

Research article

# Catalytic Conversion of Low Density Polyethylene and Polyvinyl Chloride Mixture into Fuel using $\text{Al}_2\text{O}_3$

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## Abstract

Low density polyethylene waste and polyvinyl chloride waste plastics are creating environmental problems because plastic are slowly degradable and its can remain long period into environment. For environmental problem solve and recovery fuel energy from waste plastics by using catalytic process with aluminum oxide. Polyvinyl chloride and low density polyethylene mixture to fuel recovery using aluminum oxide catalyst at temperature range 150 -420 °C. Polyvinyl chloride was use 25 gm and low density polyethylene was use 50 gm by weight and aluminum oxide was use 2%. Experiment was performing under laboratory fume hood with Pyrex glass reactor at temperature range was 150- 420 °C. Produce fuel density was 0.76 gm/ ml and conversion rate was 75.85 including liquid and light gas. Fuel was analysis by Perkin Elmer GC/MS and hydrocarbon compounds chain detected  $\text{C}_3$ - $\text{C}_{28}$  including alcoholic compounds, halogenated compounds, oxygen containing compounds, nitrogen containing compounds and some aromatic group. **Copyright © IJMMT, all rights reserved.**

**Keywords:** low density polyethylene, polyvinyl chloride, fuel, catalytic conversion, aluminum oxide, GC/MS

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## 1. 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 lignosellulosic 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 [3].

The huge amount of waste plastics that resulted from the dramatic increase in polymer production gives rise to serious environmental concerns, as plastic does not degrade and remains in municipal refuse tips for decades. Plastic waste being more voluminous than the organic waste takes up a lot of landfill space that is becoming scarce and expensive. Incineration is not an acceptable solution to the problem, as toxic gases are produced and solid waste problems become air pollution. The only sustainable solution is polymer recycling. Between various polymer recycling methods, thermal and/or catalytic degradation of plastic waste to fuel show the highest potential for a successful future commercial process [4–8], especially as plastics waste can be considered as a cheap source of raw materials in times of accelerated depletion of natural resources [9]. Catalytic degradation of plastic waste of considerable advantages as compared to pure thermal degradation, as the latter demands relatively high temperatures and its products require further processing for their quality to be upgraded. Some catalytic process mainly zeolite-based catalysts have been used, as well as silica–alumina, clay-based catalysts and MCM-type mesoporous materials [10-21]. 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 coliquefaction process due to the fact that coal is an abundant fuel resource [22, 23]. Furthermore, previous studies indicated that reactions involved in liquefaction techniques included addition of hydrogen and ring opening of the large carbonaceous molecules, and consequently these transformations would be favored in the case of lignitic substrates [24]. Finally, acidic catalysts have been found to promote this type of Liquefaction process [25, 26]. In this experiment main goal was low density polyethylene waste plastic with mixture of polyvinyl chloride waste plastic to fuel recovery by using aluminum oxide catalyst at temperature range 150-420 °C.

