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Recycling of used engine oil using composite solvents and cashew bark activated carbon extraction technology

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ABSTRACT

This research studies the recycling of 6 months used engine oil, using activated carbon from Cashew tree (*Anacardium occidentale*) bark. The recycling process of the used engine oil, eventually led to comparison of results of the recycled engine oil with the fresh engine oil using ASTM standards. Test carried out on the used engine oil, fresh engine oil and the recycled engine oil include: viscosity at 40 and 100 °C respectively, specific gravity (Sp.g), flash point (FP), and fire point. The results shows that the recycled engine oil had the following physiochemical properties: viscosity at 40 °C was 137.01CSTmmSec⁻¹, viscosity at 100 °C was 13.50CSTmmSec⁻¹, specific gravity (Sp.g) was 0.8957gcm⁻³, flash point was 225.01 °C, fire point was 330.71 °C; This result shows an improvement in the physiochemical properties of the recycled engine oil.

Keywords - Engine oil, recycling used engine oil, specific gravity, viscosity

1. INTRODUCTION

Engine oils are viscous liquids of petroleum origin, used for protecting machines and moving engine parts [1]. They are gotten from petroleum and its derivatives by mixing additives for improving certain properties. They are used to lubricate moving engine parts, friction reduction, protect against engine wear and tear, acts as an anticorrosion agent, cooling agent and removing contaminants from engine [2].

Used engine oil is defined as engine oil which is left after a certain time of useful life. Engine oil when in use degrades because of its contamination with metals, vanish, ash, carbon residue, water, dirt and other

contaminating materials. As it is contaminated over time, and loses its lubricating function and hence after a predefined time of usefulness, becomes replaceable with fresh engine oil and the replaced engine oil is termed used engine oil [3]. Engine oil becomes unsuitable for any further use for these two main reasons: chemical changes and accumulation of contaminations in the engine oil. It is very difficult to characterize used engine oil because the composition varies with the types and age of machines, the service life of the engine oil, the operating conditions and place of collection. The major composites of used engine oil are: Hydrocarbon, Polycyclic Aromatic Hydrocarbons

(PAHs), Soot and Carbon, Metals Fragments, Sand and Dirt, Water, Oxidation Products [4].

The base oil used in the formulation of engine oil are made up of hydrocarbon chains of $C_{15} - C_{50}$. At high temperature, the hydrocarbon chains are oxidized to lighter hydrocarbons and other hydrocarbon forms, hence breaking the hydrocarbon chains to a lesser chain [5]. After recycling to remove the light hydrocarbons and other impurities in the used engine oil, the hydrocarbon chain of the recycled engine oil falls below the specifications and requirements for use by the Society of Automotive Engineers (SAE) specified engines and machines for the original engine oil [6]. Though the physiochemical parameters especially the viscosity have been improved on, the hydrocarbon chain of the original base oil will be reduced due to oxidation to lighter hydrocarbons and other hydrocarbon forms. Hence it is required that the recycled engine oils be used in lighter engines like generators, motor cycle engine, etc. [4]. In the recycled engine oils, there are additives already present in it even though it might have depleted due to usage, but it is not totally absent. The removal of contaminants could also regenerate the additives, like viscosity modifier additive [4].

Engine oil has properties that are very peculiar to them. Some of these properties include: viscosity, specific gravity, flash point (FP), fire point etc.

An important property for grading engine oil is viscosity. It is a determination of fluids resistance to flow and is temperature dependent. A reduction in its viscosity shows that the engine oil is contaminated. Society of Automotive Engineers (SAE) numbers used by manufacturers of automotive equipment explain the viscosity of the engine oil recommended for use in their productions. The higher SAE number, the more is the viscous the oil [6].

Specific gravity of a substance is the ratio of mass of a fixed volume of a substance to the mass of same volume of water which is dependent on temperature with which the mass of the substance and water are determined. Specific gravity is much influenced by the chemical composition of the engine oil. An increase in the Specific gravity can be a result of an increase in the amount of aromatic compounds in the engine oil, while a decrease in the Specific gravity can be a result of an increase in the saturated compounds [3].

Flash Point is the lowest temperature where oil will give off vapours to form explosive mixture with air. The FP test indicates the presence of volatile compounds in the engine oil and that is the temperature at which oil should be heated under a given condition to give off vapour to form an inflammable mixture with air [7].

Fire point is the temperature where oil ignites and burns continually for at least five seconds. Fire point is a continuation of FP test [7].

The study aimed at recycling the used engine oil using composite solvents and cashew bark activated carbon extraction technology

2. MATERIALS AND METHODS

2.1. Sample collection

Cashew (*Anacardium occidentale*) bark which is the source of the activated carbon was obtained from Cashew (*Anacardium occidentale*) tree and was identified in the department of Animal and Environmental Biology, University of Port Harcourt.

2.2. Sample preparation

The six months used engine oil which was recycled was obtained from a mechanic shop at Choba Park in Rivers state, and identified in the Department of Pure and Industrial Chemistry, University of Port Harcourt.

