

## Motor Vehicle Used Tire Conversion into Fuel Using Thermal Degradation Process with Ferric Carbonate Catalyst

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**Abstract:**—The disposal of motor vehicle scrap tires is currently a major environmental and economical big issue. Recently estimates of the annual arise of scrap tires in North America are about 2.5 million tonnes, in European Union about 2.0-2.5 million tonnes, and in Japan about 0.5-1.0 million tonnes. In China, more than 1.0 million tonnes per year of tires are generated, which results in about 0.22 million tonnes of used tires per year. Unfortunately, most of these scrap tires are simply dumped in the open place and in landfills in our country. Open dumping may result in accidental fires with highly toxic emissions or may act as breeding grounds for insects. Landfills full of tires are not acceptable to the environment because tires do not easily degrade naturally. It can remain as a long period into land fill. In recent years, many attempts have been made to find new ways to recycle tires, i.e., tire grinding and crumbling to recycle rubber powders and tire incineration to supply thermal energy. During incineration is creating also harmful toxic gases and this process is not environmental friendly. Natural State Research has establishes new method for converting all type of motor vehicle used tire into fuel energy. Because this waste tire made by rubber and petroleum mixture. The experiment has been carried out on the motor vehicle used tire in the thermal degradation process in a stainless steel reactor at 200 to 420 °C with ferric carbonate catalyst. By using this process was collect liquid fuel, tar and light gas (C<sub>1</sub>-C<sub>4</sub>). Fuel analysis purpose was use GC/MS equipment. This tire to fuel could be used for feed stock refinery for further modified fuel energy.

**Keywords:**—motor vehicle tire, energy, fuel, thermal degradation, GC/MS, FT-IR, conversion

### I. 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 2012 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 a higher efficiency for energy and a lower environmental impact than incineration[4, 5] As illegal dumping of waste tires is becoming an object of public concern in the world, their disposal and treatment come under the spotlight. In Japan, nearly 1 million tons of waste tires have been discharged annually in the past decade [6]. The most popular utilization of waste tires is thermal recovery, given that the combustion heat of tires (7.2-8.5 kcal kg<sup>-1</sup>) is much higher than that of other solid residues such as plastic-derived fuel or municipal solid wastes and is comparable to that of C-grade heavy oil (9.2 kcal kg<sup>-1</sup>) [7]. As automobile tires contain appreciable amounts of heavy metals such as zinc, iron, and cobalt, these metals are eventually concentrated in the combustion ashes, especially in fly ash. In view of resource recycling, waste tire fly ash (TFA) would be a promising secondary source for these valuable metals [8].

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 [9]. Different types of reactors have been used for tire pyrolysis, such as autoclaves and fixed bed reactors,[10-14] and for a larger scale operation, bubbling fluidized bed reactors,[13-18] moving beds under vacuum, in one and two steps,[19-21] ablative beds,[22] and rotary ovens[23-25]. 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, Indane and so on.

### II. EXPERIMENTAL PROCESS

#### 2.1. Materials

Motor vehicle waste tire was collected from NY, Pawling city, road 22, car collision center. Collected tire cut into small pieces for experimental setup. Tire has metal part and also cloth part with rubber. For experimental purpose only use tire part with cloth portion. Without wash tire was transfer into reactor chamber for liquefaction process with ferric carbonate [Fe<sub>2</sub>(CO<sub>3</sub>)<sub>3</sub>] catalyst. Ferric carbonate catalyst was prepared into Natural State Research Laboratory.

## 2.2. Ferric Carbonate Preparation

Ferric chloride ( $\text{FeCl}_3$ ) and sodium bicarbonate ( $\text{NaHCO}_3$ ) collect from VWR.com Company. 1(N) Ferric chloride solution made with D-Ionization water and 1(N) Sodium Bicarbonate solution made with same water. After both solution preparation mixed with Ferric chloride solution and sodium bicarbonate solution. After mixing both solutions it was start to precipitate in to bottom. When was finished precipitate watery portion separated by filter paper with funnel system and kept into separate container for treatment. Solid Ferric Carbonate was stuck into filter paper and from filter paper to solid part transfer into crucible for drying. Wet solid ferric carbonate put into drying oven at 80 °C temperature for 4-6 hours. After drying solid part it was become hard it call Ferric Carbonate [ $\text{Fe}_2(\text{CO}_3)_3$ ] catalyst. For whole process finished it took time 8-10 hours.

