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Conversion of Hazardous Motor Vehicle Used Tire and Polystyrene Waste Plastic Mixture into useful Chemical Products

By

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Abstract
Motor vehicle used tire and polystyrene waste plastic mixture into fuel recovery using thermal degradation process in laboratory batch process. Motor vehicle used tire and polystyrene waste plastic was use 75 gm by weight. Motor vehicle tire was 25 gm and polystyrene waste plastic was 50 gm. In presence of oxygen experiment was performed under laboratory fume hood. Thermal degradation temperature range was 100 - 420 ºC and experiment run time was 5 hours. Product fuel density is 0.84 gm/ml and liquid fuel conversion rate was 54.93 %. Fuel was analysis by GC/MS and compounds are present aliphatic group, aromatic group, alcoholic group, oxygen content and nitrogen content. Fuel can use refinery process as a refinery feed.

Keywords: Tire, polystyrene, conversion, chemical product, vehicle, hydrocarbon

1. Introduction

The generation of used tires in 2005 was estimated to be 2.5 million tonnes in North America, 2.5 million in Europe, and 0.5-1.0 million in Japan, which means 6 kg (approximately the weight of a car tire) per inhabitant and year in these developed countries [1]. The forecast for 2013 is that world generation will exceed 17 million tonnes per year, given that economic growth in developing countries drives vehicle sales and the substitution of less deteriorated tires, and the measures adopted to lengthen tire life are insufficient to offset these circumstances [2]. China generated 1 million tonnes in 2005 and the annual increase is 12%. This outlook makes the valorization of used tires more interesting, and among the different technologies, pyrolysis has the following advantages: (i) it enables the subsequent individual valorization of gaseous, liquid, and carbon black fractions, which is an interesting aspect for economic viability;[3] (ii) it has

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a higher efficiency for energy and a lower environmental impact than incineration [4]. Different types of reactors have been used for tire pyrolysis, such as autoclaves[5] and fixed bed reactors,[6-10] and for a larger scale operation, bubbling fluidized bed reactors,[9-14] moving beds under vacuum, in one and two steps,[15-17] ablative beds,[18] and rotary ovens [19-21]. 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) [22]. Pyrolysis as an attractive method to recycle scrap tires has recently been the subject of renewed interest. Pyrolysis of tires can produce oils, chars, and gases, in addition to the steel cords, all of which have the potential to be recycled. Within the past 2 decades, most experiments have been conducted using laboratory-scale batch units to characterize oil, char, and gas products [23].

Some conclusions from these laboratory-scale studies are as follows: Pyrolytic char has potential as a low-grade carbon black for a reinforcing filler or a printing ink pigment, [4-6] as a carbon adsorbent after proper activation, [7-9] and as a solid or slurry fuel [10]. Pyrolytic oil, a mixture of parafins, olefins, and aromatic compounds, possesses a high calorific value (43 MJ/kg) and can be used directly as fuel or can be added to petroleum refinery feedstocks [11-15]. Oils can also be properly cut based on their evaporating temperatures to solely produce valuable chemical feedstocks (i.e., benzene, xylene, toluene, and D-limonene), or some of the chemicals can be extracted with residue used as fuel [16-22]. Pyrolytic gas contains high concentrations of methane, butadiene, and other hydrocarbons, which results in a high calorific value (35 - 40 MJ/kg) sufficient to heat the pyrolysis reactor [23-25] The gas is generally not sold as a commercial product but used as a process heat resource because of its low yield (10 wt %).

2. Materials and Method

2.1 Materials

Polystyrene waste plastic was collected from local restaurant and motor vehicle tire was collected from local car collision center. Both waste materials were washing with liquid soap and cut into small pieces. Waste Tire has metal portion and metal portion did put into reactor for liquefaction process. Laboratory experimental process sample was taken total 75 gm by weight. 50 gm of polystyrene waste and 25 gm of motor vehicle used tire. Both waste materials have additives because plastic and tire manufacturing period manufacturing company are adding different types of additives for hardness and softness. Polystyrene plastic and motor vehicle tire chemical structure are shown figure 1.