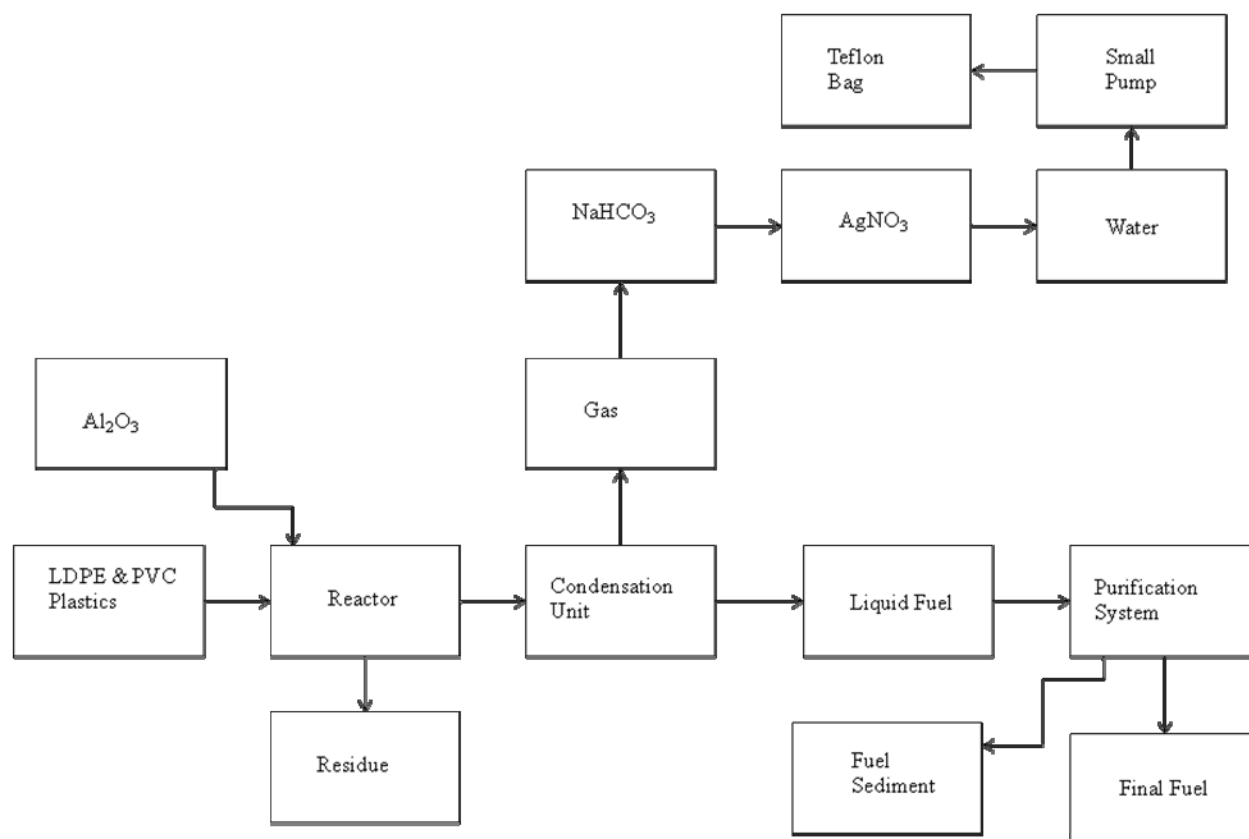
## 2. Materials

Polyvinyl chloride waste plastic and low density polyethylene waste plastic was collected from Stamford municipality. Polyvinyl chloride waste plastic was pipe and low density polyethylene was garbage container. Both waste plastics were hard type and PVC color was transparent and LDPE color was gray. Plastics was cut into small pieces and placed into reactor chamber for liquefaction process. Aluminum Oxide catalyst was collected from VWR.COM Company and it was powder types. Polyvinyl chloride waste plastics add 25 gm and low density polyethylene was added 50 gm and 1.5 gm was aluminum oxide catalyst.

