

Research article

Motor Vehicle Tire and High Density Polyethylene (HDPE-2) Mixture Convert into Fuel Energy Using Thermal Process

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Abstract

Motor vehicle used tire and municipality high density polyethylene mixture converted into fuel energy using thermal degradation process in laboratory batch scale process. Thermal degradation temperature range was 225 °C to 405 °C. In this process glass reactor was use and initial raw materials ratio was 2:1 by weight. High density polyethylene was 50 gm by weight and motor vehicle used tire was 25 gm by weight. Produced fuel was analyzed by GC/MS and compound was detected carbon chain C₃ – C₂₂ and benzene group compound was detected from HDPE and tire mixture into fuel. Conversion rate was liquid 52.8 % and gas was 9.07 %. HDPE and tire mixture to fuel density is 0.76 gm/ml. Produced fuel could be used for electricity generation, home heating or use as furnace oil or refinery process for further modification. **Copyright © IJWMT, all rights reserved.**

Keywords: waste plastic, conversion, polyethylene, fuel, tire, hydrocarbon, HDPE, energy

1. Introduction

The last 50 years have witnessed an explosive growth of the plastic industry. The production of synthetic polymers represented by polyethylene (PE), polypropylene (PP), polystyrene (PS), and poly (vinyl chloride) (PVC) worldwide has increased more than 100 times for the last three decades [1–3]. These plastics are widely used in many important everyday applications such as clothing, household appliances, automotive products, and even aerospace. While we are enjoying the conveniences that plastics can provide, the treatment of waste plastics becomes an unavoidable and imminent issue [4]. All over the world, waste plastics create a very serious environmental challenge because of their

huge quantities and their disposal problems. Plastics are now indispensable materials and their applications in the industrial field are continually increasing. Plastics are produced from petroleum derivatives and are composed primarily of hydrocarbons but also contain additives such as antioxidants, colorants, and other stabilizers. However, when plastic products are used and discarded, these additives are undesirable from an environmental point of view [5, 6]. Plastics are not presently biodegradable and are extremely troublesome components for land filling. Their destruction by incineration poses serious air pollution problems due to the release of airborne particles and carbon dioxide into the atmosphere [7, 8, 9]. Recycling has become a major response to the environmental challenges facing the plastics industry. Nowadays there are three ways to utilize plastic waste: landfilling, incineration with or without energy recovery and recycling. The largest amount of plastic wastes is disposed of by landfilling (65-70%), and incineration (20-25%). Recycling is only about 10%. Moreover, the problem of wastes cannot be solved by landfilling and incineration, because suitable and safe depots are expensive, and incineration stimulates the growing emission of harmful, greenhouse gases, e.g. NO_x, SO_x, CO_x, etc. Recycling can be divided into further important categories, such as mechanical recycling and chemical recycling. Chemical recycling is virtually a thermal method by which the long alkyl chains of polymers are broken into a mixture of lighter hydrocarbons. This is one of the prospective ways to utilize waste polymers [10-17].

Environmental pollution as well as efficient use of resources represents two important issues that concern all modern societies. Tyres and plastics are widely used all over the world, resulting in an increasing amount of residues, which have become a problem to human kind, due to their highly negative environmental impact. Some publications [18, 19] have reported the negative implications of this growing problem, which has been developing for many years. Landfilling and incineration processes used so far to deal with these wastes present several problems. Landfilling, the most common disposal route, does not allow the recovery of the organic content of these wastes. Though incineration has the advantage of recovering some of wastes energetic content, pollutants are produced like light hydrocarbons, nitrous and sulphur oxides, dusts and dioxins, which have highly negative bearing on the environment [20]. Moreover, rubber tyres sulphur content may reach values around 2%, due to vulcanisation processes, which means that the cost of tyres incineration process increases, due to the need of flue gas desulphurisation. The natural raw material for rubber tyre and plastics production is petroleum [20], whose reserves have a limited lifetime [21, 22, 23]. Therefore, it is advisable to have a better management of the remaining petroleum resources. This goal can be achieved through the application of pyrolysis or thermal technology to deal with these wastes.

