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Treatment Of Spent Lubricating Oil Using Sugarcane Bagasse

Mfon I. Otite-Douglas[1], Jonathan Favour Ozioma[2]

Science Laboratory Technology Department, Petroleum Training Institute
P.M.B 20, Effurun, Delta State, Nigeria
Corresponding Author: Mfon I. Otite-Douglas
Corresponding Email: favourjnt@gmail.com

Abstract: *Recovery of used lubricating oil (ULO) generally comprises cleaning, drying, and adsorption to eliminate water, sludge, and impurities. This study investigates the effectiveness of treating used lubricating oil with sugarcane bagasse modified by sulfuric acid and sodium hydroxide. The characterization results reveal significant changes in the properties of the lubricating oil before and after treatment. The density of the oil increased from 0.8785 g/cm³ (unused) to a range of 0.8888 g/cm³ to 0.8934 g/cm³ for treated samples, indicating a more concentrated product. In contrast, the flash point decreased from 220°C (unused) to 165°C (treated with 15g of bagasse), suggesting a reduced ability to resist ignition due to the Viscosity showed a notable decline from 196.23 cSt (unused) to 107.43 cSt (used), with treated samples gradually increasing to 108.27 cSt, indicating restoration of some lubricating properties. Moisture content rose sharply from 1.62% (unused) to 48.70% (used), but treatment effectively reduced it to 4.30% for the treated samples. Ash content also decreased from 0.0076% (used) to 0.0075% (treated), demonstrating the removal of inorganic residues. These findings suggest that the treatment process not only enhances the quality of used lubricating oil but also offers a cost-effective and environmentally friendly method for oil purification and can be optimized to achieve the desired level of oil purification.*

Keywords: Spent lubricating oil, Sugarcane bagasse.

1.0 INTRODUCTION

The increased use of several automobiles and machinery associated with petroleum products have led to the widespread contamination of the environment (water, air and land). Oil and its derivatives are some of the products with high polluting potentials, because besides being stable to light and to heat, they are also very difficult to undergo biodegradation (Adipah, 2019). Lubricating oil is a generic name for a wide range of products that are characterized by hundreds of base chemicals and additives. The most common lubricating oils are crude oil distillate fractions. It is estimated that more than 30.3 billion liters of used oil are produced every year (Rostek et al.,2017).

Unlike other petroleum products, Lubrication oil is not readily used up in its working process in automobile engines and machines instead, it serves as a continuous flow lubricating, cooling, and cleaning the internal components of an engine and protects it from friction, heat, and corrosion. The lubricating oil also helps collect any dirt, debris, and particles that could otherwise cause engine damage. Lubricating oil loses its properties as it ages, been influence by multiple factors such as temperatures. This lubricant waste has a very high hazardous content from ash, carbon residue, asphaltenes, materials, metals, water, and other dirty materials produced during lubricants inside the machine (Ahmed and Nassar, 2011). Used oils as hazardous wastes if disposed directly into the environment, especially rivers, seas and lakes create problems, such as the problem of disposing of used oil into water bodies not only contaminate water but also harmful to freshwater and marine life (Rațiu et al., 2020). Soil contamination are also on the rise especially at places where automobile workshop (mechanic workshops) are situated or concentrated. These areas are continuously subjected to intense soil contamination due to mishandling, deliberate disposal, spilling and leakage of waste lubricating oils. A survey by Obini, 2013 of Abakaliki capital city in Ebonyi State, Nigeria indicated that apart from the centralized Abakaliki auto-mechanic workshops cluster (popularly called mechanic village or site), there are several other automobile workshops scattered all over the town from which used engine oils, lubricating oils and other solvents containing petroleum hydrocarbons are indiscriminately dumped or spilled on every available space by artisans in the business of auto-repairs. Previous researches aimed at restoring used lubricating oil to a reusable state have proven successful using a combination of solvent extraction and adsorption methods (Riyanto et al., 2017 and Temityo et al, 2018). In the present times, there is even more need to provide cheap, available and yet, effective green adsorbent for the treatment of used lubricating oil. Green adsorbent (Plants based adsorbent) obtained from plant waste have been widely used in many remediation process as regards petroleum contamination and heavy metals due to their high cellulose content (Xue et al., 2018). Although only few research work has been attributed to treatment of waste lubricating oil using plant based adsorbent.