## 3. Process Description

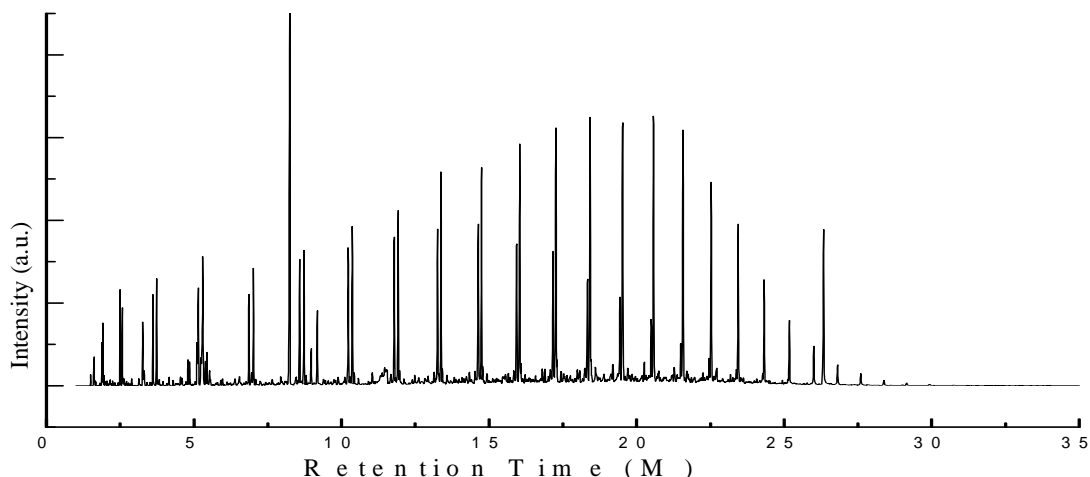
Polyvinyl chloride and low density polyethylene waste plastics to fuel was recover using aluminum oxide catalyst and temperature range was 150-420 °C. Experimental process was setup under laboratory fume hood without vacuum system. For experiment purpose raw materials was used only 75 gm of PVC and LDPE mixture waste plastics. Experimental process shown into figure 1 and it was fully close system. For this experimental purpose required accessories and materials such as reactor, condensation unit, liquid fuel collection tank, fuel purification device, sediment container, final fuel collection tank, residue collection container, light gas cleaning device, two types of liquid solution [0.25 (N) NaHCO<sub>3</sub>, 0.25 (N) AgNO<sub>3</sub>], distilled water, small pump and Teflon Bag. All small parts were connected one end to another end and connection was tightening enough to prevent gas leak. Because PVC has chlorine content and its can produce harmful gas for that reason gas was transferred into NaHCO<sub>3</sub>, AgNO<sub>3</sub> and finally passed through clean water removed all toxic gas during conversion period. PVC and LDPE waste plastic to fuel production starting temperature was 150 °C and finished temperature was 420 °C. Production temperature was controlled with variac meter and experiment temperature was observed continuously. Experimental

temperature sometimes increased and sometimes decreased based on fuel production quality and reactor inside gas generation. PVC and LDPE waste plastic to fuel production starting temperature when increase within 15-20 minutes reactor inside was smoke and its come out via condensation unit and start to drop wise liquid fuel. Aluminum Oxide was use as a catalyst to remove some portion of chlorine content and recovery liquid fuel from chlorine content. Chlorine content and aluminum content can react and produce aluminum chloride salt and settle down into reactor bottom as residue. A PVC waste plastic has high percentage of chlorine content and it is more than 50% with hydrocarbon compounds and some additives. On the other hand LDPE waste plastic has long chain hydrocarbon compounds with additives. Plastics have different types of additives and all additives are adding base on their requirement. Plastics additives are reinforcing fiber, fillers, coupling agent, plasticizers, colorants, stabilizers (halogen stabilizers, antioxidants, ultraviolet absorbers and biological preservatives), processing aids (lubricants, and flow control), flame retardants, peroxide and antistatic agent. All additives are not come with fuel during conversion period and it is settle down inside reactor bottom as residue. In this experiment temperature range was 150 - 420 °C and all additives temperature above experimental temperature for that reason additives part is not coming with fuel. Fuel was cleaned with filter purification system and transfer into final collection tank and fuel sediment was collected into different another container from purification part. In mass balance calculation shown liquid fuel was 44.4 gm, light gas was generated 12.5 gm and left over residue was 18.1 gm. In this experiment shown residue part high because PVC has high percentage chlorine content this was not convertible. Total experiment time was 4.30 hours and input electricity was required 0.744 KWh.



