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Characterization of Pyrolyzed Oil from Disposable Low-Density Polyethylene Sachet Water Nylon Waste Utilizing Calcium Hydroxide Waste [$Ca(OH)_2$] Catalyst

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The sachet water nylon (popularly known as pure water nylon) waste was pyrolyzed using batch reactor at a temperature of 500°C and atmospheric pressure. The sachet water nylon waste pyrolized oil percentage yield obtained was 63% without application of the catalyst while the pyrolyzed oil obtained utilizing $Ca(OH)_2$ catalyst was found to be 80% and the pyrolyzed carbon black (PCB) was found to be 0% while the remaining % was mainly pyrolyzed gas. The calorific value of waste nylon pyrolyzed oils was found to be 41.7-42.1MJ/Kg while the density and viscosity were 0.79-0.82 g\cm^3 and 2.9-3.2Cst respectively. The results obtained from the Gas Chromatography Mass Spectrometer (GC-MS) revealed total of 100 compounds pyrolyzed oils from both catalyzed and uncatalyzed pyrolysis process. More so, many compounds found to be common in both catalyzed and uncatalyzed pyrolyzed oils.

Keywords: Calcium hydroxide, Pyrolysis, Pyrolyzed oil, Polyethylene, sachet water nylon.

1. Introduction

Municipal solid waste management is a major task for developed and developing countries worldwide, mainly for developing countries such as Serbia, Ice land, China and others. Many issues like growing urban population, limited financial resources with less advanced technologies for waste treatment, and disposal, lead to poor waste management, which are major environmental problem (Arabiourrutia *et al.,* 2020). The insufficiencies and non-sustainable future stock, in conjunction with ecological contamination produced by illegal dumping of the solid waste is unfavorable to human health. It may lead to pandemic diseases if not properly maintain (Nanda *et al.,* 2015). The principal aim of the waste management system in many developed countries is source recovery from waste. Waste-to-energy recycling technologies, like thermal technology of pyrolysis, incineration, or gasification have been applied for managing municipal solid waste in several countries all over the world for many years. These thermal technologies are energy intensive methods that try to reduce the capacity of waste by converting it into useful fuel or energy. Many thermal technologies attempt to treat large quantities of heterogeneous mixed municipal solid waste (Tangri and Wilson, 2017).

Moreover, plastic standard quantity leads to ecological damage, renewable energy sources such as the waste plastics can develop the most reasonable reactant that produces wealth conversion from waste to energy. Additional possible renewable sources are solar, geothermal, wind, most waste of biomass which are pull an important consideration attention to fight global warming, moreover concerning the span of constant growing energy demand with small and supply in Nigeria, it becomes necessary to go into obtaining useful products from the waste (Al-Kalali et al., 2023; Battsetseg *et al.,* 2022; Czajczynska et al., 2020). The pyrolysis is considered to be an innovative ideal alternative way for converting municipal solid waste into different chemicals and fuels. Pyrolysis methods are better than conventional municipal solid waste burning because energy can be produced in a hygienic way. Also, may possess less productions of unwanted compound such as nitrogen oxides (NOx) and sulphur oxides (SO_2) and better quality of solid residues can be expected from this thermal technique for municipal solid waste (Karmina *et al.,* 2019;

Moon et al., 2022; Mishra et al., 2023; Orcid et al. 2023)

For these plastic waste which are treated to produce petrochemical compounds, innovative technical processes, and cost effective techniques together with governmental incentives can help to initiate and increase the development of sustainable energy source (Olugbenga *et al.,* 2022).

Moreover, rubber is also hydrocarbon polymer made of latex derived from the tree sap of several types of rubber, in the meantime, almost every corner and cranny in Nigeria is tormented with sachet water nylon waste, popularly called (pure water waste), the large volume of which in ordinary parlance, creates pollution and named negative externality or economic (bad) in economics (Adetunji *et al.,* 2010). As a result of millions of used sachets being thrown on daily basis onto the streets of almost every city, town, and village in Nigeria as reported by Edoga *et al.,* (2008).