## 2.3. Process Description

Small size scrapes motor vehicle tire transfer into reactor chamber with ferric carbonate catalyst. For experimental purpose tire was 100 gm and Ferric Carbonate was 1 gm (1%) by weight. Glass reactor was use for this experiment and temperature was controlled by veriac meter (Figure 1). Tire to fuel production temperature rand was 200 to 420 °C and experiment was under labconco fume hood in presence of oxygen without vacuumed system. Ferric Carbonate and motor vehicle scrape tire mixture put into reactor the reactor was connected with condensation system. Condensation unit was connected with fuel collection system. Reactor and condensation unit connection joint was proper tightening with high temperature tolerable vacuum grease to prevent gas loss or gas leak. Reactor, condensation unit, grease, collection tank and all other necessary parts was provided from VWR.com. Collection tank one end was connected with light gas cleaning and light gas cleaning purposed sodium hydroxide and sodium bicarbonate solution was use as 0.25(N). Light gas collection was connecting with water basin to remove alkali portion from light gas. After light gas wash with water it was transfer into Teflon bag using small pump system. Fuel collection tank was connecting with filter system to remove fuel sediment then filter system was connecting with final fuel collection tank. Reactor temperature capability is 500 °C but in this experimental process was use up to 420 °C. Ferric carbonate and tire mixture to fuel production process heat start from 200 °C and temperature was increase slowly and monitor whole experiment until finished the experiment. Ferric carbonate helps to accelerate the reaction from tire to fuel production. Tire made by rubber, metal, petroleum, additives and cloth mixture. Rubber portion cannot be made fuel but only petroleum part can convert into fuel and rest of all portion settle down as residue. Tire to fuel production conversion rate including light gas almost 40% and rest of 60 percentages was residue. Fuel was filtered with filter system and kept into separate container for GC/MS analysis. Tire to fuel production period some gas was generated that gas was cleaned by using sodium hydroxide and sodium bicarbonate solution to remove contamination if present into light gas then light gas passes through with clean water to remove alkali portion in light gas present. Produce fuel density is 0.84 g/ml. In mass balance calculation liquid fuel was 28.1 gm, light gas generated 13 gm and 58.9 gm was solid black residue. Light gas and black residue analysis under investigation. Total experiment finished time was 3-4 hours and input electricity was 0.690KWh.

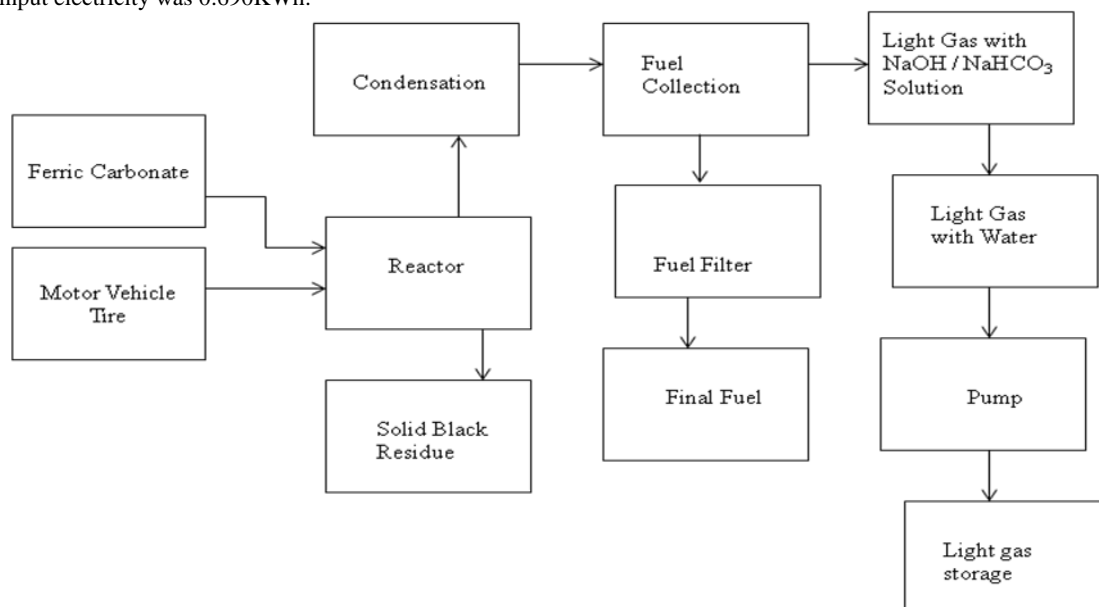


Figure 1: Motor Vehicle used tire into fuel production process with Ferric Carbonate

