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RECOVERY OF HYDROCARBON CONTENT OF SPENT LUBRICATING OIL

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B.Tech. (Chemical Engineeering)

LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO.

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CERTIFICATION

This is to certify that **BELLO TOPE KAYODE (TP13/14/H/1602)** of the department of Chemical Engineering, Obafemi Awolowo University, Ile-Ife, Osun State is the original author of this project and that I supervised the research work accordingly.

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DEDICATION

This project is dedicated to almighty God, the Alpha and Omega of my life for His infinite and divine favour and mercy.

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BELLO Tope Kayode

April, 2016

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ABSTRACT

The thrust of the study was to find an alternative use for spent lubricating oil. It characterized spent and fresh lubricating oil samples and fractionated the spent oil to recover the hydrocarbon content. It further characterized the recovered hydrocarbon. This is with the view to eliminating this waste which is a serious environmental pollutant.

Samples of spent oil were collected from automechanic workshops in Ile-Ife. The collected spent oil samples were characterized; and afterwards mixed with water and allowed to settle for 72 hours. It was then fractionated in a controlled distillation set-up at 176ºC; after which the residue was centrifuged, and decanted to remove all solid particles that were present. The liquid products were analysed using GC-MS.

The study showed that the weight percentage of moisture and solids present in the spent lubricating oil were 10.56% and 0.38% respectively. The viscosities of the spent lubricating oil and fresh lubricating oil at 28.5ºC were 1166.9728 and 144259.2460 cm^2/s while their densities at the same temperature were found to be 0.8004 and 0.8556 g/ml respectively. The products of the distillation process were in three layers, these were named top product, bottom product, and residue. The viscosities of the three products were 327.069, 356.832 and 1040.760 cm^2/s while their densities were estimated to be 0.9150, 0.9572, 0.8510 g/ml respectively at 28.5ºC. Hydrocarbons identified in the recovered products were predominantly aromatic compounds in the carbon range less than or equal to 20 carbons, with very few exception. 2-tert-butyl-3,4,5,6-tetrahydropyridine and methyl-2-phenyl-5-(1,4-dihydropyridin-4-ylidene)-1,3dioxan-4,6-dione were pyridine derivatives identified in the fresh and the spent lubricating oil respectively. Unsaturated compounds such as styrene, 1,7-dimethyl-3-phenyltricyclo[4.1.0.0(2,7)]hept-3-ene, cymene, naphtalene, cyclopentene, 1,2-dimethyl-4-methylene-3phenyl indene and some others

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were prevalent in the spent oil, while almost not present in the fresh oil. Aliphatic and aromatic hydrocarbon compounds in the form of esters and alkanols, such as 2,5-octadecadiynoic acid, methyl ester, 2,9-heptadecadiene-4,6diyn-8-ol, 5,8,11,14-eicosatetraynoic acid, methyl ester, 2-hexadecanol, 1,3,5-trimethyl benzene, and some others were identified in spent oil. Also, heterocyclic ringed hydrocarbons with maximum unsaturation, 3H-cycloocta[c]pyran-3-one, 5,6,7,8,10-hexahydro-4-isopropyl-1-phenyl was identified in the fresh lubricating oil while, 1H-indene, 2,3-dihydro-5-methyl, 1H-indene, 2,3-dihydro-1,2-dimethyl, 1H-indene, 2,3-dihydro-4,7-dimethyl and 3-(2-methyl-propenyl)-1H-indene were also found.

The study concluded that the hydrocarbon content of spent lubricating oil makes them useful as potential industrial chemical feedstock.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Global economic recessions are much felt in Africa and third world countries. This recession is characterized by an alarming to influx of used vehicles, machineries, engines, and heavy duty trucks into third world countries as "second hand machines and vehicles" and it has become a thing of great concern. These vehicles and machineries need lubricants especially lubricating oils for proper functioning of engine parts and reduction in its wear (Aucelio, 2007). The newly manufactured vehicles and machines of various categories also need lubricating oils (Nwosu *et al*., 2008).