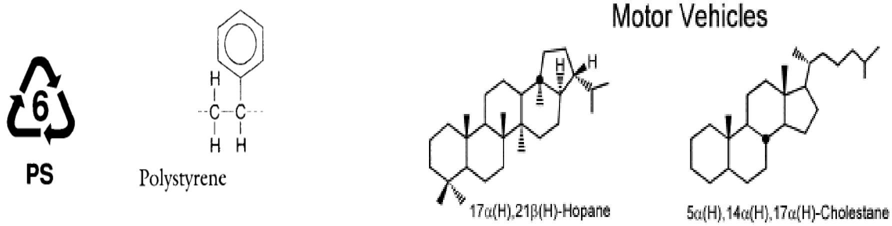

Figure 1: *Polystyrene waste plastic structure and Tire structure*

2.2 Method Description

Polystyrene waste plastic and motor vehicle used tire mixture into fuel production process setup shown into figure 2. Small pieces waste materials put into reactor inside for liquefaction process. Then condensation unit was setup with reactor and collection device. Fuel collection container was setup with fuel purification system and final fuel collection container and sediment container. Gas cleaning device was setup with condensation unit with liquid solution (sodium hydroxide, sodium bicarbonate and water). Teflon bag, small pump was setup with cleaning device and residue collection container was connecting with reactor. Temperature range was 100 - 420 ºC and thermal degradation without vacuumed system. No extra chemical was added in this experiment and whole experiment was close system. Experiment was monitored with temperature controller because some time experimental temperature need to increase and sometime experiment temperature need to decrease for quality product. Starting temperature 100 ºC to final temperature 420 ºC was use for whole procedure finish. Total time consumes 5 hours and input electricity was 0.71KWh. Waste polystyrene plastics and tire mixture to fuel production process during heating period was observed that lot of smoke was created. All vapors did not condense and came out as gas because it was light fraction C_1-C_4. Waste polystyrene plastic and tire has additives those additives cannot convert in to fuel only polymer portion can converted into fuel. Tire has high percentage of additives, cloth metal portion, and rubber and all of those parts cannot convertible. All additives come out as solid black residue. Polymer waste polystyrene has aromatic group and tire has petroleum component. When heat apply long chin carbon molecule breakdown and form into short chain hydrocarbon fuel or chemicals. Gas was cleaned with alkali wash and water wash then storage into Teflon bag using small pump. Fuel was filtered using RCI technology purification system. Product fuel density is 0.84gm/ml. In mass balance calculation showed 75 gm polystyrene waste plastic and tire mixture to fuel weight is 41.2 gm, sample as light gas generated 2.5 gm, and leftover black residue was 31.3 gm. Conversion rate percentage result showed liquid fuel was 54.93 %, light gas generation 3.34 % and residue percentage was 41.73%. Residue percentage was high because tire has rubber and additive, cloth and metal. Residue and light gas analysis are under investigation.