Almost 70% percent of Nigerian adults drink at least a sachet of pure water per day resulting in about 50 to 60 million used water-sachets disposed daily all over the country. Nowadays the greatest environmental problem arising developing countries particularly Nigeria, is municipal and public waste management, the cities are foul-smelling from heavy incontrollable solid waste. Due to the present economic condition in Nigeria, water is packaged in low-density polyethylene (LDPE) sachet, this is popularly recognized as (pure water), pure water sachet (PWS) serves as the cheapest packaging material. It has become common in all the communities but unfortunately this has led to new source of solid waste since the LDPE has extremely low rate of degradation. (Ademiluyi *et al.,* 2007).

This research aimed to study the performance of $Ca(OH)_2$ catalyst in the conversion of polyethylene sachet water (pure water nylon) waste to liquid fuel and GC-MS characterization of the pyrolyzed oils

2. Materials and Methods

2.1. Materials

The major materials used in this research work were waste polyethylene nylon and calcium hydroxide waste (waste from gas welding centers).

2.2 Sample and Sample Pretreatment

2.2.1 Polyethylene Nylon Sachet Waste

The waste polyethylene nylon sachet was collected randomly from Sahara area in Sokoto South Local Government, Sokoto. The waste nylon sachet was cut into pieces and a clean towel was used to clean all the pieces before loading into pyrolysis reactor

2.2.2 Calcium Hydroxide [$Ca(OH)_2$] Waste

The catalyst (calcium hydroxide waste) was locally sourced from a gas welding center in Buzaye mechanic workshop centers, Sokoto and random sampling process was carried out. The catalyst was dried in an oven at a temperature of 105°C overnight and calcined at 500°C in muffle furnace for 4 hours.

2.3 Pyrolysis Test

About 2 kg of the pieces of polyethylene nylon sachet was gently loaded into the pyrolyzer. The pyrolysis reaction was conducted at a temperature of 500°C and atmospheric pressure in a locally made pyrolysis reactor. The pyrolyzed oil from sachet water nylon starts to drop from the reactor outlet after 15 minutes in the absence of catalyst and same procedure was applied for the catalytic pyrolysis except that 0.05 kg of catalyst was added into the reactor and the oil starts to drop within the first 8 minutes. The pyrolyzed oil was collected at the reactor outlet from the begging of pyrolysis to the end. The total quantity of the pyrolyzed oil, steel wire and pyrolyzed carbon black were calculated, while the pyrolysis gas was estimated. The composition of pyrolyzed oil was investigated using GCMS-QP2010SE Gas Chromatography Mass Spectrophotometer (Shimadzu) equipped with a 30m×0.32mm, Rxi-624 Sil MS capillary column (Restek Corp.).

2.5 Characterization of the Nylon Sachet Pyrolyzed Oil

The bomb calorimeter model-IKA C2000 and viscometer model 3530 Chandler Engineering were used to investigate the calorific value and viscosity of the nylon sachet pyrolyzed oil.

3. Results and Discussion

3.1 Results

3.1.1 Results of Calorific value and Viscosity

The results of calorific value found to be 41.7 and 42.1 MJ/kg for the oils obtained from uncatalyzed and catalyzed pyrolysis process respectively. While the viscosity found to be 2.9 and 3.2 Cst for the oils obtained from uncatalyzed and catalyzed pyrolysis process respectively. However, the density of the oils generated from waste polyethylene sachet nylon was found to be 0.79 and 0.820 g/cm^3 for the catalyzed and uncatalyzed pyrolysis process respectively and

these findings are in conformity with research carried out by Prurapark et al. (2020).