### III. RESULTS AND DISCUSSIONS

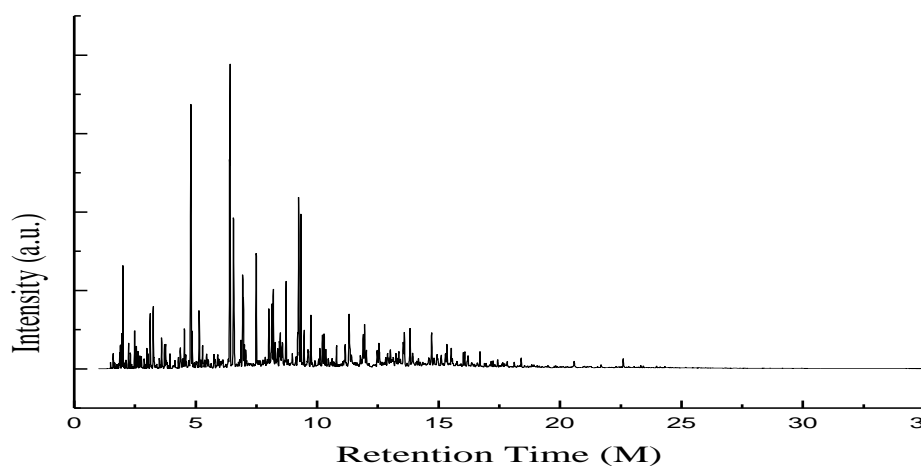


Figure 2: GC/MS chromatogram of motor vehicle tire to fuel

Table 1: GC/MS chromatogram compound list of motor vehicle tire 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	Cyclopropane	C <sub>3</sub> H <sub>6</sub>	42	70.1	18854
2	1.56	43	Isobutane	C <sub>4</sub> H <sub>10</sub>	58	57.5	18936
3	1.60	41	2-Butene, (E)-	C <sub>4</sub> H <sub>8</sub>	56	24.1	105
4	1.75	55	1-Butene, 3-methyl-	C <sub>5</sub> H <sub>10</sub>	70	16.5	160477
5	1.81	43	Butane, 2-methyl-	C <sub>5</sub> H <sub>12</sub>	72	70.3	61287
6	1.87	42	Cyclopropane, ethyl-	C <sub>5</sub> H <sub>10</sub>	70	22.3	114410
7	1.90	55	Cyclopropane, 1,2-dimethyl-, cis-	C <sub>5</sub> H <sub>10</sub>	70	15.2	19070
8	1.95	67	1,3-Pentadiene	C <sub>5</sub> H <sub>8</sub>	68	19.2	291890
9	2.01	55	2-Pentene, (E)-	C <sub>5</sub> H <sub>10</sub>	70	16.4	291780
10	2.05	67	1,3-Pentadiene	C <sub>5</sub> H <sub>8</sub>	68	21.6	291890
11	2.13	66	1,3-Cyclopentadiene	C <sub>5</sub> H <sub>6</sub>	66	46.1	196
12	2.24	67	Bicyclo[2.1.0]pentane	C <sub>5</sub> H <sub>8</sub>	68	18.5	192491
13	2.31	42	1-Pentanol, 2-methyl-	C <sub>6</sub> H <sub>14</sub> O	102	35.4	19924
14	2.36	54	Propanenitrile	C <sub>3</sub> H <sub>5</sub> N	55	94.3	40084
15	2.42	57	Pentane, 3-methyl-	C <sub>6</sub> H <sub>14</sub>	86	44.1	565
16	2.49	41	1-Hexene	C <sub>6</sub> H <sub>12</sub>	84	27.0	227613
17	2.56	57	Hexane	C <sub>6</sub> H <sub>14</sub>	86	76.5	61280
18	2.63	69	2-Butene, 2,3-dimethyl-	C <sub>6</sub> H <sub>12</sub>	84	18.2	289588