2. Materials and Method Description

High density polyethylene (HDPE) was collect from local city donut store and tire was collected from local car collision center. Waste plastic and tire was cut into small pieces by manually with scissors. Tire has metal and cloth part also but in this experiment metal portion was avoid and took only tire part with cloth. Small pieces tire and high density polyethylene waste plastic transferred into small glass reactor chamber. Reactor chamber was placed into Glas-col company provided glacs-col heating chamber and veriac meter was setup with reactor for temperature control (Seen Figure1) (Patent pending). High temperature vacuum grease was use for reactor chamber neck and condensation unit neck setup. Because high temperatures vacuum grease prevent to gas loss or gas escape during HDPE and tire to fuel production process. Condensation unit another neck was connecting with fuel collection device. Fuel collection device was filling into water with half part. Fuel collection device was connect with light gas cleaning system and light gas cleaning device was fill with NaOH solution. 0.5 (N) NaOH solutions was use for light gas cleaning purposed. Light gas device to light gas transferred into another washing chamber it was fill with only water. Then light gas transfer into Teflon bag with small pump system. Liquid fuel with water device was connected with filter system and filtered fuel was collected into small vial. In this experiment was main goal HDPE waste plastic and motor vehicle tire to liquid fuel production. Starting temperature was 225 °C and finished temperature was 405 °C. High density polyethylene waste plastic was use for experiment 50 gm by weight and tire was use 25 gm by weight and sample ratio was 2:1. HDPE waste plastic has long chain hydrocarbon and motor

vehicle has hydrocarbon compound with rubber. Tire hydrocarbon portion was converted with HDPE waste plastic mixture but rest of rubber portion was not converted because rubber made from rubber tree. Without catalyst and without vacuum system under labconco fume hood experiment was performed in batch process. Temperature was monitor by using veriac meter for good quality product collection. Sometimes temperature was increased and sometimes temperature was decreased for waste plastic (HDPE) and tire mixture to fuel production. In mass balance calculation showed liquid fuel was 39.6 gm, light gas was 6.8 gm and residue was 28.6 gm. In this experiment total sample was 75 gm, HDPE waste plastic was 50 gm and motor vehicle tire was 25 gm. Fuel density was 0.76 g/ml. In this experiment conversion rate liquid fuel percentage was 52.8 %, light gas percentage was 9.07 % and left over solid residue was 38.13%. Leftover was settle down in to the glass reactor chamber and it was collected from glass reactor and kept into separate container for analysis purpose. Left over residue and light gas analysis is under investigation. This produced fuel can be use internal combustion engine and can be used for feed stock refinery for further modification.