3.1.2 GC-MS characterization of pyrolyzed oil

Table 1: Peak no., RT, % Area and compound present, molecular formula and qual found in the nylon sachet pyrolyzed oil without application of catalyst (uncatalyzed)

Peak No	RT	Area %	Compound present	Qual
1	5.015	9.55	1-Octene-3,7-dimethyl-	70
2	6.045	6.92	5-Dodecene, (E)-	87
3	6.663	1.01	Cyclopropanemethanol, 2-methyl-2-(4-methyl-3-pentenyl)-	52
4	6.927	0.93	Bicyclo[2.2.2]octane, 2-methyl-	60
5	6.99	6.33	4-Dodecene, (E)-	95
6	7.058	5.11	Undecane	78
7	7.196	0.34	Oleyl alcohol, trifluoroacetate	86
8	7.373	0.29	3-octyne-5-methyl	42
9	7.442	0.32	Pentadecafluorooctanoic acid, tridecyl ester	49
10	7.499	0.16	Bicyclo[2.2.1]heptane-2-carboxaldehyde, 3-methyl-, (2-exo,3-endo)-	53
11	7.751	1.12	1,12-Tridecadiene	83
12	7.808	5.3	1-Tridecene	94
13	7.865	4	Tridecane	87
14	7.928	2.8	1-Hexene, 3,3-dimethyl-	46
15	7.991	0.94	2-Undecanethiol, 2-methyl-	64
16	8.054	1.8	2-Undecanethiol, 3-methyl-	59
17	8.111	0.13	Cyclohexylmethanol, trifluoroacetate (ester)	27
18	8.18	0.15	(R)-(-)-(Z)-14-Methyl-8-hexadecen-1-ol	64
19	8.254	0.73	2,3-Dimethyl-3-heptene, (Z)-	52
20	8.323	0.17	10-Heneicosene (c,t)	49
21	8.414	0.2	Bicyclo[3.1.1]heptan-3-one, 2,6,6-trimethyl-, (1.alpha.,2.beta.,5.alpha.)-	43
22	8.454	0.39	Dihydromyrcenol, heptafluorobutyrate	50
23	8.483	0.8	9-Octadecen-1-ol, (Z)-	96
24	8.535	5.21	5-Tetradecene, (E)-	96
25	8.586	3.64	Decane, 2,4,6-trimethyl-	90
26	8.62	0.24	5-Tetradecene, (E)-	96
27	8.695	0.17	3-Tetradecene, (E)-	96
28	8.798	0.13	Cyclotetradecane	86
29	8.895	0.3	1,4-Dimethylazulene	56
30	8.952	0.23	Cyclopentane, 1-methyl-3-(1-methylethyl)-	43
31	9.095	0.22	1-Hexadecyne	52
32	9.152	0.78	1,12-Tridecadiene	90
33	9.198	4.08	9-Eicosene, (E)-	94
34	9.244	3.09	Pentadecane	91
35	9.347	0.28	3-(But-3-enyl)-cyclohexanone	46
36	9.387	0.12	2,4-Di-tert-butylphenol	81
37	9.416	0.75	Ethanone, 1-(1,2,2,3-tetramethylcyclopentyl)-, (1R-cis)-	46
38	9.473	0.27	4-n-Pentylthiane, S,S-dioxide	64
39	9.587	0.66	Bicyclo[3.1.1]heptan-3-one, 2,6,6-trimethyl-, (1.alpha.,2.beta.,5.alpha.)-	38
40	9.645	0.18	Tetradecanal	59
41	9.685	0.16	Pentadecafluorooctanoic acid, dodecyl ester	58
42	9.742	0.2	1-Hexadecyne	96
43	9.776	0.78	cis-9-Tetradecen-1-ol	86
44	9.816	3.42	9-Eicosene, (E)-	94
45	9.856	3.2	Hexadecane	97
46	9.919	0.08	cis-9,10-Epoxyoctadecan-1-ol	64
47	9.959	0.2	Cyclohexadecane	90
48	10.022	0.12	6-Octen-1-ol, 3,7-dimethyl-, (R)-	64
49	10.085	0.12	2-Methyl-Z,Z-3,13-octadecadienol	74