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19	2.67	41	2-Pentene, 3-methyl-, (Z)-	C <sub>6</sub> H <sub>12</sub>	84	26.8	114483
20	2.70	67	1,3-Pentadiene, 3-methyl-, (E)-	C <sub>6</sub> H <sub>10</sub>	82	9.53	62975
21	2.88	56	Cyclopentane, methyl-	C <sub>6</sub> H <sub>12</sub>	84	67.3	114428
22	2.94	67	2,4-Hexadiene, (Z,Z)-	C <sub>6</sub> H <sub>10</sub>	82	10.7	113646
23	2.99	79	1,3-Cyclopentadiene, 5-methyl-	C <sub>6</sub> H <sub>8</sub>	80	26.7	419
24	3.04	79	1,3-Cyclopentadiene, 5-methyl-	C <sub>6</sub> H <sub>8</sub>	80	24.5	419
25	3.13	67	Cyclopentene, 1-methyl-	C <sub>6</sub> H <sub>10</sub>	82	19.1	107747
26	3.26	78	Benzene	C <sub>6</sub> H <sub>6</sub>	78	68.9	114388
27	3.40	43	Hexane, 3-methyl-	C <sub>7</sub> H <sub>16</sub>	100	69.1	113081
28	3.50	67	Cyclohexene	C <sub>6</sub> H <sub>10</sub>	82	26.2	114431
29	3.55	56	1-Hexene, 2-methyl-	C <sub>7</sub> H <sub>14</sub>	98	12.7	114433
30	3.60	56	1-Heptene	C <sub>7</sub> H <sub>14</sub>	98	22.5	19704
31	3.72	43	Heptane	C <sub>7</sub> H <sub>16</sub>	100	70.6	61276
32	3.76	81	1,4-Hexadiene, 4-methyl-	C <sub>7</sub> H <sub>12</sub>	96	9.08	113135
33	3.79	81	Cyclopentene, 4,4-dimethyl-	C <sub>7</sub> H <sub>12</sub>	96	8.92	38642
34	3.87	69	2-Hexene, 3-methyl-, (Z)-	C <sub>7</sub> H <sub>14</sub>	98	26.2	114046
35	3.94	81	Cyclopentene, 4,4-dimethyl-	C <sub>7</sub> H <sub>12</sub>	96	11.8	38642
36	4.15	83	Cyclohexane, methyl-	C <sub>7</sub> H <sub>14</sub>	98	51.0	118503
37	4.29	43	Pentanal, 2,3-dimethyl-	C <sub>7</sub> H <sub>14</sub> O	114	19.2	118167
38	4.37	79	1,3,5-Heptatriene, (E,E)-	C <sub>7</sub> H <sub>10</sub>	94	17.4	118126
39	4.53	81	Cyclobutane, (1-methylethylidene)-	C <sub>7</sub> H <sub>12</sub>	96	12.7	150272
40	4.59	67	1-Ethylcyclopentene	C <sub>7</sub> H <sub>12</sub>	96	42.5	114407
41	4.81	91	Toluene	C <sub>7</sub> H <sub>8</sub>	92	56.3	291301
42	4.85	81	Cyclohexene, 3-methyl-	C <sub>7</sub> H <sub>12</sub>	96	13.3	236066
43	5.14	55	Pentane, 2-cyclopropyl-	C <sub>8</sub> H <sub>16</sub>	112	9.52	113439
44	5.29	43	Hexane, 2,4-dimethyl-	C <sub>8</sub> H <sub>18</sub>	114	36.4	118871
45	5.45	95	Cyclopentene, 1,2,3-trimethyl-	C <sub>8</sub> H <sub>14</sub>	110	13.4	113461
46	5.52	93	Pyridine, 3-methyl-	C <sub>6</sub> H <sub>7</sub> N	93	32.0	791
47	5.63	81	1-Ethyl-5-methylcyclopentene	C <sub>8</sub> H <sub>14</sub>	110	16.7	114420
48	5.75	95	Bicyclo[3.1.0]hexane, 1,5-dimethyl-	C <sub>8</sub> H <sub>14</sub>	110	12.8	142175
49	5.79	95	Cyclohexene, 3,5-dimethyl-	C <sub>8</sub> H <sub>14</sub>	110	19.0	113436
50	5.95	54	Cyclohexene, 4-ethenyl-	C <sub>8</sub> H <sub>12</sub>	108	13.0	227540