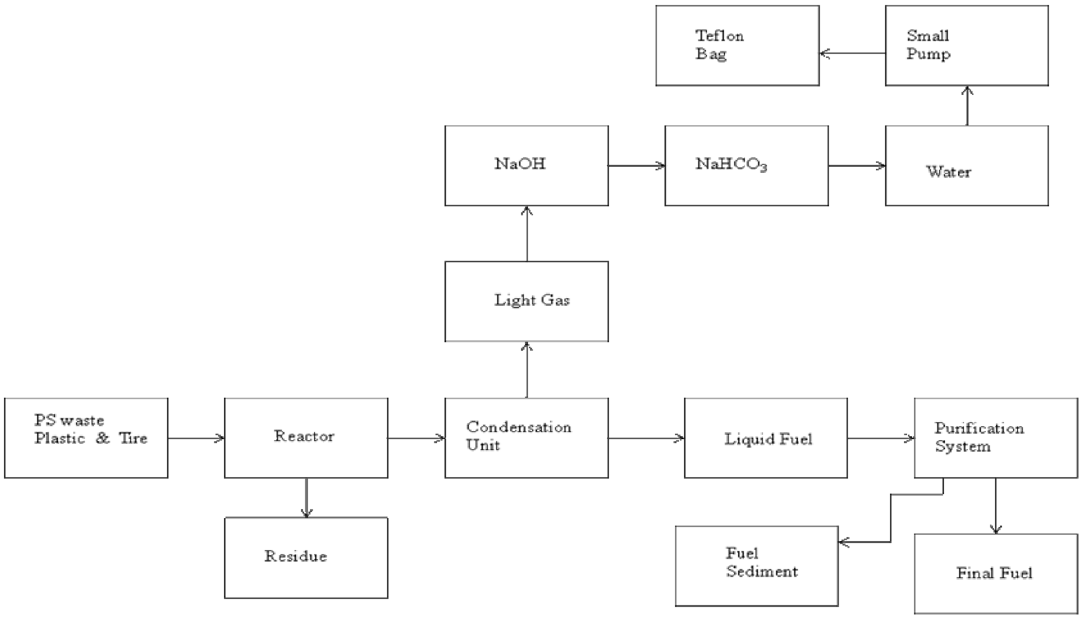

Figure 2: *Polystyrene (PS) Waste Plastic and Motor Vehicle Used Tire to Chemical Product Production Process*

3. Results and Discussions

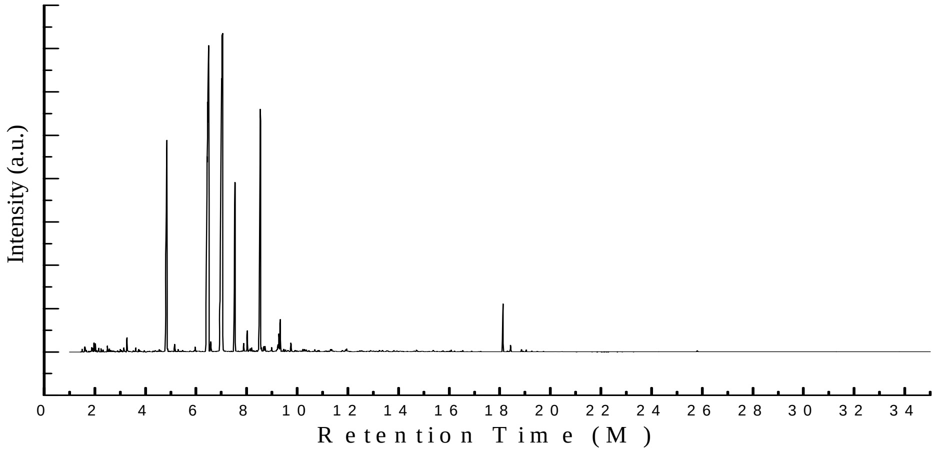

Figure 3: *GC/MS Chromatogram of Polystyrene (PS) Waste Plastic and Motor Vehicle Used Tire to Chemical Product*

Table 1: GC/MS Chromatogram Compound List of Polystyrene (PS) Waste Plastic and Motor Vehicle Used Tire Mixture to Chemical Product