50	10.32	0.26	8-Heptadecene	83
51	10.36	0.64	E-2-+Octadecadecen-1-ol	87
52	10.4	2.49	1-Nonadecene	91
53	10.434	2.08	Heptadecane	97
54	10.503	0.07	13-Octadecenal, (Z)-	83
55	10.537	0.15	1-Heptadecene	96
56	10.577	0.07	1-Cyclohexyl-2-methyl-prop-2-en-1-one	49
57	10.64	0.08	11,13-Dimethyl-12-tetradecen-1-olacetate	68
58	10.68	0.55	1-Decanol, 2-hexyl-	53
59	10.726	0.15	3-Tetradecene, (E)-	64
60	10.829	0.42	Ethanol, 2-(tetradecyloxy)-	78
61	10.875	0.08	n-Tetracosanol-1	49
62	10.915	0.5	Myristic acid, 9-octadecenyl ester, (Z)-	90
63	10.949	1.78	3-Eicosene, (E)-	95
64	10.978	1.31	Octadecane	95
65	11.081	0.39	Bicyclo[2.2.1]heptane-2,5-dione, 1,7,7-trimethyl-	87
66	11.224	0.05	Cyanoacetic acid, tetradecyl ester	86
67	11.441	0.31	E-2-Octadecadecen-1-ol	93
68	11.47	1.37	Z-5-Nonadecene	99
69	11.499	1.2	Nonadecane	94
70	11.539	0.68	2-Heptadecanone	90
71	11.602	0.09	Cyclotetradecane	92
72	11.642	0.05	Octadecanal	76
73	11.802	0.17	Disparlure	89
74	11.836	0.06	Tetradecanal	70
75	11.939	0.21	(R)-(-)-(Z)-14-Methyl-8-hexadecen-1-ol	93
76	11.968	0.87	3-Eicosene, (E)-	94
77	11.991	0.95	Heptadecane	91
78	12.174	0.2	n-Nonenylsuccinic anhydride	74
79	12.454	0.66	1-Nonadecene	95
80	12.477	0.51	Heneicosane	95
81	12.54	0.06	Oxirane, tetradecyl-	64
82	12.878	0.04	Disparlure	81
83	12.981	0.43	1-Nonadecene	97
84	13.009	0.37	Nonadecane	93
85	13.324	0.04	1,7-Nonadiene, 4,8-dimethyl-	46
86	13.593	0.24	9-Tricosene, (Z)-	99
87	13.621	0.23	Octadecane	94
88	13.873	0.03	2-Methyl-E-7-octadecene	58
89	14.325	0.24	Cyclotetracosane	99
90	14.651	0.03	1-Nonadecene	95
91	14.943	0.03	1,3-Dioxolane, 4-ethyl-5-octyl-2,2	47
92	15.115	0.02	13-Methyl-Z-14-nonacosene	46
93	15.229	0.18	17-Pentatriacontene	93
94	15.584	0.03	n-Propyl 11-octadecenoate	47
95	15.824	0.15	Bis(2-ethylhexyl) phthalate	47
96	16.128	0.39	Eicosane	91
97	16.837	0.26	Eicosane	91
98	17.215	0.06	Tris(tert-butyldimethylsilyloxy)arsane	35
99	17.444	0.23	Cyclohexane, 1-(1-tetradecylpentadecyl)-	35
100	17.541	0.42	Decanedioic acid, bis(2-ethylhexyl) ester	74

The GC-MS results of the generated pyrolyzed oils from both catalyzed and uncatalyzed pyrolysis of waste nylon revealed the presence of many common compounds in both samples. Total of 54 hydrocarbon compounds are found in pyrolyzed oil generated from non-catalytic process while 59 hydrocarbon compounds were found in the pyrolyzed oil from catalytic process. Other compounds found to be common in catalyzed and uncatalyzed pyrolyzed oils are