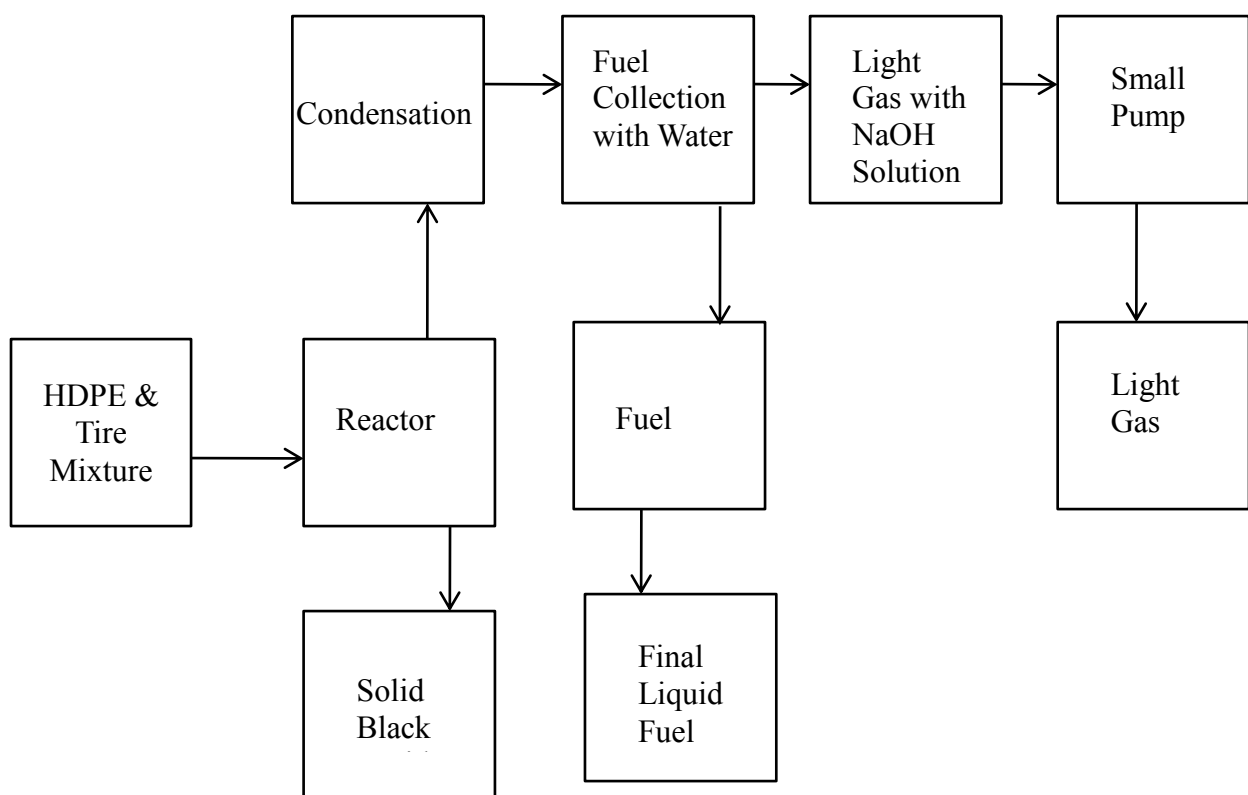


Figure 1: Motor Vehicle Tire and High Density Polyethylene (HDPE) Mixture into Fuel Production Process Diagram

3. Results and Discussions

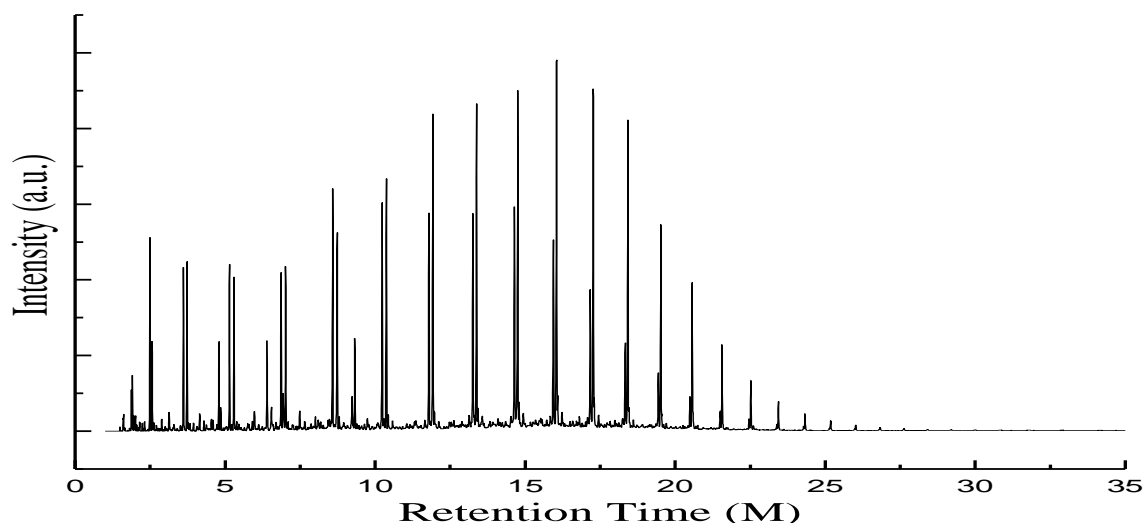


Figure 2: GC/MS Chromatogram of Motor Vehicle Tire and High Density Polyethylene (HDPE) Mixture to Fuel

Table 1: GC/MS Chromatogram Compound list of Motor Vehicle Tire and High Density Polyethylene (HDPE) 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 ₃ H ₈	44	38.5	18863
2	1.56	43	Isobutane	C ₄ H ₁₀	58	73.8	121
3	1.60	41	1-Propene, 2-methyl-	C ₄ H ₈	56	22.1	61293
4	1.61	43	Butane	C ₄ H ₁₀	58	71.1	18940
5	1.63	41	2-Butene	C ₄ H ₈	56	31.8	61292
6	1.67	41	1-Butene	C ₄ H ₈	56	23.6	18920
7	1.75	55	Cyclopropane, 1,1-dimethyl-	C ₅ H ₁₀	70	22.1	34618
8	1.81	43	Butane, 2-methyl-	C ₅ H ₁₂	72	82.2	291251
9	1.87	42	Cyclopropane, ethyl-	C ₅ H ₁₀	70	19.1	114410
10	1.91	43	Pentane	C ₅ H ₁₂	72	84.4	114462
11	1.95	55	1,3-Pentadiene, (Z)-	C ₅ H ₈	68	10.5	160480
12	1.99	55	Cyclopropane, 1,2-dimethyl-, trans-	C ₅ H ₁₀	70	19.1	114453
13	2.01	55	2-Pentene, (E)-	C ₅ H ₁₀	70	19.0	291780
14	2.06	67	1,3-Pentadiene	C ₅ H ₈	68	20.2	291890
15	2.32	42	1-Pentanol, 2-methyl-	C ₆ H ₁₄ O	102	27.1	19924
16	2.49	41	1-Hexene	C ₆ H ₁₂	84	34.0	500
17	2.56	57	Hexane	C ₆ H ₁₄	86	87.0	61280
18	2.62	55	3-Hexene, (Z)-	C ₆ H ₁₂	84	21.5	114381
19	2.71	67	Cyclobutene, 3,3-dimethyl-	C ₆ H ₁₀	82	9.06	62288
20	2.77	41	Pentane, 3-methylene-	C ₆ H ₁₂	84	23.5	19323

