ml and fuel was analysis by GC/MS and compounds range showed  $C_3$  to  $C_{21}$ . Fuel has some benzene group compounds because initial materials were tyre and tyre has aromatic group. Aromatic group are present into fuel such as Toluene, Ethylbenzene, (1-methylethyl)-Benzene, propyl-Benzene, 1-ethyl-3-methyl-Benzene, 1, 3, 5-trimethyl-Benzene, 3-methyl-3-phenyl-Azetidine, Limonene, and etc. ZnO catalyst recover under consideration and light gas, solid black residue is under consideration. Fuel can use direct internal combustion engines and it can produce electricity by using generator.

Using this present technology can convert all polypropylene waste plastic and waste tyre mixture to fuel and reduce environmental problem same time.

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