alcohols, ketones, aldehydes, carboxylic acids and esters. The common compounds that are found in both oils include 1-octene-3,7-dimethyl, 5-dodecene (E), Bicyclo [2.2.2] octane-2-methyl, 5-dodecene (E), Undecane, 1-tridecene, 2-undecanethiol-2-methyl,(R)-(Z)-14-methyl-8-hexane, 5-tetradecene, Heptadecane and 13-octadecenal (Z). More the results revealed that, the quality number of some compounds increased in the catalyst aided pyrolysis process. These compounds include 5-dodecene (E), undecane, 1-tridecene. The results revealed that, the % carbon bearing compounds found in the pyrolyzed oil from non-catalytic process are C_9 = 5.45%, C_{10} = 11.76%, C_{11} = 6.51%, C_{12} = 14.19%, C_{13} = 17.34%, C_{14} = 7.06%, C_{15} = 3.09%, C_{16} = 9.32%, C_{17} = 0.51%, C_{18} = 4.09%, C_{19} = 6.9%, C_{20} = 10.59%, C_{21} = 0.68%, C_{23} = 0.42%, C_{24} = 0.32% and C_{25} = 0.14%. While those found in catalyst aided pyrolyzed oil are C_9 = 4.74%, C_{10} = 15.25%, C_{11} = 7.47%, C_{12} = 12.77%, C_{13} = 6.2%, C_{14} = 5.57%, C_{15} = 0.2%, C_{16} = 3.95%, C_{17} = 3.92%, C_{18} = 5.95%, C_{19} = 10.12%, C_{20} = 3.04%, C_{21} = 0.51%, C_{23} = 0.24% and C_{24} = 0.24%. The catalytic system was able to increase the %area of C_{10} from 11.76% to 15.25% while the %area of C_{12} compounds rose from 14.19% to 17.77%. More so, the %area of carbon bearing compounds C_{13}, C_{14}, C_{15} and C_{16} reduced significantly from 17.34%, 7.06%, 3.09% and 9.32% to 6.2%, 5.57%, 0.2% and 3.96% respectively. As such, it is evidently clear that, most of the carbon bearing compounds found in the pyrolyzed oil without catalyst application have %area greater than compounds with similar carbon content found in the process that used catalyst. This implies that, the catalyst has a potential in the cracking of the compounds with higher carbon content to compounds with lower carbon skeleton and similar findings were reported elwhere (Felix and Eki, 2023; Hasan et al., 2023; Setiawan et al., 2021).

Table 2: Peak no., RT, Area% compound present, molecular formula and qual found in the nylon sachet waste pyrolyzed oil with application of catalyst

Peak No	RT	Area %	Compound	Qual
1	5.021	11.85	1-Octene, 3,7-dimethyl-	70
2	6.051	7.28	4-Undecene, (E)-	91
3	6.669	0.44	2,6-Octadienal, 3,7-dimethyl-, (E	49
4	6.932	1.06	3-Decen-1-ol, (Z)-	62
5	6.995	7.23	4-Dodecene, (E)-	95
6	7.058	5.85	Decane, 2,4-dimethyl-	64
7	7.195	0.35	5-Dodecene, (Z)-	60
8	7.379	0.24	3,4-Octadiene, 7-methyl-	46
9	7.441	0.31	2-Undecanethiol, 2-methyl-	43
10	7.504	0.09	Bicyclo[2.2.2]octane, 2-methyl-	45
11	7.613	0.16	3-Nonen-1-ol, (Z)-	52
12	7.75	1.15	8-Dodecen-1-ol, (Z)-	86
13	7.808	5.42	2-Tridecene, (E)-	95
14	7.865	4.14	3-Methyl-4-(methoxycarbonyl)hexa-,4-dienoic acid	90
15	7.928	1.6	2-Undecanethiol, 2-methyl-	53
16	7.991	0.56	2-Undecanethiol, 2-methyl-	72
17	8.054	0.87	1-Ethyl-2,2,6-trimethylcyclohexan	53
18	8.111	0.14	3-Tetradecyn-1-ol	43
19	8.18	0.15	6-Tetradecyne	64
20	8.254	0.51	2-sec-Butyl-3-methyl-1-pentene	50
21	8.328	0.16	1,2-15,16-Diepoxyhexadecane	59
22	8.386	0.09	5-Undecyne	46
23	8.414	0.11	Nonacos-1-ene	86
24	8.454	0.2	(R)-(-)-(Z)-14-Methyl-8-hexadecen	64
25	8.483	0.82	1,11-Dodecadiene	92
26	8.534	4.74	5-Tetradecene, (E)-	94
27	8.586	3.44	Nonadecane	94
28	8.62	0.25	5-Tetradecene, (E)-	96
29	8.695	0.14	Cyclododecane	83
30	8.746	0.09	1-Pentadecyne	93
31	8.798	0.14	1-Tetradecene	64
32	8.901	0.19	8-Dodecen-1-ol, (Z)-	50
33	8.952	0.19	Cyclohexane, (1,3-dimethylbutyl)-	46
34	9.009	0.13	5-Dodecene, (E)-	50
35	9.095	0.13	1-Chloro-4-decyne	49
36	9.158	0.78	13-Oxabicyclo[10.1.0]tridecane	62
37	9.198	3.69	9-Octadecene, (E)-	95