**Figure 1:** Low density polyethylene and polyvinyl chloride mixture to fuel production using aluminum oxide

#### 4. Result and Discussion



**Figure 2:** GC/MS chromatogram of low density polyethylene and polyvinyl chloride mixture to fuel

**Table 1:** GC/MS chromatogram compounds list of low density polyethylene and polyvinyl chloride 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	Propane	C <sub>3</sub> H <sub>8</sub>	44	36.4	18863
2	1.61	43	Butane	C <sub>4</sub> H <sub>10</sub>	58	74.9	123
3	1.63	41	2-Butene	C <sub>4</sub> H <sub>8</sub>	56	37.6	61292
4	1.67	41	2-Butene, (E)-	C <sub>4</sub> H <sub>8</sub>	56	26.7	105
5	1.87	42	Cyclopropane, ethyl-	C <sub>5</sub> H <sub>10</sub>	70	19.5	114410
6	1.91	43	Pentane	C <sub>5</sub> H <sub>12</sub>	72	82.4	61286
7	1.95	55	2-Pentene	C <sub>5</sub> H <sub>10</sub>	70	19.8	19079
8	1.99	55	2-Pentene, (E)-	C <sub>5</sub> H <sub>10</sub>	70	19.4	291780
9	2.01	55	1-Butene, 3-methyl-	C <sub>5</sub> H <sub>10</sub>	70	26.3	160477
10	2.06	67	1,3-Pentadiene	C <sub>5</sub> H <sub>8</sub>	68	20.6	291890
11	2.24	67	Bicyclo[2.1.0]pentane	C <sub>5</sub> H <sub>8</sub>	68	12.7	192491
12	2.32	42	1-Pentanol, 2-methyl-	C <sub>6</sub> H <sub>14</sub> O	102	16.5	19924
13	2.44	57	Pentane, 3-methyl-	C <sub>6</sub> H <sub>14</sub>	86	59.4	19375
14	2.50	41	1-Hexene	C <sub>6</sub> H <sub>12</sub>	84	22.4	227613
15	2.57	57	Hexane	C <sub>6</sub> H <sub>14</sub>	86	85.5	291337
16	2.62	55	3-Hexene, (E)-	C <sub>6</sub> H <sub>12</sub>	84	19.7	19325
17	2.72	55	3-Hexene, (Z)-	C <sub>6</sub> H <sub>12</sub>	84	34.6	114381
18	2.89	56	Cyclopentane, methyl-	C <sub>6</sub> H <sub>12</sub>	84	67.0	114428
19	3.14	67	Cyclopentene, 3-methyl-	C <sub>6</sub> H <sub>10</sub>	82	12.0	114408
20	3.26	78	Benzene	C <sub>6</sub> H <sub>6</sub>	78	69.7	114388
21	3.31	41	Butane, 2-chloro-2-methyl-	C <sub>5</sub> H <sub>11</sub> Cl	106	78.1	58840