Number of Peak	Retention Time (min.)	Trace Mass (m/z)	Compound Name	Compound Formula	Molecular Weight	Probability %	NIST Library Number
1	1.49	41	Cyclopropane	C_3H_6	42	40.9	18854
2	1.56	43	Isobutane	C_4H_{10}	58	68.9	18936
3	1.60	41	2-Butene, (E)-	C_4H_8	56	23.9	105
4	1.75	55	1-Butene, 3-methyl-	C_5H_{10}	70	23.6	160477
5	1.81	43	Butane, 2-methyl-	C_5H_{12}	72	77.4	19107
6	1.87	42	Cyclopropane, ethyl-	C_5H_{10}	70	39.6	114410
7	1.91	55	1-Butanol, 3-methyl-	$C_5H_{12}O$	88	12.7	151656
8	1.97	67	1,3-Pentadiene	C_5H_8	68	18.4	291890
9	1.99	55	Cyclopropane, 1,2-dimethyl-, trans-	C_5H_{10}	70	17.3	114453
10	2.02	55	2-Pentene, (E)-	C_5H_{10}	70	18.0	291780
11	2.06	67	1,4-Pentadiene	C_5H_8	68	27.0	114494
12	2.25	67	Bicyclo[2.1.0]pentane	C_5H_8	68	15.4	192491
13	2.32	42	1-Pentanol, 2-methyl-	$C_6H_{14}O$	102	29.5	19924
14	2.44	57	Pentane, 3-methyl-	C_6H_{14}	86	43.3	19375
15	2.50	56	1-Hexene	C_6H_{12}	84	35.3	500
16	2.57	57	Hexane	C_6H_{14}	86	79.6	61280
17	2.64	41	Pentane, 3-methylene-	C_6H_{12}	84	27.3	19323
18	2.68	41	Pentane, 3-methylene-	C_6H_{12}	84	22.9	19323
19	2.72	67	1,3-Pentadiene, 3-methyl-, (E)-	C_6H_{10}	82	9.33	62975
20	2.78	41	Pentane, 3-methylene-	C_6H_{12}	84	21.7	19323
21	2.90	56	Cyclopentane, methyl-	C_6H_{12}	84	55.0	114428
22	2.96	67	3-Hexyne	C_6H_{10}	82	20.2	19282
23	3.00	79	1,3-Cyclopentadiene, 5-methyl-	C_6H_8	80	18.2	419
24	3.14	67	Cyclopentene, 1-methyl-	C_6H_{10}	82	12.3	107747
25	3.27	78	Benzene	C_6H_6	78	65.9	114388
26	3.38	79	1,3-Cyclopentadiene, 1-methyl-	C_6H_8	80	13.0	164279
27	3.52	67	Cyclohexene	C_6H_{10}	82	21.6	61209
28	3.57	56	Cyclobutanone, 3,3-dimethyl-	$C_6H_{10}O$	98	24.1	957
29	3.62	41	1-Heptene	C_7H_{14}	98	27.9	19704
30	3.74	43	Heptane	C_7H_{16}	100	51.3	61276
31	3.78	81	Cyclopropane, trimethylmethylene-	C_7H_{12}	96	14.1	63085
32	3.96	81	Cyclopentene, 4,4-dimethyl-	C_7H_{12}	96	10.3	38642
33	4.09	67	1-Ethylcyclopentene	C_7H_{12}	96	33.7	114407
34	4.16	55	Cyclohexane, methyl-	C_7H_{14}	98	41.1	118503
35	4.21	79	1,3,5-Heptatriene, (E,E)-	C_7H_{10}	94	7.59	118126
36	4.31	43	Acetic acid, dichloro-, heptyl	C_9H_{16}	226	7.15	280485