38	9.244	2.98	Hexadecane	90
39	9.273	0.2	1-Pentadecene	94
40	9.307	0.11	9-Tetradecenal, (Z)-	76
41	9.347	0.2	Undec-10-ynoic acid, undecyl ester	74
42	9.387	0.07	Nonacos-1-ene	42
43	9.416	0.33	2-sec-Butyl-3-methyl-1-pentene	43
44	9.473	0.14	1-Hexacosanol	46
45	9.507	0.05	(S)(+)-Z-13-Methyl-11-pentadecen-	42
46	9.587	0.22	Disparlure	58
47	9.644	0.1	n-Tetracosanol-1	49
48	9.684	0.08	Aspidospermidin-17-ol, 1-acetyl-1	83
49	9.742	0.14	1-Hexadecyne	94
50	9.776	0.62	Trichloroacetic acid, undec-2-enyester	86
51	9.816	2.76	9-Octadecene, (E)-	95
52	9.856	2.56	Tetradecane, 1-iodo-	91
53	9.925	0.07	12-Methyl-E,E-2,13-octadecadien-1ol	86
54	9.965	0.14	3-Hexadecene, (Z)-	98
55	10.085	0.05	cis-7-Hexadecenoic acid	81
56	10.325	0.17	cis-11-Hexadecenal	93
57	10.36	0.48	1,11-Dodecadiene	91
58	10.4	1.91	9-Octadecene, (E)-	93
59	10.434	1.67	Heptadecane	97
60	10.503	0.05	13-Octadecenal, (Z)-	74
61	10.537	0.14	Disparlure	93
62	10.571	0.05	cis-9-Hexadecenal	78
63	10.64	0.06	9-Octadecenal, (Z)-	87
64	10.68	0.27	1-Decanol, 2-hexyl-	46
65	10.726	0.05	1-Pentacontanol	49
66	10.829	0.18	7-Hexadecenal, (Z)-	52
67	10.915	0.56	Oxiranedodecanoic acid, 3-octyl-,	90
68	10.949	1.6	E-14-Hexadecenal	91
69	10.978	1.62	Heptadecane, 8-methyl-	93
70	11.081	0.22	Disparlure	74
71	11.441	0.19	(R)-(-)-(Z)-14-Methyl-8-hexadecen-1-ol	93
72	11.47	1.1	1-Nonadecene	99
73	11.498	0.9	Nonadecane	94
74	11.601	0.07	1-Nonadecene	95
75	11.802	0.09	Pentadecafluorooctanoic acid, penadecyl ester	60
76	11.842	0.07	Tetradecanal	89
77	11.968	0.96	Heptacos-1-ene	99
78	11.996	1.12	Heptadecane	87
79	12.174	0.11	4-Methyl-dodec-3-en-1-ol	64
80	12.454	0.83	Henicos-1-ene	99
81	12.477	0.87	Heneicosane	94
82	12.986	0.72	1-Docosene	95
83	13.009	0.76	Heptadecane	95
84	13.593	0.57	1-Tricosene	98
85	13.627	0.67	Tricosane	91
86	13.781	0.09	Heptadecanoic acid, heptadecyl ester	64
87	13.867	0.07	4-Cyclopropylcarbonyloxytetradeca	40
88	14.331	0.52	Cyclotetracosane	99
89	14.359	0.67	Tetracosane	93
90	14.56	0.07	Heptadecanoic acid, heptadecyl ester	76
91	14.663	0.05	13-Methyl-Z-14-nonacosene	43
92	15.264	1.03	Octadecane	94
93	15.498	0.04	Heptadecanoic acid, heptadecyl ester	76
94	15.83	0.11	3-Octadecene, (E)-	53
95	16.128	0.92	Octadecane	92
96	16.843	0.75	Eicosane	93
97	17.22	0.12	Cyclotrisiloxane, hexamethyl-	35