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51	6.02	42	2-Nonyn-1-ol	C <sub>9</sub> H <sub>16</sub> O	140	12.7	114747
52	6.07	93	1,2-Dimethyl-1,4-cyclohexadiene	C <sub>8</sub> H <sub>12</sub>	108	13.5	113101
53	6.12	56	6-Hepten-1-ol, 3-methyl-	C <sub>8</sub> H <sub>16</sub> O	128	5.97	60715
54	6.42	91	Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	106	53.3	158804
55	6.56	91	p-Xylene	C <sub>8</sub> H <sub>10</sub>	106	37.7	113952
56	6.86	56	1-Nonene	C <sub>9</sub> H <sub>18</sub>	126	5.17	229029
57	6.94	104	Styrene	C <sub>8</sub> H <sub>8</sub>	104	36.7	291542
58	6.96	91	p-Xylene	C <sub>8</sub> H <sub>10</sub>	106	40.6	113952
59	7.01	57	Nonane	C <sub>9</sub> H <sub>20</sub>	128	27.3	228006
60	7.06	57	Ethanol, 2-butoxy-	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	118	44.6	118812
61	7.49	105	Benzene, (1-methylethyl)-	C <sub>9</sub> H <sub>12</sub>	120	46.7	228742
62	7.59	57	1-Nonyne, 7-methyl-	C <sub>10</sub> H <sub>18</sub>	138	6.80	114524
63	7.65	55	Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-, [1R-(1 $\alpha$ ,2 $\alpha$ ,5 $\alpha$ )]-	C <sub>10</sub> H <sub>18</sub>	138	7.03	140998
64	7.86	117	Deltacyclene	C <sub>9</sub> H <sub>10</sub>	118	13.9	261521
65	8.01	91	Benzene, propyl-	C <sub>9</sub> H <sub>12</sub>	120	71.7	113930
66	8.14	105	Benzene, 1-ethyl-3-methyl-	C <sub>9</sub> H <sub>12</sub>	120	33.8	228743
67	8.28	105	Benzene, 1,2,3-trimethyl-	C <sub>9</sub> H <sub>12</sub>	120	22.6	228017
68	8.37	93	Silanediamine, 1,1-dimethyl-N,N'-diphenyl-	C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> Si	242	46.4	73688
69	8.49	118	$\alpha$ -Methylstyrene	C <sub>9</sub> H <sub>10</sub>	118	23.7	229186
70	8.57	55	2-Decene, (Z)-	C <sub>10</sub> H <sub>20</sub>	140	6.89	114151
71	8.72	105	Benzene, 1,3,5-trimethyl-	C <sub>9</sub> H <sub>12</sub>	120	24.9	20469
72	8.81	55	5-Methylene-1,3a,4,5,6,6a-hexahydropentalen-1-ol	C <sub>9</sub> H <sub>12</sub> O	136	8.67	193003
73	8.98	105	Benzene, (1-methylpropyl)-	C <sub>10</sub> H <sub>14</sub>	134	36.1	228188
74	9.13	119	2,3-Epoxy-carane, (E)-	C <sub>10</sub> H <sub>16</sub> O	152	19.2	156146
75	9.24	119	Benzene, 1-methyl-2-(1-methylethyl)-	C <sub>10</sub> H <sub>14</sub>	134	23.1	114006
76	9.33	68	D-Limonene	C <sub>10</sub> H <sub>16</sub>	136	25.8	62287
77	9.47	117	Indane	C <sub>9</sub> H <sub>10</sub>	118	15.0	118485
78	9.62	115	Benzene, 1-ethynyl-4-methyl-	C <sub>9</sub> H <sub>8</sub>	116	21.2	43759
79	9.74	119	1,3,8-p-Menthatriene	C <sub>10</sub> H <sub>14</sub>	134	21.4	70247
80	9.91	105	Bicyclo[3.1.1]hept-2-ene-2-ethanol, 6,6-dimethyl-	C <sub>11</sub> H <sub>18</sub> O	166	9.15	114741
81	10.06	119	2,3-Epoxy-carane, (E)-	C <sub>10</sub> H <sub>16</sub> O	152	18.4	156146