			ester	Cl_{22}			
37	4.39	79	1,3-Cycloheptadiene	C_7H_{10}	94	10.4	237922
38	4.50	79	1,3-Cyclopentadiene, 1,2-dimethyl-	C_7H_{10}	94	10.3	800
39	4.55	81	Cyclobutane, (1-methylethylidene)-	C_7H_{12}	96	11.1	150272
40	4.61	67	Cyclopentane, ethylidene-	C_7H_{12}	96	35.1	114403
41	4.85	91	Toluene	C_7H_8	92	56.6	291301
42	5.05	55	(5-Methylcyclopent-1-enyl)methanol	$C_7H_{12}O$	112	22.9	99174
43	5.15	55	Pentane, 2-cyclopropyl-	C_8H_{16}	112	9.93	113439
44	5.23	55	2-Octyn-1-ol	$C_8H_{14}O$	126	25.1	113247
45	5.29	43	Octane	C_8H_{18}	114	36.4	61242
46	5.39	55	3-Octene, (Z)-	C_8H_{16}	112	12.7	113895
47	5.47	207	Cyclotrisiloxane, hexamethyl-	$C_6H_{18}O_3Si_3$	222	72.7	238029
48	5.55	93	Pyridine, 3-methyl-	C_6H_7N	93	50.8	791
49	5.65	81	3,5-Octadiene, (Z,Z)-	C_8H_{14}	110	12.7	250525
50	5.77	95	1-Methyl-2-methylenecyclohexane	C_8H_{14}	110	9.50	113437
51	5.92	81	1-Ethyl-5-methylcyclopentene	C_8H_{14}	110	17.1	114420
52	5.97	54	Cyclohexene, 4-ethenyl-	C_8H_{12}	108	28.9	227540
53	6.05	93	Cyclohexane, 1,4-bis(methylene)-	C_8H_{12}	108	14.4	1399
54	6.46	106	Ethylbenzene	C_8H_{10}	106	39.8	158804
55	6.58	91	p-Xylene	C_8H_{10}	106	30.4	113952
56	7.05	103	1,3,5,7-Cyclooctatetraene	C_8H_8	104	38.6	113230
57	7.54	105	Benzene, (1-methylethyl)-	C_9H_{12}	120	42.5	228742
58	7.88	117	Benzene, 2-propenyl-	C_9H_{10}	118	16.1	114744
59	8.02	91	Benzene, propyl-	C_9H_{12}	120	75.9	113930
60	8.14	105	Benzene, 1-ethyl-3-methyl-	C_9H_{12}	120	35.2	228743
61	8.20	105	Benzene, 1-ethyl-3-methyl-	C_9H_{12}	120	29.0	228743
62	8.28	105	2,3-Heptadien-5-yne, 2,4-dimethyl-	C_9H_{12}	120	7.80	33204
63	8.54	117	α-Methylstyrene	C_9H_{10}	118	34.3	2021
64	8.73	105	Benzene, 1,3,5-trimethyl-	C_9H_{12}	120	19.7	20469
65	8.99	105	Benzene, (1-methylpropyl)-	$C_{10}H_{14}$	134	38.4	228188
66	9.23	119	Benzene, 1-methyl-3-(1-methylethyl)-	$C_{10}H_{14}$	134	16.6	149866
67	9.27	117	Benzene, 2-propenyl-	C_9H_{10}	118	16.8	114744
68	9.33	68	Limonene	$C_{10}H_{16}$	136	21.0	57640
69	9.46	117	Indane	C_9H_{10}	118	13.1	118485
70	9.53	91	Benzene, 3-butenyl-	$C_{10}H_{12}$	132	76.5	113933
71	9.63	115	Benzene, 1-propynyl-	C_9H_8	116	25.4	113196
72	9.75	91	1,2,3,4,5,8-Hexahydronaphthalene	$C_{10}H_{14}$	134	25.2	113559
73	9.92	117	Benzene, 1-methyl-4-(2-propenyl)-	$C_{10}H_{12}$	132	17.7	113549
74	10.22	41	3-Undecene, (E)-	$C_{11}H_{22}$	154	4.78	60565
75	10.29	117	2,4-Dimethylstyrene	$C_{10}H_{12}$	132	10.6	136251
76	10.36	57	Undecane	$C_{11}H_{24}$	156	24.1	114185
77	10.46	105	Benzene, (1-methylbutyl)-	$C_{11}H_{16}$	148	35.8	245071