98	17.449	0.6	Eicosane	91
99	17.541	0.87	Decanedioic acid, bis(2-ethylhexy) ester	35
100	18.016	0.53	Methoxyacetic acid, heptadecyl ester	43

The presence of 1-Octene-3,7-dimethyl- , 5-Dodecene, (E)-, Cyclopropanemethanol, 2-methyl-2-(4-methyl-3-pentenyl)-,Bicyclo[2.2.2]octane, 2-methyl-, 4-Dodecene, (E)-, Undecane, Oleyl alcohol, trifluoroacetate, 3-octyne-5-methyl, Pentadecafluorooctanoic acid, tridecyl ester, Bicyclo[2.2.1]heptane-2-carboxaldehyde, 3-methyl-, (2-exo,3-endo)-, 2,3-Dimethyl-3-heptene, (Z), 1-Hexene 3,3-dimethyl- in the pyrolyzed oils is in resemblance with findings of Setiawan et al. 2021 on Characterization of fuel oil from pyrolysis waste light density polyethylene (LDPE) and polypropylene (PP). Further the detection of Undecane, 4-Dodecene, (E), 5-Tetradecene, (E)- , 3-Tetradecene, (E)-, Cyclotetradecane, 1,12-Tridecadiene, 9-Eicosene, (E)-, Pentadecane, 1-Hexadecyne, Hexadecane, 1-Nonadecene,Octadecane, n-Tetracosanol-1, Heneicosane is in clear agreement with the findings of the research conducted by Felix and Eki (2023) on production and characterization of liquid oil from the pyrolysis of waste high-density polyethylene plastics using spent fluid catalytic cracking catalyst. The oxygen containing compounds in the pyrolyzed oils aligned with work carried out by Hasan et al. (2023).

4. Conclusion

The conversion of polyethylene sachet water nylon waste to liquid fuel is a cheap eco-friendly strategy that can be used to mitigate this waste to wealth. More so, the pyrolysis of polyethylene waste if utilize properly it will create a lot of jobs to the Nigerian population in addition to providing cheaper alternative energy source. Moreover, based on the GC-MS results, calorific value, viscosity, density and oil yields of the pyrolyzed oils from polyethylene sachet water waste is found to be a promising material for the generation of oil with characteristic of kerosene and diesel fractions. Most of the compounds found in the oils are components that either act as a fuel or enhance the combustion property of the oil. The catalyst used found to be useful in cracking compounds with higher carbon contents in fuel to compounds with lower carbon skeleton. The physical appearance of the pyrolyzed oils found to be similar to that of conventional fossil fuel (diesel). Further studies are required to investigate the combustion property of the pyrolyzed oil in comparison to that of conventional diesel fuel. The catalyst reusability or its stability over multiple cycles of pyrolysis, different heating rates, and different reactor sizes will be considered in the future work

Conflict of interest

The authors declare no conflict of interest.

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References

Ademiluyi, T. and Adebayo, T. A. (2007). Fuel gases from pyrolysis of waste Polyethylene sachets: J. Appl. Sci. Environ. Manage. JASEM ISSN 1119-8362. Vol. 11 (2): 21 - 26.

Adetunji M. B. and Ilias B. M. (2010). Externality Effects of Sachet Water Consumption and the Choice of Policy Instruments in Nigeria: Evidence from Kwara State.: Journals of Economics, 1 (2): 113-131.

A., Al-Ahmadi, M. A., Al-Bassam, A. M. Al-Kalali and Riyadh, S. A. (2023). Municipal Solid Waste Management in Saudi Arabia: Drivers for Implementing a Circular Economy Approach. Integr. Waste Manag. Circ. Econ. 2023: 139–160.