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82	10.12	119	Benzene, 1-methyl-3-(1-methylethyl)-	C <sub>10</sub> H <sub>14</sub>	134	13.5	149866
83	10.29	117	Indan, 1-methyl-	C <sub>10</sub> H <sub>12</sub>	132	7.92	150963
84	10.36	57	Undecane	C <sub>11</sub> H <sub>24</sub>	156	26.4	114185
85	10.46	105	7-Methyl-1,2,3,5,8,8a-hexahydronaphthalene	C <sub>11</sub> H <sub>16</sub>	148	8.19	142188
86	10.62	119	Benzene, 1,3-diethyl-5-methyl-	C <sub>11</sub> H <sub>16</sub>	148	26.8	113941
87	10.69	117	2,4-Dimethylstyrene	C <sub>10</sub> H <sub>12</sub>	132	9.40	136251
88	10.80	119	Benzene, 1,2,3,4-tetramethyl-	C <sub>10</sub> H <sub>14</sub>	134	16.2	232298
89	10.86	117	3a,6-Methano-3aH-indene, 2,3,6,7-tetrahydro-	C <sub>10</sub> H <sub>12</sub>	132	7.53	185591
90	10.92	131	Benzene, (3-methyl-2-butenyl)-	C <sub>11</sub> H <sub>14</sub>	146	11.3	186387
91	11.16	117	Benzene, 1-methyl-2-(2-propenyl)-	C <sub>10</sub> H <sub>12</sub>	132	9.47	2982
92	11.41	130	Tetracyclo[5.3.0.0<2,6>.0<3,10>]deca-4,8-diene	C <sub>10</sub> H <sub>10</sub>	130	10.8	193836
93	11.54	104	Naphthalene, 1,2,3,4-tetrahydro-	C <sub>10</sub> H <sub>12</sub>	132	29.4	113929
94	11.78	41	3-Dodecene, (E)-	C <sub>12</sub> H <sub>24</sub>	168	16.1	70642
95	11.83	131	Benzene, (3-methyl-2-butenyl)-	C <sub>11</sub> H <sub>14</sub>	146	9.64	186387
96	11.95	128	Naphthalene	C <sub>10</sub> H <sub>8</sub>	128	40.8	114935
97	12.03	131	1H-Indene, 2,3-dihydro-1,6-dimethyl-	C <sub>11</sub> H <sub>14</sub>	146	15.8	4241
98	12.13	133	Benzaldehyde, 4-(1-methylethyl)-	C <sub>10</sub> H <sub>12</sub> O	148	19.5	35365
99	12.47	117	Benzene, cyclopentyl-	C <sub>11</sub> H <sub>14</sub>	146	52.5	187011
100	12.55	135	Benzothiazole	C <sub>7</sub> H <sub>5</sub> NS	135	70.8	118929
101	12.90	91	Benzene, hexyl-	C <sub>12</sub> H <sub>18</sub>	162	17.3	113954
102	13.01	129	Naphthalene, 1,2-dihydro-3-methyl-	C <sub>11</sub> H <sub>12</sub>	144	18.8	4003
103	13.10	129	1H-Indene, 2,3-dihydro-1,2-dimethyl-	C <sub>11</sub> H <sub>14</sub>	146	15.5	4235
104	13.25	41	Oct-3-ene-1,5-diyne, 3-t-butyl-7,7-dimethyl-	C <sub>14</sub> H <sub>20</sub>	188	12.2	211230
105	13.36	57	Tridecane	C <sub>13</sub> H <sub>28</sub>	184	17.4	114282
106	13.43	145	Naphthalene, 1,2,3,4-tetrahydro-1,8-dimethyl-	C <sub>12</sub> H <sub>16</sub>	160	10.9	39302
107	13.55	149	Benzothiazole, 2-methyl-	C <sub>8</sub> H <sub>7</sub> NS	149	23.9	227888
108	13.59	142	Naphthalene, 1-methyl-	C <sub>11</sub> H <sub>10</sub>	142	25.3	291511
109	13.71	145	Benzene, (1,3-dimethyl-2-butenyl)-	C <sub>12</sub> H <sub>16</sub>	160	10.0	62328
110	13.83	141	Naphthalene, 1-methyl-	C <sub>11</sub> H <sub>10</sub>	142	20.9	291511
111	13.93	145	Falcarinol	C <sub>17</sub> H <sub>24</sub> O	244	10.4	112661
112	14.18	145	Oct-3-ene-1,5-diyne, 3-t-butyl-7,7-dimethyl-	C <sub>14</sub> H <sub>20</sub>	188	7.61	211230
113	14.24	143	Tricyclo[6.4.0.0(3,7)]dodeca-1,9,11-triene	C <sub>12</sub> H <sub>14</sub>	158	29.2	298964

114	14.60	143	(1-Methylpenta-1,3-dienyl)benzene	C <sub>12</sub> H <sub>14</sub>	158	31.1	210058
115	14.72	154	Biphenyl	C <sub>12</sub> H <sub>10</sub>	154	63.7	53609
116	14.81	162	Isoquinoline, 1-[3-methoxy-5-hydroxybenzyl]-1,2,3,4-tetrahydro-6-methoxy-	C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	299	12.0	117076
117	15.11	156	Naphthalene, 1,3-dimethyl-	C <sub>12</sub> H <sub>12</sub>	156	14.1	27648
118	15.28	156	Naphthalene, 1,8-dimethyl-	C <sub>12</sub> H <sub>12</sub>	156	13.4	118790
119	15.34	156	Naphthalene, 1,7-dimethyl-	C <sub>12</sub> H <sub>12</sub>	156	20.4	39233
120	15.52	157	Quinoline, 2,4-dimethyl-	C <sub>11</sub> H <sub>11</sub> N	157	47.6	5407
121	15.76	141	Naphthalene, 1,2-dihydro-2,5,8-trimethyl-	C <sub>13</sub> H <sub>16</sub>	172	9.88	34865
122	16.02	57	Pentadecane	C <sub>15</sub> H <sub>32</sub>	212	13.7	22620
123	16.08	168	1,1'-Biphenyl, 4-methyl-	C <sub>13</sub> H <sub>12</sub>	168	29.7	155802
124	16.22	168	1,1'-Biphenyl, 2-methyl-	C <sub>13</sub> H <sub>12</sub>	168	24.6	157536
125	16.71	170	Naphthalene, 2,3,6-trimethyl-	C <sub>13</sub> H <sub>14</sub>	170	20.1	228329
126	16.89	170	3-(2-Methyl-propenyl)-1H-indene	C <sub>13</sub> H <sub>14</sub>	170	45.6	187785
127	17.24	57	Hexadecane	C <sub>16</sub> H <sub>34</sub>	226	9.81	114191
128	17.49	182	1,1'-Biphenyl, 3,4'-dimethyl-	C <sub>14</sub> H <sub>14</sub>	182	20.1	7573
129	17.60	153	1-Isopropenyl-naphthalene	C <sub>13</sub> H <sub>12</sub>	168	37.1	217205
130	18.12	92	Benzene, 1,1'-(1,3-propanediyl)bis-	C <sub>15</sub> H <sub>16</sub>	196	66.9	34894
131	18.40	57	Heptadecane	C <sub>17</sub> H <sub>36</sub>	240	12.8	22871
132	18.54	184	2(3H)-Naphthalenone, 4,4a,5,6,7,8-hexahydro-4a-phenyl-, (R)-	C <sub>16</sub> H <sub>18</sub> O	226	45.9	47572
133	20.58	41	Hexadecanenitrile	C <sub>16</sub> H <sub>31</sub> N	237	58.6	72104
134	22.60	43	Heptadecanenitrile	C <sub>17</sub> H <sub>33</sub> N	251	21.3	12200
135	23.32	230	p-Terphenyl	C <sub>18</sub> H <sub>14</sub>	230	47.6	287537
136	23.42	220	Tricyclo[9.2.2.2(4,7)]heptadeca-1(14),2,4(17),5,7(16),11(15),12-heptaene	C <sub>17</sub> H <sub>16</sub>	220	43.4	202224
137	23.98	219	Phenanthrene, 1-methyl-7-(1-methylethyl)-	C <sub>18</sub> H <sub>18</sub>	234	50.5	243807
138	24.13	57	di(Butoxyethyl)adipate	C <sub>18</sub> H <sub>34</sub> O <sub>6</sub>	346	22.5	279801
139	26.00	57	5 $\alpha$ -Cholest-8-en-3-one, 14-methyl-	C <sub>28</sub> H <sub>46</sub> O	398	10.4	48716