78	10.70	117	Benzene, 1-methyl-4-(2-propenyl)-	$C_{10}H_{12}$	132	13.1	113549
79	10.86	117	Benzene, (2-methyl-2-propenyl)-	$C_{10}H_{12}$	132	11.4	113536
80	11.32	115	4-Methyl-α-methyl-α-nitrostyrene	$C_{10}H_{11}NO_2$	177	7.20	135064
81	11.35	91	Benzene, pentyl-	$C_{11}H_{16}$	148	69.7	113915
82	11.78	41	3-Dodecene, (E)-	$C_{12}H_{24}$	168	9.07	113960
83	11.90	57	Dodecane	$C_{12}H_{26}$	170	8.59	291499
84	11.94	128	Naphthalene	$C_{10}H_8$	128	23.5	114935
85	12.02	131	Benzene, 1-methyl-3-(1-methyl-2-propenyl)-	$C_{11}H_{14}$	146	13.4	155781
86	12.38	117	trans-1-Phenyl-1-pentene	$C_{11}H_{14}$	146	19.2	113579
87	12.47	117	Benzene, cyclopentyl-	$C_{11}H_{14}$	146	24.8	187011
88	12.54	135	Benzothiazole	C_7H_5NS	135	65.7	73061
89	12.89	91	Benzene, hexyl-	$C_{12}H_{18}$	162	50.0	113954
90	13.01	129	Benzene, 4-pentynyl-	$C_{11}H_{12}$	144	16.6	113572
91	13.25	41	7-Tetradecene	$C_{14}H_{28}$	196	7.77	70643
92	13.36	57	Tridecane	$C_{13}H_{28}$	184	13.9	114282
93	13.55	144	2,3-Diazabicyclo[2.2.1]hept-2-ene, 5-phenyl-	$C_{11}H_{12}N_2$	172	18.0	142358
94	13.82	142	1H-Indene, 1-ethylidene-	$C_{11}H_{10}$	142	22.6	155753
95	14.06	104	Benzene, 3-cyclohexen-1-yl-	$C_{12}H_{14}$	158	62.8	114816
96	14.35	91	Benzene, heptyl-	$C_{13}H_{20}$	176	49.3	60570
97	14.45	104	(4-Methyl-1-methylenepent-4-enyl)benzene	$C_{13}H_{16}$	172	17.7	210729
98	14.62	41	7-Tetradecene	$C_{14}H_{28}$	196	10.7	70643
99	14.71	154	Biphenyl	$C_{12}H_{10}$	154	66.4	53609
100	14.90	80	Benzene, 1,1'-(3-methylbutylidene)bis-	$C_{17}H_{20}$	224	13.4	10579
101	15.21	80	17-Octadecen-14-yn-1-ol	$C_{18}H_{32}O$	264	8.14	36083
102	15.37	167	Diphenylmethane	$C_{13}H_{12}$	168	50.7	21969
103	15.52	157	Quinoline, 4,8-dimethyl-	$C_{11}H_{11}N$	157	28.7	5413
104	15.76	94	1,7-Dimethyl-4-oxa-tricyclo[5.2.1.0(2,6)]decane-3,5,8-trione	$C_{11}H_{12}O_4$	208	11.5	275441
105	16.02	57	Tetradecane	$C_{14}H_{30}$	198	15.2	113925
106	16.08	167	Benzene, 1,1'-ethylidenebis-	$C_{14}H_{14}$	182	43.1	22224
107	16.21	168	1,1'-Biphenyl, 4-methyl-	$C_{13}H_{12}$	168	21.3	113287
108	16.54	91	Benzene, 1,1'-(1,2-ethanediyl)bis-	$C_{14}H_{14}$	182	87.2	187213
109	16.70	170	3-(2-Methyl-propenyl)-1H-indene	$C_{13}H_{14}$	170	32.7	187785
110	16.89	105	Benzene, 1,1'-(1-methyl-1,2-ethanediyl)bis-	$C_{15}H_{16}$	196	39.0	34633
111	17.01	91	Benzene, nonyl-	$C_{15}H_{24}$	204	5.77	113903
112	17.16	41	Cyclohexane, 2-butyl-1,1,3-trimethyl-	$C_{13}H_{26}$	182	15.3	7582
113	17.24	57	Hexadecane	$C_{16}H_{34}$	226	9.89	62249
114	17.30	105	Benzene, 1,1'-(1,2-dimethyl-	$C_{16}H_{18}$	210	10.1	41226

			1,2-ethanediyl)bis-, (R*,R*)-(ñ)-				
115	17.43	167	Benzene, 1,1'-ethylidenebis-	$C_{14}H_{14}$	182	36.9	22224
116	17.83	44	Benzene, 1-methyl-3-(phenylmethyl)-	$C_{14}H_{14}$	182	36.4	202278
117	18.13	92	Benzene, 1,1'-(1,3-propanediyl)bis-	$C_{15}H_{16}$	196	95.7	133399
118	18.43	105	Benzene, 1,1'-(1-methyl-1,3-propanediyl)bis-	$C_{16}H_{18}$	210	90.5	149665
119	18.86	91	Naphthalene, 1,2,3,4-tetrahydro-2-phenyl-	$C_{16}H_{16}$	208	29.6	9510
120	19.47	115	Benzene, 1,1'-(1-butenylidene)bis-	$C_{16}H_{16}$	208	23.8	156823
121	19.73	115	Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-	$C_{16}H_{16}$	208	48.1	9505
122	21.15	44	1-Pentene, 1,5-diphenyl-	$C_{17}H_{18}$	222	22.5	63202
123	25.80	91	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-	$C_{22}H_{20}OS$	332	26.5	142947