Aim and Objectives of the Paper

This study aims to treat used or waste lubricating oil using sugarcane bagasse, the objectives include:

I. To develop sugarcane bagasse from sugarcane.
II. To determine the ash content, moisture content, density, flash point, pour point and viscosity of lubricating oil
III. To use the sugarcane bagasse developed for the treatment of waste lubricating oil.

2.0 LITERATURE REVIEW

Used lubricating oil (ULO) refers to oil that has undergone degradation during its service life, resulting from the mechanical and thermal stresses of operation. ULOs are primarily derived from various sources, including automotive engines, industrial machinery, and hydraulic systems. Over time, these oils accumulate contaminants such as soot, metals, and chemical additives, which can significantly alter their properties and functionality. Used lubricating oils (ULOs) are identified as hazardous waste and present serious risks to both human health and the environment. These oils contain dangerous contaminants such as heavy metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (Boadu et al., 2019). Poor management and careless disposal practices can lead to significant environmental harm (Lam et al., 2016).

In West Africa, studies have shown that air pollutants from burning these oils can travel at speeds between 10-12 m/s (Emetere et al., 2019). This means that the effects of air pollution are not limited to the immediate area of the source; instead, they can extend far beyond. For example, black soot was recently reported to cover the city of Port Harcourt, originating from pollution sources located about 22 km away in suburban areas (Sonibare and Omoleye, 2018; Boadu et al., 2019).

Sugarcane (Saccharum officinarum) is a robust and vigorous tropical plant, with superior growth over most other crop species partially because of its high photosynthetic efficiency as a C4 grass. Further, it contributes about 70% of the world sugar production and holds a great potential for the biomass as well as ethanol-based biofuel production. Alongside sugar, various by-products of the sugar industry (Jaggery, ethanol, electricity, paper and high value biomolecules) contribute to the economic growth as well. Various other byproducts of sugarcane industries such as bagasse and vinasse. Sugarcane bagasse is a by-product of the sugar industry, created during the processing of sugarcane into sugar or ethanol. It consists of the fibrous remnants that remain after the juice is extracted, including crushed stalks and leaves. This material is plentiful and easily sourced, making it a valuable resource for various applications. Worldwide, the production of sugarcane bagasse is estimated to exceed 700 million tons annually, with Brazil and India leading in production. Other countries such as China, Thailand, and Pakistan also generate significant quantities. The high availability of sugarcane bagasse is due to the rapid growth of sugarcane, which is cultivated extensively around the globe. With the sugar industry continuously expanding, there is a reliable supply of bagasse.

3.0 METHODOLOGY

3.1 Materials

Analytical weighing balance

Crucible

Oven

Furnace

Viscosity meter

Hydrometer

Kitchen knife

3.1.1 Reagents

Sulfuric acid (H_2SO_4)

Sodium Hydroxide (NaOH)

3.1.2 Plant Material

Sugarcane

3.2 Methods

3.2.1 Sampling Location

Warri Metropolis is geographically located between 5°30' N to 5°35' N and 5°29' E to 5°48' E (Olanrewaju et al., 2017). Warri is fast growing and subject to increasing machinery and automobiles use. Therefore

3.2.2 Sample Collection (Used and Unused Lubricating oil)

A 5 litre sampling container was thoroughly washed and sterilized in an auto clave. A motor workshop along PTI Road, Effurun was visited and waste lubricating oil (engine oil) was collected in the container already presterilized. High grade unused lubricating oil was also purchase at a retail outlet and was used as control for this work. Both lubricating oils were kept in the lab prior to analysis.

3.2.3 Collection and Preparation of Sugarcane Bagasse

Sugarcane samples will be obtained from a sugarcane farm at Udu Local Government Area of Warri. The harvested sugarcane will be washed to remove debris. 5 kg of the washed sugarcane will be chopped into smaller sizes using a kitchen knife, followed by proper crushing and squeezing to remove the sugar rich sugarcane juice. The crushed bagasse will be treated with 0.01M of sulfuric acid and dilute sodium hydroxide, and washed with distilled water until it becomes colour free. The colour free bagasse will be dried in the oven at 800°C, after which it will be kept for batch adsorption process (Abdolali et al., 2014).