Produce fuel was analysis by using Perkin Elmer GC/MS (Clarus 500) with auto sampler chromatogram shown figure 2 and traced compounds list showed table 1. GC/MS analysis result showed table 1 produced fuel has different types of compounds mixture such as hydrocarbon compounds aliphatic and aromatic group compounds, alcoholic compounds, oxygen containing compounds, nitrogen containing compounds. Benzene group compounds present in this produce fuel with hydrocarbon group. Present fuel carbon range showed in to GC/MS analysis chromatogram C<sub>3</sub> to C<sub>28</sub>. Chromatogram compounds was detected based on retention time (t) and trace mass (m/z). Large peak detected from GC/MS chromatogram Ethylbenzene at retention time 6.42 min and trace mass 91. From analysis result some compounds are elaborated in this section based on compounds retention time and trace mass (time vs. m/z) such as Cyclopropane (C<sub>3</sub>H<sub>6</sub>) (t=1.49, m/z= 41) compounds molecular weight is 42 and compound probability is 70.1%, cis-1,2-dimethyl-Cyclopropane (C<sub>5</sub>H<sub>10</sub>) (t=1.90, m/z=55) compounds molecular weight is 70 and compound probability is 15.2%, Propanenitrile (C<sub>3</sub>H<sub>5</sub>N) (t=2.36, m/z=54) compounds molecular weight is 55 and compound probability is 94.3%, methyl-Cyclopentane (C<sub>6</sub>H<sub>12</sub>) (t=2.88, m/z=56)