Motor vehicle waste tire and polystyrene waste plastic mixture to product fuel was analysis by GC/MS and determine compounds structure. Figure 3 and table 1 shown analysis GC/MS chromatogram and chromatogram compounds list. Perkin Elmer GC/MS (model clarus 500) was use for liquid fuel analysis purpose. Chromatogram compounds was detected form chromatogram based on trace mass (m/z) and retention time (t). Compounds table showed product fuel has large amount of aromatic group and aliphatic group. Oxygen content, nitrogen content, sulfur and halogenated group are present in this fuel. GC/MS analysis result showed chromatogram starting compound is Cyclopropane (C_3H_6) (t=1.49, m/z=41) and highest carbon chain compound is trans-(2, 3-Diphenylcyclopropyl) methyl phenyl sulfoxide ($C_{22}H_{20}OS$) (t=25.80, m/z=91). All compounds were traced based on retention time, trace mass and peak intensity. For compounds detection purpose search library was use Perkin Elmer NIST library. Compounds were traced lower number carbon compounds to higher number carbon compounds such as Isobutane (C_4H_{10}) (t=1.56, m/z=43) Compound probability percentage is 68.9%, 2-methyl- Butane (C_5H_{12}) (t=1.81, m/z=43) Compound probability percentage is 77.4%, trans-1, 2-dimethyl- Cyclopropane (C_5H_{10}) (t=1.99, m/z=55) Compound probability percentage is 17.3%, 3-methyl-Pentane (C_6H_{14}) (t=2.44, m/z=57) Compound probability percentage is 43.3%, 3-methylene-Pentane (C_6H_{12}) (t=2.68, m/z=41) Compound probability percentage is 22.9%, methyl-Cyclopentane (C_6H_{12}) (t=2.90, m/z=56) Compound probability percentage is 55.0 %, Benzene (C_6H_6) (t=3.27, m/z=78) Compound probability percentage is 65.9%, 3,3-dimethyl-Cyclobutanone ($C_6H_{10}O$) (t=3.57, m/z=56) Compound probability percentage is 24.1%, trimethylmethylene-Cyclopropane (C_7H_{12}) (t=3.78, m/z=81) Compound probability percentage is 14.1%, methyl-Cyclohexane (C_7H_{14}) (t=4.16, m/z=55) Compound probability percentage is 41.1%, 1,2-dimethyl-1,3-Cyclopentadiene (C_7H_{10}) (t=4.50, m/z=79) Compound probability percentage is 10.3%, Toluene (C_7H_8)