21	2.83	67	3-Hexyne	C ₆ H ₁₀	82	14.6	19282
22	2.89	56	Cyclopentane, methyl-	C ₆ H ₁₂	84	65.5	114428
23	2.95	67	3-Hexyne	C ₆ H ₁₀	82	14.7	19282
24	3.00	79	3-Thiatricyclo[3.1.1.0(2,4)]heptane	C ₆ H ₈ S	112	8.73	221370
25	3.05	79	1,3-Cyclopentadiene, 5-methyl-	C ₆ H ₈	80	15.9	419
26	3.14	67	Cyclopentene, 1-methyl-	C ₆ H ₁₀	82	15.3	107747
27	3.26	78	Benzene	C ₆ H ₆	78	68.6	221957
28	3.29	56	Cyclohexane	C ₆ H ₁₂	84	14.9	228008
29	3.37	79	1,3-Cyclohexadiene	C ₆ H ₈	80	16.4	118700
30	3.51	67	Cyclohexene	C ₆ H ₁₀	82	32.1	114431
31	3.61	56	1-Heptene	C ₇ H ₁₄	98	37.6	107734
32	3.73	43	Heptane	C ₇ H ₁₆	100	77.7	61276
33	3.77	81	Cyclopropane, trimethylmethylene-	C ₇ H ₁₂	96	16.4	63085
34	3.82	56	2-Heptene, (E)-	C ₇ H ₁₄	98	21.9	932
35	4.06	81	Cyclohexene, 1-methyl-	C ₇ H ₁₂	96	15.7	139432
36	4.15	83	Cyclohexane, methyl-	C ₇ H ₁₄	98	68.3	118503
37	4.29	69	Cyclopentane, ethyl-	C ₇ H ₁₄	98	32.0	231044
38	4.43	81	Norbornane	C ₇ H ₁₂	96	11.2	114371
39	4.49	79	1,3,5-Hexatriene, 2-methyl-	C ₇ H ₁₀	94	13.9	60713
40	4.54	81	Cyclobutane, (1-methylethylidene)-	C ₇ H ₁₂	96	16.4	150272
41	4.59	67	1-Ethylcyclopentene	C ₇ H ₁₂	96	37.5	114407
42	4.79	91	Toluene	C ₇ H ₈	92	59.8	291301
43	4.85	81	Cyclohexene, 3-methyl-	C ₇ H ₁₂	96	11.6	236066
44	5.15	55	1-Octene	C ₈ H ₁₆	112	29.3	1604
45	5.22	55	2-Octene, (Z)-	C ₈ H ₁₆	112	8.41	113889
46	5.29	43	Octane	C ₈ H ₁₈	114	40.2	229407
47	5.39	55	3-Octene, (Z)-	C ₈ H ₁₆	112	16.1	113895
48	5.45	95	Bicyclo[3.1.0]hexane, 1,5-dimethyl-	C ₈ H ₁₄	110	15.3	142175
49	5.91	81	4H-1,3-Benzodioxin-4-one, hexahydro-4a,5-dimethyl-, [4a-(4 α ,5 β ,8 α)]-	C ₁₀ H ₁₆ O ₃	184	6.37	187248
50	5.97	55	2,4-Dimethyl-1-heptene	C ₉ H ₁₈	126	8.09	113516
51	6.12	67	Cyclopentene, 1-propyl-	C ₈ H ₁₄	110	7.10	142659
52	6.40	91	Ethylbenzene	C ₈ H ₁₀	106	67.0	114918
53	6.54	91	p-Xylene	C ₈ H ₁₀	106	15.4	113952
54	6.70	55	1,8-Nonadiene	C ₉ H ₁₆	124	13.7	107523
55	6.86	56	1-Nonene	C ₉ H ₁₈	126	13.8	107756
56	6.93	104	Styrene	C ₈ H ₈	104	39.4	291542
57	7.02	57	Nonane	C ₉ H ₂₀	128	35.1	228006
58	7.10	55	cis-2-Nonene	C ₉ H ₁₈	126	13.6	113508
59	7.24	55	4-Nonene	C ₉ H ₁₈	126	9.53	113904
60	7.37	41	Bicyclo[6.1.0]nonane, 9-(1-methylethylidene)-	C ₁₂ H ₂₀	164	7.73	39288
61	7.43	95	trans-1-Butenylcyclopentane	C ₉ H ₁₆	124	20.2	113509