compounds molecular weight is 84 and compound probability is 67.3%, Benzene (C<sub>6</sub>H<sub>6</sub>) (t=3.26, m/z=78) compounds molecular weight is 78 and compound probability is 68.9 %, Heptane (C<sub>7</sub>H<sub>16</sub>) (t=3.72, m/z=43) compounds molecular weight is 100 and compound probability is 70.6 %, methyl-Cyclohexane (C<sub>7</sub>H<sub>14</sub>) (t=4.15, m/z=83) compounds molecular weight is 98 and compound probability is 51.0%, Toluene (C<sub>7</sub>H<sub>8</sub>) (t=4.81, m/z=91) compounds molecular weight is 92 and compound probability is 56.3%, 2,4-dimethyl-Hexane (C<sub>8</sub>H<sub>18</sub>) (t=5.29, m/z=43) compounds molecular weight is 114 and compound probability is 36.4%, 1-Ethyl-5-methylcyclopentene (C<sub>8</sub>H<sub>14</sub>) (t=5.63, m/z=81) compounds molecular weight is 110 and compound probability is 16.7%, 2-Nonyl-1-ol (C<sub>9</sub>H<sub>16</sub>O) (t=6.02, m/z=42) compounds molecular weight is 140 and compound probability is 12.7%, p-Xylene (C<sub>8</sub>H<sub>10</sub>) (t= 6.56, m/z=91) compounds molecular weight is 106 and compound probability is 37.7%, Styrene (C<sub>8</sub>H<sub>8</sub>) (t=6.94, m/z=104) compounds molecular weight is 104 and compound probability is 36.7 %, 2-butoxy- Ethanol (C<sub>6</sub>H<sub>14</sub>O<sub>2</sub>) (t=7.06, m/z=57) compounds molecular weight is 118 and compound probability is 44.6 %, Deltacyclene (C<sub>9</sub>H<sub>10</sub>) (t=7.86, m/z=117) compounds molecular weight is 118 and compound probability is 13.9%,  $\alpha$ -Methylstyrene (C<sub>9</sub>H<sub>10</sub>) (t=8.49, m/z=118) compounds molecular weight is 118 and compound probability is 23.7%, 1-methylpropyl- Benzene (C<sub>10</sub>H<sub>14</sub>) (t=8.98, m/z=105) compounds molecular weight is 134 and compound probability is 36.1 %, D-Limonene (C<sub>10</sub>H<sub>16</sub>) (t=9.33, m/z=68) compounds molecular weight is 136 and compound probability is 25.8 %, 1-methyl-3-(1-methylethyl)-Benzene (C<sub>10</sub>H<sub>14</sub>) (t=10.12, m/z=119) compounds molecular weight is 134 and compound probability is 13.5%, 1,3-diethyl-5-methyl-Benzene (C<sub>11</sub>H<sub>16</sub>) (t=10.62, m/z=119) compounds molecular weight is 148 and compound probability is 26.8 %, 3-methyl-2-butenyl- Benzene (C<sub>11</sub>H<sub>14</sub>) (t=10.92, m/z=131) compounds molecular weight is 146 and compound probability is 11.3%, (E)- 3-Dodecene (C<sub>12</sub>H<sub>24</sub>) (t=11.78, m/z=41) compounds molecular weight is 168 and compound probability is 16.1 %, cyclopentyl- Benzene (C<sub>11</sub>H<sub>14</sub>) (t=12.47, m/z=117) compounds molecular weight is 146 and compound probability is 52.5%, Tridecane (C<sub>13</sub>H<sub>28</sub>) (t=13.36, m/z=57) compounds molecular weight is 184 and compound probability is 17.4%, 1,3-dimethyl-2-butenyl-Benzene (C<sub>12</sub>H<sub>16</sub>) (t=13.71, m/z=145) compounds molecular weight is 160 and compound probability is 10.0 %, Biphenyl (C<sub>12</sub>H<sub>10</sub>) (t=14.72, m/z=154) compounds molecular weight is 154 and compound probability is 63.7%, 1,7-dimethyl-Naphthalene (C<sub>12</sub>H<sub>12</sub>) (t=15.34, m/z=156) compounds molecular weight is 156 and compound probability is 20.4 %, 4-methyl-1,1'-Biphenyl (C<sub>13</sub>H<sub>12</sub>) (t=16.08, m/z=168) compounds molecular weight is 168 and compound probability is 29.7 %, 2,3,6-trimethyl- Naphthalene (C<sub>13</sub>H<sub>14</sub>) (t=16.71, m/z=170) compounds molecular weight is 170 and compound probability is 20.1 %, Heptadecane (C<sub>17</sub>H<sub>36</sub>) (t=18.40, m/z=57) compounds molecular weight is 240 and compound probability is 12.8%, p-Terphenyl (C<sub>18</sub>H<sub>14</sub>) (t=23.32, m/z=230) compounds molecular weight is 230 and compound probability is 47.6%, 14-methyl- 5 $\alpha$ -Cholest-8-en-3-one (C<sub>28</sub>H<sub>46</sub>O) (t=26.00, m/z=57) compounds molecular weight is 398 and compound probability is 10.4%. Benzene or aromatic group concentration high in present fuel and fuel efficiency is high for that reason this fuel can be use a feed for electricity generation.

#### IV. CONCLUSION

Motor vehicle scrape tire to fuel production process thermal degradation process applied with ferric carbonate catalyst. Temperature range was 200- 420 °C and fuel density is 0.84 g/ml and fuel production conversion rate was almost 40%. Fuel color is light yellow and odor is burning tire. Fuel analysis purpose gas chromatography and mass spectrometer was use and carbon compounds detected Cyclopropane to 14-methyl-5 $\alpha$ -Cholest-8-en-3-one. Aromatic compounds percentage is higher than other compounds and aromatics compounds present into fuel such as Benzene, Toluene, Ethylbenzene, p-Xylene, Styrene, propyl-Benzene,  $\alpha$ -Methylstyrene, D-Limonene, Indane, 1,2,3,4-tetramethyl-Benzene, Naphthalene, 1,3-dimethyl-Naphthalene, p-Terphenyl and so on. The technology can convert all motor vehicle used tire to fuel and save the environmental problem as well as reduce some oil problem at this time. Fuel can be use for refinery station for further modification and after that can be use for internal combustion engine.

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