3.2.4 Determination of Ash content, Carbon Residue, Viscosity and Specific gravity of both Used lubricating Oil and Unused Lubricating Oil.

2g of lubricant oil sample was weighed in a suitable crucible and carefully heated and ignited by flame until leaving a carbonaceous material only. Then, the carbon residue was calculated (ASTM D 482., 2003). After that, it was heated in a furnace at 775±25 ˚C until the carbonaceous material disappeared. The crucible was removed from the furnace and left to cool at room temperature, and the ash amount was calculated (Hameed et al., 2017). ASTM D7110 was used in determining the viscosity of the lubricating oils and the specific gravity measured using ASTM D287 method.

3.2.5 Treatment of Used lubricating Oil

The waste oil was allowed to settle down and all the free water and sediment were separated. The mixture was mixed with a fixed amount of 15%(wt) of the adsorbent and stirred properly for different contact time in a batch adsorption process at ambient temperature. The sample was then filtered, and then analyzed for different physical properties such as; kinematic viscosity, pourpoint, viscosity index, flashpoint and density.

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

Used lubricating oil was obtained from a mechanic workshop and treated with sugarcane bagasse modified with 0.01M sulfuric acid and dilute sodium hydroxide. The data presented in the table provides valuable insights into the changes in the properties of the lubricating oil samples, both before and after treatment with the modified sugarcane bagasse. The unused sample represents the baseline characteristics of the lubricating oil, while the used sample reflects the impact of the oil's application and degradation over time.

Table 4.1 Characterization values of new, used and treated lubricating oil

Parameter	Unit	ASTM Method	Unused Sample (Standard)	Used Sample	Treated Used sample		
					5g	10g	15g
Density @15 ºC	g/cm³	D1298	0.8785	0.8785	0.8888	0.8908	0.8934
Flash Point	ºC	D92	220	190	180	170	165
Viscosity @ 40ºC	Cst	D445	196.23	107.43	109.85	106.41	108.27
Moisture Content	%	D4442	1.62	48.70	8.92	6.40	4.30
Ash Content	%	D482	<1	0.0076	0.0070	0.0078	0.0075
Pour Point	ºC	D97	-32	-32	-32	-32	-32

Key: Degree Centigrade (ºC), Grams Per Centimeter (g/cm³), America Society for Testing and Materials (ASTM), Centistokes (Cst), Percentage (%)