62	7.48	105	Benzene, (1-methylethyl)-	C ₉ H ₁₂	120	40.6	249348
63	7.53	67	cis-1,4-Dimethyl-2-methylenecyclohexane	C ₉ H ₁₆	124	8.96	113533
64	7.60	41	1-Nonyne, 7-methyl-	C ₁₀ H ₁₈	138	12.2	114524
65	7.65	55	2,4-Pentadien-1-ol, 3-propyl-, (2Z)-	C ₈ H ₁₄ O	126	18.0	142179
66	7.76	95	3,4-Octadiene, 7-methyl-	C ₉ H ₁₆	124	5.31	54090
67	7.80	107	Bicyclo[6.1.0]nonane, 9-(1-methylethylidene)-	C ₁₂ H ₂₀	164	22.9	39288
68	7.86	67	Cyclopentene, 1-butyl-	C ₉ H ₁₆	124	12.9	113491
69	7.94	41	Cycloheptene, 1,2-dimethyl-	C ₉ H ₁₆	124	4.23	2342
70	8.01	91	Benzene, propyl-	C ₉ H ₁₂	120	71.0	113930
71	8.11	67	Bicyclo[4.1.0]heptane, 7-(1-methylethylidene)-	C ₁₀ H ₁₆	136	7.49	3316
72	8.48	118	Azetidine, 3-methyl-3-phenyl-	C ₁₀ H ₁₃ N	147	39.3	4393
73	8.59	56	1-Decene	C ₁₀ H ₂₀	140	15.8	107686
74	8.74	57	Decane	C ₁₀ H ₂₂	142	41.9	291484
75	8.81	55	cis-3-Decene	C ₁₀ H ₂₀	140	16.8	113558
76	9.07	55	2-Decyn-1-ol	C ₁₀ H ₁₈ O	154	10.6	53366
77	9.23	119	2,3-Epoxy-carane, (E)-	C ₁₀ H ₁₆ O	152	31.7	156146
78	9.32	68	D-Limonene	C ₁₀ H ₁₆	136	24.8	62287
79	9.39	83	2-Decyn-1-ol	C ₁₀ H ₁₈ O	154	9.74	53366
80	9.46	117	1,3-Methanopentalene, 1,2,3,5-tetrahydro-	C ₉ H ₁₀	118	8.86	221371
81	9.55	67	Cyclopentene, 1-pentyl-	C ₁₀ H ₁₈	138	19.2	139585
82	9.65	105	Isopinocarveol	C ₁₀ H ₁₆ O	152	9.85	292836
83	9.74	91	Bicyclo[3.1.0]hex-3-en-2-ol, 2-methyl-5-(1-methylethyl)-, (1 α ,2 α ,5 α)-	C ₁₀ H ₁₆ O	152	13.4	250249
84	9.91	105	Cyclohexanol, 2-methylene-5-(1-methylethenyl)-	C ₁₀ H ₁₆ O	152	9.22	150918
85	10.24	55	1-Undecene	C ₁₁ H ₂₂	154	6.77	232523
86	10.38	57	Undecane	C ₁₁ H ₂₄	156	34.1	107774
87	10.43	55	5-Undecene, (E)-	C ₁₁ H ₂₂	154	14.1	114227
88	10.58	55	3-Undecene, (Z)-	C ₁₁ H ₂₂	154	10.1	142598
89	11.79	55	1-Dodecene	C ₁₂ H ₂₄	168	15.5	107688
90	11.92	57	Dodecane	C ₁₂ H ₂₆	170	34.6	291499
91	11.97	55	3-Dodecene, (E)-	C ₁₂ H ₂₄	168	14.5	70642
92	13.13	41	1,12-Tridecadiene	C ₁₃ H ₂₄	180	19.1	7380
93	13.26	41	1-Tridecene	C ₁₃ H ₂₆	182	11.9	107768
94	13.38	57	Tridecane	C ₁₃ H ₂₈	184	44.9	107767
95	13.43	55	5-Tridecene, (E)-	C ₁₃ H ₂₆	182	7.63	142619
96	13.57	55	7-Tetradecene	C ₁₄ H ₂₈	196	4.46	70643
97	14.64	41	1-Tetradecene	C ₁₄ H ₂₈	196	5.57	69725
98	14.76	57	Tetradecane	C ₁₄ H ₃₀	198	41.3	113925
99	14.80	55	7-Tetradecene	C ₁₄ H ₂₈	196	7.48	70643
100	14.94	55	7-Tetradecene	C ₁₄ H ₂₈	196	12.2	70643
101	15.94	55	1-Pentadecene	C ₁₅ H ₃₀	210	9.29	69726