Arabiourrutia, M., Lopez, G., Artexe, M. Alvarez, J. and Bilbao, J. (2020). Liquid fuel from waste tires: novel refining, advanced characterization and utilization in engines with ethyl levulinate as an additive Renewable Sustainable Energy Rev., 129(109): 932.

Battsetseg, B.; Sukhbaatar, S., Oyunchimeg, T. (2022). Current status and prospects of plastic and plastic bag waste recycling. Int. J. Soc. Sci. Humanit. Res., 2: 1–16.

Czajczynska, D., Czajka, K. Krzyzynska, R. and Jouhara, H. (2020). Waste tyre pyrolysis impact of the process and its products on the environment. Therm. Sci. Eng., 20: 100–690

Edoga, M. O., Onyeji, L. I. and Oguntosin, O. O. (2008). Achieving Vision 20:2020 through Waste Produce Candle. Journal of Engineering and Applied Sciences, 3(8): 642-646

Felix, A. A. and Eki, T. A. (2023). Production and characterization of liquid oil from the

pyrolysis of waste high-density polyethylene plastics using spent fluid catalytic cracking catalyst Sustainable Chemistry for Climate Action 2,

Hasan, M. M., Rasul, M. G., Jahirul, M. I. and Khan, M. M. K. (2023). Characterization of pyrolysis oil produced from organic and plastic wastes using an auger reactor Energy Conversion and Management, 278: 1-10.

Karmina, M. (2019). Production of sustainable energy from solid waste by pyrolysis - a review. Recycling and Sustainable Development 12: 69-77.

Khan, Z. A., Chowdhury, S. R. Mitra, B. Mozumder, M. S., Elhaj, A.I., Salami, B. A., Rahman, M. M. and Rahman, S. M. (2023). Analysis of industrial symbiosis case studies and its potential in Saudi Arabia. J. Clean. Prod. 2023, 385: 135536.

Mishra, R., Kumar, A., Singh, E. and Kumar, S. (2023). Recent research advancements in catalytic pyrolysis of plastic waste. ACS Sustain. Chem. Eng. 11: 2033–2049.

Moon, Y., Shim, W. J., Han, G. M., Jeong, J., Cho, Y., Kim, I. H., Kim, M. S., Lee, H. R., Hong, S. H. (2022). What type of plastic do sea turtles in Korean waters mainly ingest? Quantity, shape, color, size, polymer composition, and original usage. Environ. Pollut. 298: 118849.

Nanda, S. and Berruti, F. (2021). Municipal solid waste management and landfilling technologies: A review. Environ. Chem. Lett. 19: 1433–1456.

Olugbenga, A. G., Egbedayo, T. T., Yahya, M. D. and Garba, M. U., (2021). Production of Fuels from Nigeria's Untapped 'Waste Wealth' Using Pyrolysis.International Conference on Energy and Sustainable Environment IOP Conf. Series: Earth and Environmental Science 665: 012002IOP Publishing doi:10.1088/1755-1315/665/1/012002

Orcid K., P. R., Ibrahim, M. A. G. and Orcid S. P. T., (2023). Catalytic Pyrolysis of Waste Low-Density Polyethylene (LDPE). Waste and Renewable Sources, 8(4): 63

Prurapark, R., Owjaraen, K., Bordin Saengphrom, B., Limthongtip, I. and Tongam, N. (2020). Effect of Temperature on Pyrolysis Oil Using High-Density Polyethylene and Polyethylene Terephthalate Sources from Mobile Pyrolysis Plant, frontiers in energy research, vol. 8, doi: 10.3389/fenrg.2020.541535

Setiawan, A., Setiani, V., Mazdhatina, O. V. (2021). Characterization of fuel oil from pyrolysis waste light density polyethylene (LDPE) and polypropylene (PP): IOP Conf. Ser.: Mater. Sci. Eng. 1034 012069: 1-7

Tangri, N. and Wilson, M. (2019). Waste gasification and pyrolysis: High risk, low yield processes for waste management, Report: A Technology Risk Analysis, GAIA, 2017, United States, no-burn.org/gasification-pyrolysis risk-analysis, overtaken 22.05.