22	3.41	43	Hexane, 3-methyl-	C <sub>7</sub> H <sub>16</sub>	100	70.3	113081
23	3.52	67	Cyclohexene	C <sub>6</sub> H <sub>10</sub>	82	23.2	114431
24	3.61	56	1-Heptene	C <sub>7</sub> H <sub>14</sub>	98	37.7	107734
25	3.73	43	Heptane	C <sub>7</sub> H <sub>16</sub>	100	77.1	61276
26	3.77	41	3-Hexene, 2-methyl-, (E)-	C <sub>7</sub> H <sub>14</sub>	98	14.2	114086
27	3.82	55	2-Heptene	C <sub>7</sub> H <sub>14</sub>	98	31.2	160628
28	4.08	67	1-Ethylcyclopentene	C <sub>7</sub> H <sub>12</sub>	96	22.1	114407
29	4.16	55	Cyclohexane, methyl-	C <sub>7</sub> H <sub>14</sub>	98	75.0	118503
30	4.30	69	Cyclopentane, ethyl-	C <sub>7</sub> H <sub>14</sub>	98	37.1	940
31	4.38	81	Cyclopropane, trimethylmethylen-	C <sub>7</sub> H <sub>12</sub>	96	11.1	63085
32	4.43	55	3-Hepten-1-ol	C <sub>7</sub> H <sub>14</sub> O	114	26.8	113238
33	4.47	55	1-Heptene, 3-methyl-	C <sub>8</sub> H <sub>16</sub>	112	10.9	60730
34	4.55	81	2,3-Diazabicyclo[2.2.1]hept-2-ene, 1,4-dimethyl-	C <sub>7</sub> H <sub>12</sub> N <sub>2</sub>	124	5.76	142837
35	4.59	67	Cyclopentane, ethylidene-	C <sub>7</sub> H <sub>12</sub>	96	9.54	151340
36	4.73	43	1-Heptene, 5-methyl-	C <sub>8</sub> H <sub>16</sub>	112	19.8	60729
37	4.75	43	1-Heptene, 4-methyl-	C <sub>8</sub> H <sub>16</sub>	112	25.3	113433
38	4.79	91	Toluene	C <sub>7</sub> H <sub>8</sub>	92	38.6	291301
39	4.85	43	4-Hepten-1-ol	C <sub>7</sub> H <sub>14</sub> O	114	8.27	157563
40	4.95	67	1,4-Heptadiene	C <sub>7</sub> H <sub>12</sub>	96	7.20	113639
41	5.11	70	Heptane, 3-methylene-	C <sub>8</sub> H <sub>16</sub>	112	58.4	288517
42	5.15	55	1-Octene	C <sub>8</sub> H <sub>16</sub>	112	31.3	1604
43	5.30	43	Hexane, 2,4-dimethyl-	C <sub>8</sub> H <sub>18</sub>	114	35.5	118871
44	5.39	55	2-Octene, (Z)-	C <sub>8</sub> H <sub>16</sub>	112	22.7	113889
45	5.44	70	2-Heptene, 3-methyl-	C <sub>8</sub> H <sub>16</sub>	112	21.1	149374
46	5.53	55	2-Octene, (Z)-	C <sub>8</sub> H <sub>16</sub>	112	22.0	113889
47	5.80	67	1-Methylcycloheptene	C <sub>8</sub> H <sub>14</sub>	110	18.0	113672
48	5.91	41	3-Octen-1-ol, (Z)-	C <sub>8</sub> H <sub>16</sub> O	128	6.58	53353
49	5.97	83	Cyclohexane, ethyl-	C <sub>8</sub> H <sub>16</sub>	112	60.5	113476
50	6.11	67	Cyclopentene, 1-propyl-	C <sub>8</sub> H <sub>14</sub>	110	13.0	142659
51	6.24	81	1-Nonyne	C <sub>9</sub> H <sub>16</sub>	124	8.10	231601
52	6.40	91	Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	106	51.9	114918
53	6.54	81	Cyclohexene, 1,2-dimethyl-	C <sub>8</sub> H <sub>14</sub>	110	11.9	113912
54	6.60	67	1-Methyl-2-methylenecyclohexane	C <sub>8</sub> H <sub>14</sub>	110	8.65	113437
55	6.86	56	1-Nonene	C <sub>9</sub> H <sub>18</sub>	126	22.6	107756
56	6.96	91	p-Xylene	C <sub>8</sub> H <sub>10</sub>	106	40.3	113952
57	7.02	43	Nonane	C <sub>9</sub> H <sub>20</sub>	128	37.6	228006
58	7.10	55	cis-2-Nonene	C <sub>9</sub> H <sub>18</sub>	126	19.7	113508
59	7.24	55	4-Nonene	C <sub>9</sub> H <sub>18</sub>	126	11.5	113904
60	8.25	55	Heptane, 3-chloro-3-methyl-	C <sub>8</sub> H <sub>17</sub> Cl	148	71.1	114670
61	8.58	56	1-Decene	C <sub>10</sub> H <sub>20</sub>	140	20.7	107686
62	8.83	57	Decane	C <sub>10</sub> H <sub>22</sub>	142	36.6	291484