102	16.05	57	Pentadecane	C ₁₅ H ₃₂	212	40.4	107761
103	16.09	55	E-2-Hexadecacen-1-ol	C ₁₆ H ₃₂ O	240	5.53	131101
104	17.17	55	1-Hexadecene	C ₁₆ H ₃₂	224	8.69	69727
105	17.27	57	Hexadecane	C ₁₆ H ₃₄	226	37.5	114191
106	17.45	55	1-Dodecanol, 3,7,11-trimethyl-	C ₁₅ H ₃₂ O	228	3.94	22776
107	18.34	55	E-14-Hexadecenal	C ₁₆ H ₃₀ O	238	7.57	130980
108	18.42	57	Heptadecane	C ₁₇ H ₃₆	240	32.9	107308
109	19.44	55	E-15-Heptadecenal	C ₁₇ H ₃₂ O	252	5.22	130979
110	19.52	57	Octadecane	C ₁₈ H ₃₈	254	23.2	57273
111	20.49	55	9-Nonadecene	C ₁₉ H ₃₈	266	8.12	113627
112	20.57	57	Nonadecane	C ₁₉ H ₄₀	268	31.4	114098
113	21.50	55	1-Nonadecene	C ₁₉ H ₃₈	266	7.09	113626
114	21.56	57	Eicosane	C ₂₀ H ₄₂	282	19.7	290513
115	22.46	55	10-Heneicosene (c,t)	C ₂₁ H ₄₂	294	9.86	113073
116	22.52	57	Heneicosane	C ₂₁ H ₄₄	296	23.5	107569
117	22.60	43	Heptadecanenitrile	C ₁₇ H ₃₃ N	251	39.9	233149
118	23.39	43	1-Docosene	C ₂₂ H ₄₄	308	13.9	113878
119	23.43	57	Heneicosane	C ₂₁ H ₄₄	296	11.3	107569
120	23.62	44	1-Docosene	C ₂₂ H ₄₄	308	6.83	113878
121	24.28	43	1-Docosene	C ₂₂ H ₄₄	308	9.04	113878
122	24.33	57	Nonadecane	C ₁₉ H ₄₀	268	11.6	114098
123	25.18	57	Nonadecane	C ₁₉ H ₄₀	268	19.7	114098
124	26.01	57	Nonadecane	C ₁₉ H ₄₀	268	21.8	114098
125	26.83	57	Nonadecane	C ₁₉ H ₄₀	268	21.5	114098

High density polyethylene and motor vehicle tire mixture to produced fuel was analysis by gas chromatography and mass spectrometer (GC/MS) to determine compound structure and hydrocarbon range determination (seen figure 2 and table 1). Analysis chromatogram and compound table 1 showed different type of hydrocarbon compound present in to produced fuel. Aliphatic compounds, aromatic derivative, oxygenated compounds, nitrogen containing compound, alcoholic compounds and also sulfur containing compound also detected by GC/MS. Because initial raw materials has tire mixture with HDPE waste plastic. Compound was detected from chromatogram by using GC/MS based on retention time (min.) and trace mass (m/z). In this analysis some compound are elaborated from above compound table with retention time trace mass compound name compound formula molecular weight and probability percentage. Initial compound was detected from GC/MS and compound name is Propane (C₃H₈) (t=1.49, m/z=41) compound molecular weight 44 and compound probability percentage is 38.5%, then rest of compound was detected based on retention time lower to higher such as compounds Butane (C₄H₁₀) (t=1.61, m/z=43) compound molecular weight is 58 and probability percentage is 71.1% , 2-methyl-butane (C₅H₁₂) (t=1.81, m/z=43) compound molecular weight is 72 and probability percentage is 82.2% , trans-1,2-dimethyl-cyclopropane (C₅H₁₀) (t=1.99, m/z=55) compound molecular weight is 70 and probability percentage is 19.1%, 1-Hexene (C₆H₁₂) (t=2.49, m/z=41) compound molecular weight is 84 and probability percentage is 34.0% , Methyl-cyclopentane (C₆H₁₂) (t=2.89, m/z=56) compound molecular weight is 84 and probability percentage is 65.5%, Benzene (C₆H₆) (t=3.26, m/z=78) compound molecular weight is 78 and probability percentage is 68.6%, Heptane (C₇H₁₆) (t=3.73, m/z=43) compound molecular weight is 100 and probability percentage is 77.7%, Methyl-cyclohexane (C₇H₁₄) (t=4.15, m/z=83) compound molecular weight is 98 and probability percentage is 68.3%, Toluene (C₇H₈) (t=4.79, m/z=91) compound molecular weight is 92 and probability percentage is 59.8%, Octane