The new engine oil used for value comparison was obtained from a mechanic shop at Choba Park in Rivers state, and identified in the department of Pure and Industrial Chemistry, University of Port Harcourt.

The 6 months used engine oil was filtered to remove impurities that are contained in it. The *Anacardium occidentale* bark was peeled off the tree. It was Sun dried for three days, and ground to smaller size, and sieved. 200g of the sample was made into slurry with 80cm³ of distilled water and followed by the addition of 60 ml of 0.35M solution of H₂SO₄. The slurry was left for two days. The slurry was then washed several times with distilled water in order to remove any excess acid, before it became neutral. The washed sample was then dried in an oven for one hour at 45 °C. The sample is then acid activated. The sample now activated is then carbonized at 600oC, to get the activated charcoal.

100ml of the used engine oil samples was mixed with composite solvents (70% of methanol and 30% of nHexane made up the solvent) in the ratio of 1:5. KOH (3g) was also added. The mixtures were thoroughly stirred for 30 minutes and heated in the mantle at 60 °C to remove light hydrocarbons. The mixture was then settled in a separation flask for 24hours, after that, it was separated and heated at 120 °C to remove any remaining solvents in the mixture.

The engine oil collected was mixed with the activated

carbon from *Anacardium occidentale*, and then heated at 150 °C for about 1hour 30 minutes. The heated mixtures were left for 2hours to allow for gravity settling. It was thereafter filtered with a filter paper to recover the base oil.

The viscosity (400C and 100 °C: ASTM-D445 method), specific gravity, flash point, fire point were performed using standard engine oil testing methods. All analysis was conducted at Olembe Research Laboratory Asaba, Nigeria.

3. RESULT AND DISCUSSION

Anacardium occidentale activated carbon absorbent is used to absorb any impurity found in the used engine oil. It also separates hydrocarbon compounds or waste matter from the used engine oil. It is also used to remove colour and odour in the recycled engine oil. The results of this study which studies the recycling of 6 months used engine oil and compared with a fresh engine oil sample using composite solvents and *Anacardium occidentale* activated carbon have been carefully detailed in the table below.

The results show the used engine oil sample with viscosity value was 120.00 CST mm sec⁻², and the recycled engine oil was 137.01 CST mm sec⁻² whereas the new engine oil was 146.56 CST mm sec⁻² (table 1).

Table 1, shows results of the viscosity of the used engine

Table 1. Summary of analysis of results on used engine oil

Test	Specification	New	Used	Recycled
Viscosity at 40°C (cst mm sec ⁻¹)	130.00 - 150.00	146.56	120.00	137.01
Viscosity at 100°C (cst mm sec ⁻¹)	12.60-16.30	14.45	10.06	13.50
Specific gravity (gcm ⁻³)	0.8955-0.8970	0.8968	0.8800	0.8957
Flash point (°C) minimum	225.00	230.00	119.00	225.01
Fore point (°C) minimum	300.00	350.00	243.00	330.71

oil with a value of 10.06 CST mm sec⁻², compared to the recycled engine oil of 13.50 CST mm sec⁻², and fresh engine oil value of 14.45CST mm sec⁻² range required by the ASTM.

The plot of viscosity values of each of the engine oil shows that they all fall in the range of American Standard for Testing and Materials (ASTM) required specification. This finding is also in line with some previous works which suggest that viscosity is a significant fuel property with respect to in-use performance of biodiesel since it influenced the operation of the fuel injection equipment [1, 6-11].

Specific Gravity for the used engine oil, and recycled engine oil are 0.8800 gcm⁻³, and 0.8957 gcm⁻³ respectively. This indicates that the used engine oil could have been contaminated by dilution of light hydrocarbons. It could also mean that the heavier hydrocarbons of the engine oil had broken down to lighter hydrocarbon fractions at the high temperature of the operating engine. After treatment, the volatile hydrocarbons were extracted which caused the increase in the Specific gravity value [7-8, 12-13].

The Flash point of the used engine oil, recycled engine oil and the fresh engine oil was 119.00 °C, 225.01 °C and 230.00 °C respectively. The Fire point of the used engine oil, recycled engine oil and the fresh engine oil was 243.00 °C, 330.71 °C and 350.00 °C respectively. . Generally, engine oils have flash points above 200 °C, therefore they are out of as hazardous liquids classification. However, small amounts of fuel could make the oil/fuel mixture hazardous or its fire point could fall in the working temperatures interval, which should be avoided [14].

4. CONCLUSION

From the research done, the viscosity, specific gravity, flash point and fire point of the recycled and fresh engine oil were comparable. The used engine oil can be recycled

and used in the place of the fresh engine oil, so as to avoid the indiscriminate disposal of the used engine oil. This is a proposed durable solution to environmental pollution caused by waste used engine oil.

5. ACKNOWLEDGEMENT

NA

6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

7. SOURCE/S OF FUNDING

NA

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