(t=4.85, m/z=91) Compound probability percentage is 56.6%, 2-Octyn-1-ol ($C_8H_{14}O$) (t=5.23, m/z=55) Compound probability percentage is 25.1%, 3-methyl- Pyridine (C_6H_7N) (t=5.55, m/z=93) Compound probability percentage is 50.8%, 1-Ethyl-5-methylcyclopentene (C_8H_{14}) (T=5.92, m/z=81) Compound probability percentage is 17.1%, Ethylbenzene (C_8H_{10}) (t=6.46, m/z=106) Compound probability percentage is 39.8%, 2-propenyl- Benzene (C_9H_{10}) (t=7.88, m/z=117) Compound probability percentage is 16.1%, 1-ethyl-3-methyl- Benzene (C_9H_{12}) (t=8.20, m/z=105) Compound probability percentage is 29.0%, α-Methylstyrene (C_9H_{10}) (t=8.54, m/z=117) Compound probability percentage is 34.3%, 2-propenyl- Benzene (C_9H_{10}) (t=9.27, m/z=117) Compound probability percentage is 16.8%, Limonene ($C_{10}H_{16}$) (t=9.33, m/z=68) Compound probability percentage is 21.0%, 1-propynyl- Benzene (C_9H_8) (t=9.63, m/z=115) Compound probability percentage is 25.4%, Undecane ($C_{11}H_{24}$) (t=10.36, m/z=57) Compound probability percentage is 24.1%, (2-methyl-2-propenyl)-Benzene ($C_{10}H_{12}$) (t=10.86, m/z=117) Compound probability percentage is 11.4%, (E)-3-Dodecene ($C_{12}H_{24}$) (t=11.78, m/z=41) Compound probability percentage is 9.07%, Naphthalene ($C_{10}H_8$) (t=11.94, m/z=128) Compound probability percentage is 23.5%, cyclopentyl-Benzene ($C_{11}H_{14}$) (t=12.47, m/z=117) Compound probability percentage is 24.8%, Tridecane ($C_{13}H_{28}$) (t=13.36, m/z=57) Compound probability percentage is 13.9%, 3-cyclohexen-1-yl- Benzene ($C_{12}H_{14}$) (t=14.06, m/z=104) Compound probability percentage is 62.8%, Biphenyl ($C_{12}H_{10}$) (t=14.71, m/z=154) Compound probability percentage is 66.4%, Diphenylmethane ($C_{13}H_{12}$) (t=15.37, m/z=167) Compound probability percentage is 50.7%, Tetradecane ($C_{14}H_{30}$) (t=16.02, m/z=57) Compound probability percentage is 15.2%, bis-1,1'-(1,2-ethanediyl) Benzene ($C_{14}H_{14}$) (t=16.54, m/z=91) Compound probability percentage is 87.2%, bis-1,1'-(1-methyl-1,2-ethanediyl) Benzene ($C_{15}H_{16}$) (t=16.89, m/z=105) Compound probability percentage is 39.0%, Hexadecane ($C_{16}H_{34}$) (t=17.24, m/z=57) Compound probability percentage is 9.89%, 1,1'-ethylidenebis- Benzene ($C_{14}H_{14}$) (t=17.43, m/z=167) Compound probability percentage is 36.9%, bis-1,1'-(1-methyl-1,3-propanediyl)Benzene ($C_{16}H_{18}$) (t=18.43, m/z=105) Compound probability percentage is 90.5 %, bis-1,1'-(3-methyl-1-propene-1,3-diyl) Benzene ($C_{16}H_{16}$) (t=19.73, m/z=115) Compound probability percentage is 48.1%, trans- (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide ($C_{22}H_{20}OS$) (t=25.80, m/z=91) Compound probability percentage is 26.5%. Analysis result indicates that product fuel has high percentage of aromatic group then aliphatic group.

Conclusion

Motor vehicle waste tire and polystyrene waste plastic mixture to fuel production was performed without catalyst at 100-420 °C. Product fuel is ignited and fuel was analysis by GC/MS to checked fuel inside compounds structure. Carbon chain showed C_3-C_{22} and most of the compounds are aromatic group including Benzene, Toluene, Ethylbenzene, p-Xylene, 2-propenyl-Benzene, α-Methylstyrene, 2-propenyl-Benzene, Limonene, Indane, 1-methyl-4-(2-propenyl)-Benzene, Naphthalene, 3-cyclohexen-1-yl-Benzene, bis-1,1'-(1,2-ethanediyl)Benzene, 1-methyl-3-(phenylmethyl)-Benzene, bis-1,1'-(1-butenylidene)Benzene, and so on. PS waste plastic has aromatic group and motor vehicle has also aromatic group compounds. Liquid fuel conversion rate only 54.93 % and rest of percentage was solid residue and light gas. Residue percentage was high because tire has high percentage of additive, cloth, rubber. Rubber, cloth and additives that not convertible into fuel. This technology can convert all PS waste plastic and motor vehicle used tire into useful chemicals which can use internal combustion engines and refinery process for feed.

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