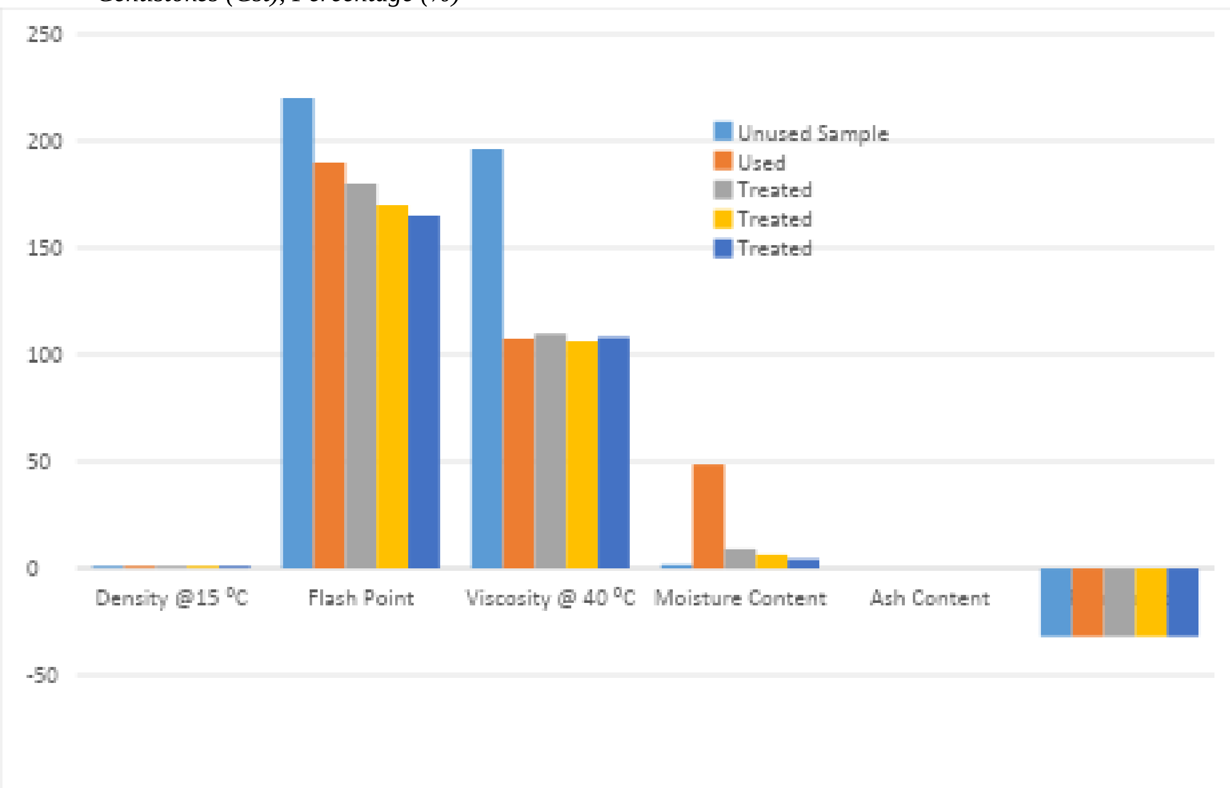

Figure 4.1: Showing values of new, used and treated lubricating oil.

4.2 DISCUSSION OF RESULTS

Used lubricating oil was treated using sugarcane bagasse modified using 0.1M Sulfuric acid and sodium hydroxide The increase in density observed in the treated used samples, ranging from 0.8888 g/cm3 (5g) to 0.8934 g/cm3 (15g), suggests that the treatment process effectively removed or altered the composition of the oil, leading to a more concentrated and denser product. This finding is consistent with the results reported by Srivastava et al. (2021). Additionally, the decrease in flash point from 220°C for the unused sample to 165°C for the 15g treated used sample indicates a reduction in the oil's ability to resist ignition, which could be attributed to the presence of contaminants introduced during the usage and treatment processes. Similar observations have been reported by Yadav et al. (2020). The changes in viscosity, with the used sample showing a significant decrease (107.43 cSt) compared to the unused sample (196.23 cSt), and the treated used samples exhibiting a gradual increase (109.85 cSt for 5g to 108.27 cSt for 15g), suggest that the treatment process was effective in restoring some of the lubricating properties of the oil. This finding aligns with the work of Garg et al. (2019). The substantial increase in moisture content from 1.62% in the unused sample to 48.70% in the used sample, followed by a gradual decrease in the treated used samples (8.92% for 5g to 4.30% for 15g), indicates the effectiveness of the treatment process in removing water and other polar contaminants from the oil. This is consistent with the observations made by Sharma et al. (2018).

Furthermore, the reduction in ash content from 0.0076% in the used sample to 0.0075% in the 15g treated used sample suggests that the treatment process was effective in removing inorganic residues and metallic additives from the oil. This finding is in line with the research conducted by Pandey et al. (2022). The consistent pour point value of -32°C across all samples indicates that the treatment process did not significantly impact the low-temperature flow characteristics of the lubricating oil, aligning with the findings of Jain et al. (2021).

5.1 CONCLUSION

Lubrication oil was treated using sugarcane bagasse (which have low cost implication) modified with sulfuric acid and sodium hydroxide. The outcome of the characterization result ascertained that the treatment process was able to restore some of the desirable characteristics of the oil, such as viscosity and moisture content, while also reducing the presence of contaminants, as evidenced by the decrease in ash content. The gradual changes observed in the treated used samples suggest that the treatment process can be optimized to achieve the desired level of oil purification.

5.2 RECOMMENDATION

Based on the outcome of this study, it is recommended that:

Optimization of Treatment Parameters: Future studies should focus on optimizing the concentration of sulfuric acid and sodium hydroxide, as well as the amount of sugarcane bagasse used, to achieve the best possible purification results.

Broader Application Testing: Investigate the efficacy of the treatment method on different types of used oils to determine its versatility and potential for widespread application in various industries.

Further Research on Additives: Explore the potential of incorporating other natural additives alongside sugarcane bagasse to enhance the treatment process and improve the performance characteristics of the recycled oil.

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APPENDIX


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