(C₈H₁₈) (t=5.29, m/z=43) compound molecular weight is 114 and probability percentage is 40.2%, 4H-1,3-Benzodioxin-4-one, hexahydro-4a,5-dimethyl-, [4as-(4a α ,5 β ,8a β)]- (C₁₀H₁₆O₃) (t=5.9, m/z=81) compound molecular weight is 184 and probability percentage is 6.37%, Ethylbenzene (C₈H₁₀) (t=6.40, m/z=91) compound molecular weight is 106 and probability percentage is 67.0%, p-Xylene (C₈H₁₀) (t=6.54, m/z=91) compound molecular weight is 106 and probability percentage is 15.4%, Styrene (C₈H₈) (t= 6.93, m/z=104) compound molecular weight is 104 and probability percentage is 39.4%, 1-methylethyl-benzene (C₉H₁₂) (t=7.48, m/z=105) compound molecular weight is 120 and probability percentage is 40.6%, 2Z-3-propyl-2,4-Pentadien-1-ol (C₈H₁₄O) (t=7.65, m/z=55) compound molecular weight is 126 and probability percentage is 18.0%, 1-butyl-cyclopentene (C₉H₁₆) (t=7.86, m/z=67) compound molecular weight is 124 and probability percentage is 12.9%, 3-methyl-3-phenyl-azetidine (C₁₀H₁₃N) (t=8.48, m/z=118) compound molecular weight is 147 and probability percentage is 39.3%, D-Limonene (C₁₀H₁₆) (t=9.32, m/z=68) compound molecular weight is 136 and probability percentage is 24.8%, Bicyclo[3.1.0]hex-3-en-2-ol, 2-methyl-5-(1-methylethyl)-, (1 α ,2 α ,5 α)- (C₁₀H₁₆O) (t=9.74, m/z=91) compound molecular weight is 152 and probability percentage is 13.4%, Undecane (C₁₁H₂₄) (t=10.38, m/z=57) compound molecular weight is 156 and probability percentage is 34.1%, Dodecane (C₁₂H₂₆) (t=11.92, m/z=57) compound molecular weight is 170 and probability percentage is 34.6%, Tridecane (C₁₃H₂₈) (t=13.38, m/z=57) compound molecular weight is 184 and probability percentage is 44.9%, Tetradecane (C₁₄H₃₀) (t=14.76, m/z=57) compound molecular weight is 198 and probability percentage is 41.3%, Pentadecane (C₁₅H₃₂) (t=16.05, m/z=57) compound molecular weight is 212 and probability percentage is 40.4%, Heptadecane (C₁₇H₃₆) (t=18.42, m/z=57) compound molecular weight is 240 and probability percentage is 32.9%, Octadecane (C₁₈H₃₈) (t=19.52, m/z=57) compound molecular weight is 254 and probability percentage is 23.2%, Eicosane (C₂₀H₄₂) (t=21.56, m/z=57) compound molecular weight is 282 and probability percentage is 19.7%, Heneicosane (C₂₁H₄₄) (t=22.52, m/z=57) compound molecular weight is 296 and probability percentage is 23.5%, 1-Docosene (C₂₂H₄₄) (t=24.28, m/z=43) compound molecular weight is 308 and probability percentage is 9.04% respectively.

4. Conclusion

High density polyethylene and motor vehicle tire to fuel production process was performed with thermal degradation without adding catalyst. Produced fuel yield percentage was 52.8% because tire has some portion of rubber and mixture with cloth. Rubber and cloth portion cannot be converting into hydrocarbon fuel. Adding tire with HDPE waste plastic into fuel production process residue percentage is high and light gas percentage is 9.07%. But in this technology can convert all HDPE waste plastic and all motor vehicle tire into liquid hydrocarbon fuel for refinery process or feed for electricity generation. In this process can solve HDPE waste plastic and used Tire environmental problem. Produced fuel color was light yellow and odor was burring tire and density was 0.76 g/ml. Liquid hydrocarbon fuel was analysis by GC/MS and carbon chain showed C₃-C₂₂ with aromatic derivatives. All aromatic derivatives are formed from tire and HDPE waste plastic mixture combination. Fuel present aromatic compounds are Benzene, Toluene, Ethylbenzene, p-Xylene, Styrene and Benzene, (1-methylethyl)- etc..