When one surface moves over another, there is always some resistance to movement. The resistance force is called friction. Lrong and Laortanakul, (2004) found that if the friction is slow and steady, there will be smooth, easy sliding. At the other extreme, the friction may be so great or so uneven, that movement becomes impossible, and the surface can overheat or be seriously damaged. Lubrication is simply the use of a material to improve the smooth movement of one surface over another and the material which is used in this way is called a lubricant. Lubricant is a liquid introduced between two surfaces to reduce friction thereby leading to decrease in wear (Nadkami, 1991). Lubricating oil functions by preventing friction between sliding or rolling engine parts; protection of surfaces from corrosion, transportation of wear metal particles and contaminants as well as transfer of heat through the engine parts (Nwosu *et al.*, 2008). Lubricants are usually liquids or semi-liquids, but may be solids or gases or any combination of solids, liquids and gases (Nigmatullin *et al*., 2007).

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The basic role of lubricants, that is, lubrication, is to reduce friction and hence prevent the wear of material surfaces as a consequence of relative mutual movement. However, it is essential that the lubricant also has other functional properties that will ensure its efficient application. These are; good oxidation and thermal stability, corrosion protection property, compatibility with different materials, low foaming, ability to release air, good detergent-dispersant properties, and some others (Novina *et al.*, 2002).

Refining of crude oil to produce lubricating oil is one of the oldest refinery arts. Suitable crudes are fractionated to isolate a suitable boiling range material, usually in the 316 to 593 °C range, to produce a distilled oil fraction (Gupte *et al*, 1997).

Motor oil, engine oil, or engine lubricant is any of various well-developed lubricants (comprising oil enhanced with additives, for example, in many cases, extreme pressure additives) used for lubrication of internal combustion engines. The main function of these lubricants is to reduce wear on moving parts; they also inhibit corrosion of surfaces, improve sealing, and cool the engine by carrying heat away from moving parts (Okeola *et al.*, 2011).

Lubricating oils used in automotive engine service (to protect rubbing surfaces and promote easier motion of connected parts) serve as the medium that remove high build-up of temperature resulting from the moving surfaces and continuous build-up of such temperature degrade the lubricating oils leading to reduction in properties such as color, specific gravity, viscosity, and others (Udonne, 2011).

Motor oils are derived from petroleum-based and non-petroleum-synthesized chemical compounds. Motor oils today are mainly blended by using base oils composed of hydrocarbons, polyalpha olefins (PAO), and polyinternal olefins (PIO) (Corsico *et al*, 1999). The base oils of some high-performance motor oils however contain up to 20% by weight of esters (Schlosberg *et al.*, 2001).

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Motor oil is a lubricant used in internal combustion engines, which power cars, lawnmowers, engine-generators, and many other machines. In engines, there are parts which move against each other, and the friction wastes otherwise useful power by converting the kinetic energy to heat. It also wears away those parts, which could lead to lower efficiency and degradation of the engine. This increases fuel consumption, decreases power output, and can lead to engine failure. Lubricating oil creates a separating film between surfaces of adjacent moving parts to minimize direct contact between them, decreasing heat caused by friction and reducing wear, thus protecting the engine. In use, motor oil transfers heat through convection as it flows through the engine by means of air flow over the surface of the oil pan, oil cooler and through the buildup of oil gases evacuated by the Positive Crankcase Ventilation (PCV) system. In petrol (gasoline) engines, the top piston ring can expose the motor oil to temperatures of 160 °C (320 °F) (Mark, 2011).

The oil obtained from crude oil refining by distillation is a complex mixture of hydrocarbons, 80 to 90% by volume and additives 10 to 20% by volume according to its grade and specific duty (Vazquez-Duhalt, 1989). Additives are added to impart new, useful, and specific properties to lubricant oil, enhance its present properties, and reduce the rate of undesirable change that can take place during its service life (Vazquez- Duhalt, 1989).

Motor oil is oil suitable for use in an engine crankcase. This term is sometimes applied to oils used to lubricate electric motors. Motor oil is one of the hundreds of different lubricant products that are made by many refineries and compounders. Motor oil is used to lubricate the parts of an automobile engine, in order to keep everything moving smoothly. Crankcase oil consists of virgin lubricating base oil and additives; it is used in the crankcase as a hydrodynamic lubricant to reduce friction, as a coolant, and to form a compression seal. Before they are used, crankcase oils consist of a base lubricating oil (a complex mixture of hydrocarbons, 80 to 90%

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