63	8.97	57	Heptane, 3-(chloromethyl)-	C <sub>8</sub> H <sub>17</sub> Cl	148	66.3	35077
64	9.18	57	1-Hexanol, 2-ethyl-	C <sub>8</sub> H <sub>18</sub> O	130	64.2	114109
65	10.11	70	4-Undecene, (Z)-	C <sub>11</sub> H <sub>22</sub>	154	5.77	142600
66	10.23	55	1-Undecene	C <sub>11</sub> H <sub>22</sub>	154	7.32	5022
67	10.29	55	5-Undecene, (E)-	C <sub>11</sub> H <sub>22</sub>	154	7.10	114227
68	10.37	57	Undecane	C <sub>11</sub> H <sub>24</sub>	156	32.3	107774
69	10.43	55	3-Undecene, (Z)-	C <sub>11</sub> H <sub>22</sub>	154	15.9	142598
70	11.67	70	2-Undecene, 3-methyl-, (Z)-	C <sub>12</sub> H <sub>24</sub>	168	5.04	61835
71	11.79	55	1-Dodecene	C <sub>12</sub> H <sub>24</sub>	168	14.7	107688
72	11.92	57	Dodecane	C <sub>12</sub> H <sub>26</sub>	170	31.5	291499
73	11.97	55	3-Dodecene, (E)-	C <sub>12</sub> H <sub>24</sub>	168	11.0	70642
74	13.14	70	5-Tridecene, (E)-	C <sub>13</sub> H <sub>26</sub>	182	6.82	142619
75	13.25	55	1-Tridecene	C <sub>13</sub> H <sub>26</sub>	182	18.6	107768
76	13.37	57	Tridecane	C <sub>13</sub> H <sub>28</sub>	184	42.3	107767
77	13.42	55	5-Tridecene, (E)-	C <sub>13</sub> H <sub>26</sub>	182	11.2	142619
78	13.57	55	4-Nonene, 5-butyl-	C <sub>13</sub> H <sub>26</sub>	182	5.43	34734
79	14.64	41	1-Tetradecene	C <sub>14</sub> H <sub>28</sub>	196	6.09	69725
80	14.75	57	Tetradecane	C <sub>14</sub> H <sub>30</sub>	198	45.2	113925
81	14.79	55	4-Tetradecene, (E)-	C <sub>14</sub> H <sub>28</sub>	196	6.36	142625
82	14.93	55	7-Tetradecene	C <sub>14</sub> H <sub>28</sub>	196	9.53	70643
83	15.94	55	1-Pentadecene	C <sub>15</sub> H <sub>30</sub>	210	10.6	69726
84	16.04	57	Pentadecane	C <sub>15</sub> H <sub>32</sub>	212	37.3	107761
85	16.08	55	E-2-Hexadecacen-1-ol	C <sub>16</sub> H <sub>32</sub> O	240	7.82	131101
86	17.17	55	1-Hexadecene	C <sub>16</sub> H <sub>32</sub>	224	9.31	69727
87	17.27	57	Hexadecane	C <sub>16</sub> H <sub>34</sub>	226	40.2	114191
88	17.44	55	1-Hexadecanol	C <sub>16</sub> H <sub>34</sub> O	242	3.18	114116
89	18.33	55	8-Heptadecene	C <sub>17</sub> H <sub>34</sub>	238	6.41	107001
90	18.43	57	Heptadecane	C <sub>17</sub> H <sub>36</sub>	240	31.0	107308
91	18.60	55	8-Heptadecene	C <sub>17</sub> H <sub>34</sub>	238	5.56	113620
92	19.20	57	Heptadecane, 2,3-dimethyl-	C <sub>19</sub> H <sub>40</sub>	268	11.8	68909
93	19.44	55	E-15-Heptadecenal	C <sub>17</sub> H <sub>32</sub> O	252	6.88	130979
94	19.53	57	Octadecane	C <sub>18</sub> H <sub>38</sub>	254	22.1	57273
95	19.70	57	1-Decanol, 2-hexyl-	C <sub>16</sub> H <sub>34</sub> O	242	4.98	114709
96	20.26	57	Heptadecane, 9-octyl-	C <sub>25</sub> H <sub>52</sub>	352	7.19	15951
97	20.49	55	9-Nonadecene	C <sub>19</sub> H <sub>38</sub>	266	10.5	113627
98	20.57	57	Nonadecane	C <sub>19</sub> H <sub>40</sub>	268	30.3	114098
99	20.75	57	1-Decanol, 2-hexyl-	C <sub>16</sub> H <sub>34</sub> O	242	5.50	114709
100	21.50	55	5-Eicosene, (E)-	C <sub>20</sub> H <sub>40</sub>	280	5.88	62816
101	21.57	57	Eicosane	C <sub>20</sub> H <sub>42</sub>	282	29.8	290513
102	21.70	57	1-Eicosanol	C <sub>20</sub> H <sub>42</sub> O	298	8.23	23222
103	22.46	55	10-Heneicosene (c,t)	C <sub>21</sub> H <sub>42</sub>	294	9.26	113073
104	22.53	57	Heneicosane	C <sub>21</sub> H <sub>44</sub>	296	30.0	107569
105	22.72	149	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl)	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	278	39.9	75949