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References

- [1] R. Buchan, B. Yarar, Recovering plastics for recycling by mineral processing techniques, *J. Metals* 47 (1995) 52–55.
- [2] I.I. Rubin, *Handbook of Plastic Materials and Technology*, Wiley, New York, 1990, pp. 799–815.
- [3] S.S. Schwartz, *Plastics Materials and Processes*, Van Nostrand Reinhold Co., New York, 1982, p. 44.
- [4] Dongsu Kim, Sunghye Shin, Seungman Sohn, Jinshik Choi, Bongchan Ban, Waste plastics as supplemental fuel in the blast furnace process: improving combustion efficiencies, *Journal of Hazardous Materials B94* (2002) 213–222
- [5] S.H. Hamid, M.B. Amin, A.G. Maadhah, *Handbook of Polymer Degradation*, Marcel Decker, New York, 1992.
- [6] P.T. Williams, E.A. Williams, *Energy Fuels* 13 (1999) 188.
- [7] L. Saeed, R. Zevenhoven, *Energy Sources* 24 (2002) 41.
- [8] S.H. Hamid, M.B. Amin, *J. Appl. Polym. Sci.* 55 (1995) 1385.
- [9] Mohammad Nahid Siddiqui, Halim Hamid Redhwi, Catalytic coprocessing of waste plastics and petroleum residue into liquid fuel oils, *J. Anal. Appl. Pyrolysis* 86 (2009) 141–147
- [10] Wong ACY, Lam F. Study of selected thermal characteristics of polypropylene/polyethylene binary blends using DSC and TGA. *Polym Test* 2002; 21:691-6.
- [11] Lee KH, Noh NS, Shin DH, Seo Y. Comparison of plastic types for catalytic degradation of waste plastics into liquid product with spent FCC catalyst. *Polym Degrad Stab* 2002; 78: 539-554.
- [12] Joseph PV, Marcelo S, Rabello LH, Mattuso S. Environmental effects on the degradation behaviour of sisal fibre reinforced polypropylene composites. *Compos Sci Technol* 2002; 62: 1357-72.
- [13] Westphal C, Perrot C, Karlsson C. Py-GC/MS as a means to predict degree of degradation by giving microstructural changes modelled on LDPE and PLA. *Polym Degrad Stab* 2001; 73:281-7.
- [14] Ballice L, Reimert R. Classification of volatile products from the temperature-programmed pyrolysis of polypropylene (PP), atactic- polypropylene (APP) and thermogravimetrically derived kinetics of pyrolysis. *Chem Eng Process* 2002;41:289-96.
- [15] Hwang EY, Kim JR, Chio JK. Performance of acid treated natural zeolites in catalytic degradation of polypropylene. *J Anal Appl Pyrolysis* 2002; 62:351-64.
- [16] Manos G, Garforth A, Dwyer J. Catalytic degradation of high-density polyethylene over different zeolitic structures. *Ind Eng Chem Res* 2000;39:1198.
- [17] N. Miskolczi, L. Bartha, G. Deak, B. Jover, Thermal degradation of municipal plastic waste for production of fuel-like hydrocarbons, *Polymer Degradation and Stability* 86 (2004) 357-366
- [18] Larsen-Morten Boberg, Schultz Lars, Glarborg Peter, Skaarup-Jensen Lars, Dam- Johansen Kim, Frandsen Flemming, et al. *Fuel* 2006;85:1335–45.

[19] Plastics Europe – Association of Plastics Manufactures; 2003.

[20] Plastics a material choice for the 21st century-Insights into plastic consumption and recovery in Western Europe; 1997.

[21] Pinto Filomena, Gulyurtlu I, Costa Paula, Cabrita I. J Anal Appl Pyrolysis 1999; 51:39–55.

[22] Pinto Filomena, Gulyurtlu I, Costa Paula, Cabrita I. J Anal Appl Pyrolysis 1999; 51:57–71.

[23] Miguel Miranda, Filomena Pinto, I. Gulyurtlu, I. Cabrita, C.A. Nogueira, Arlindo Matos, Response surface methodology optimization applied to rubber tyre and plastic wastes thermal conversion, Fuel 89 (2010) 2217–2229