			ester				
106	23.38	55	1-Docosene	C <sub>22</sub> H <sub>44</sub>	308	16.5	113878
107	23.44	57	Heneicosane	C <sub>21</sub> H <sub>44</sub>	296	15.2	107569
108	24.27	55	1-Docosene	C <sub>22</sub> H <sub>44</sub>	308	10.1	113878
109	24.32	57	Heneicosane	C <sub>21</sub> H <sub>44</sub>	296	12.7	107569
110	25.17	57	Tetracosane	C <sub>24</sub> H <sub>50</sub>	338	19.6	248196
111	26.00	57	Heneicosane	C <sub>21</sub> H <sub>44</sub>	296	9.16	107569
112	26.33	149	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	278	36.0	291384
113	26.81	57	Octacosane	C <sub>28</sub> H <sub>58</sub>	394	8.84	149865
114	27.05	57	Oxalic acid, cyclobutyl hexadecyl ester	C <sub>22</sub> H <sub>40</sub> O <sub>4</sub>	368	7.91	309706
115	27.60	57	Heptacosane	C <sub>27</sub> H <sub>56</sub>	380	11.4	79427
116	28.38	57	Tetracosane	C <sub>24</sub> H <sub>50</sub>	338	10.4	149864

Perkin Elmer Gas Chromatography and Mass Spectrometer (GC/MS) was used for product fuel analysis purpose (Figure 2 and table 1). PVC and LDPE waste plastic mixture to fuel recovery with aluminum oxide catalyst and fuel color was light yellow. Product fuel density is 0.76 gm/ml and GC/MS result showed hydrocarbon chain C<sub>3</sub>H<sub>8</sub> to C<sub>28</sub>H<sub>58</sub>. Initial raw materials were PVC and LDPE mixture for that reason product fuel has some percentage halogenated compounds. Above analysis Table 1 showed product fuel has most of the hydrocarbon compounds including alcoholic group compounds, halogenated compounds, oxygen containing compounds, nitrogen containing compounds and aromatics groups. PVC has chlorine content 56% for that reason aluminum oxide was used to remove some percentage chlorine from product fuel. In GC/MS chromatogram compounds showed some percentage chlorine compounds detected from product fuel. Aluminum oxide is help to remove some percentage chlorine during production period. GC/MS analysis compounds that is showing only 3 compounds with chlorine content and this chlorine content need to remove before run any internal combustion engine by using refinery process. Fuel is ignited and it can use as heating fuel. Above table all GC/MS compounds was traced based on compounds retention time and trace mass. From product fuel to GC/MS starting compounds was Propane (C<sub>3</sub>H<sub>8</sub>) (t=1.49, m/z=41) then rest of compounds were detected based on retention time and trace mass such as (E)-2-Butene (C<sub>4</sub>H<sub>8</sub>) (t=1.67, m/z=41), 3-methyl-1-Butene (C<sub>5</sub>H<sub>10</sub>) (t=2.01, m/z=55), 3-methyl-Pentane (C<sub>6</sub>H<sub>14</sub>) (t=2.44, m/z=57), Benzene (C<sub>6</sub>H<sub>6</sub>) (t=3.26, m/z=78), (E)-2-methyl-3-Hexene (C<sub>7</sub>H<sub>14</sub>) (t=3.77, m/z=41), 3-Hepten-1-ol (C<sub>7</sub>H<sub>14</sub>O) (t=4.43, m/z=55), 1,4-dimethyl-2,3-Diazabicyclo[2.2.1]hept-2-ene (C<sub>7</sub>H<sub>12</sub>N<sub>2</sub>) (t=4.55, m/z=81), Toluene (C<sub>7</sub>H<sub>8</sub>) (t=4.79, m/z=91), 3-methylene-Heptane (C<sub>8</sub>H<sub>16</sub>) (t=5.11, m/z=70), Ethyl-Cyclohexane (C<sub>8</sub>H<sub>16</sub>) (t=5.97, m/z=83), Ethylbenzene (C<sub>8</sub>H<sub>10</sub>) (t=6.40, m/z=91), 1-Nonene (C<sub>9</sub>H<sub>18</sub>) (t=6.86, m/z=56), 3-chloro-3-methyl-Heptane (C<sub>8</sub>H<sub>17</sub>Cl) (t=8.25, m/z=55), Undecane (C<sub>11</sub>H<sub>24</sub>) (t=10.37, m/z=57), Dodecane (C<sub>12</sub>H<sub>26</sub>) (t=11.92, m/z=57), Tridecane (C<sub>13</sub>H<sub>28</sub>) (t=13.37, m/z=57), Tetradecane (C<sub>14</sub>H<sub>30</sub>) (t=14.75, m/z=57), Pentadecane (C<sub>15</sub>H<sub>32</sub>) (t=16.04, m/z=57), Hexadecane (C<sub>16</sub>H<sub>34</sub>) (t=17.27, m/z=57), Heptadecane (C<sub>17</sub>H<sub>36</sub>) (t=18.43, m/z=57), E-15-Heptadecenal (C<sub>17</sub>H<sub>32</sub>O) (t=19.44, m/z=55), 2-hexyl-1-Decanol (C<sub>16</sub>H<sub>34</sub>O) (t=20.75, m/z=57), 1-Eicosanol (C<sub>20</sub>H<sub>42</sub>O) (t=21.70, m/z=57), 1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester (C<sub>16</sub>H<sub>22</sub>O<sub>4</sub>) (C<sub>16</sub>H<sub>22</sub>O<sub>4</sub>) (t=22.72, m/z=149), Tetracosane (C<sub>24</sub>H<sub>50</sub>) (t=25.17, m/z=57), Octacosane (C<sub>28</sub>H<sub>58</sub>) (t=26.81, m/z=57), Heptacosane (C<sub>27</sub>H<sub>56</sub>) (t=27.60, m/z=57). Product fuel ester compounds are coming from raw materials plasticizers and peak intensity very small and further refinery modification it will remove. Residue and light gas is under

investigation. Product fuel can use refinery process for further modification because product fuel has chlorine content.

## 5. Conclusion

Catalytic conversion of low density polyethylene and polyvinyl chloride mixture to fuel recovery experiment was successfully with aluminum oxide. In the experiment mass balance result was shown residue percentage was high because polyvinyl chloride has 56% chlorine content which was not convertible. Product fuel analysis result showed fuel has hydrocarbon compounds with alcoholic, halogenated, oxygen content, nitrogen content and aromatic group. Product fuel aromatic presented group are Benzene ( $C_6H_6$ ), Toluene ( $C_7H_8$ ), Ethylbenzene ( $C_8H_{10}$ ), p-Xylene ( $C_8H_{10}$ ). All aromatic groups are appeared from polyvinyl chloride because polyvinyl chloride has aromatics compounds. Product fuel has long chain hydrocarbon and aromatic combination that why fuel efficiency is high and fuel was ignite long time. By using this technology waste plastics LDPE and PVC problem can solve and recover valuable fuel energy and boost up alternative energy sector and resolve some foreign oil dependency same time.

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