# Sudan University of science &

# Collage of science

## Department of scientific laboratories (Chemistry)

# Treatment of used lubrication oils by using acid treatment methods

# معالجة الزيوت الراجعة من المحركات بواسطه طريقة التحميض

Complementary research in partial fulfillment for the

Requirement for the degree of B.Sc (honor) in chemistry

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# الأيـــــة

**بســــــــم الله الرحمن الرحيم**

قال تعالى :**( قـل إن صلاتي ونسكي ومحياي ومماتي لله رب العالمـــــــين)**

صدق الله العظيم

سورة الأنعام الأيـــــــه ( 163)

# Dedication

To our mother

To our father

And every one who helped us on this research

# Acknowledgement

Gratitude, thanks and appreciation to my supervisor DR. Dalia Mohamed osman for her valuable instructions, strong efforts, support and patience to accomplish this study.

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Lastly, thanks to all those who helped me directly or indirectly

# Abstract

This research is about treatment the used oil from benzene and gasoline engine, and then determine the physical and chemical properties. The used oil was treated by two methods:

The first one depend on adding concentrated sulphuric acid with using centrifuge device

The other method depend on using only the acid .the percentage of the oils terminated from the first method 60% v/v and, the second one 59% v/v.

The physical and chemical properties for the used oils benzene engine specific gravity at (15, 20, 50 C°), viscosity at (40,100 C°), flash point , sulfur percentage , ash content and concentration of both ferric and lead respectively ( 0.8936 , 0.890 , 0.8698 g/cm$^3$ ) , ( 79.311 , 11.195 mm$^2$/s ) , 135.5 C° , 0.8319% , 6.2% .

The properties of benzene engine oil treated by first method is ( 0.880 , 0.8675 , 0.8498 g/cm$^3$ ) , ( 96.115 , 12.687mm$^2$/s ) , 207 C° , 0.08425% , 3% .

properties of benzene engine oil treated by second method is ( 0.881 , 0.877 , 0.8567 g/cm$^3$ ) , ( 96.405 , 12.89 mm$^2$/s ) , 207.5 C° , 0.0843% , 2.7%

The properties of the used oils gasoline engine is ( 0.889,0.8855,0.8652 g/cm$^3$ ) , (88.001,11.016mm$^2$/s ) , 125 C° , 0.695% , 1.23% .

The properties of gasoline engine oil treated by first method is (0.881,0.875,0.850g/cm$^3$ ) , (98.97,12.807mm$^2$/s ) , 207.5 C° , 0.044% , 1.07% .

properties of gasoline engine oil treated by second method is ( 0.8818,0.8783,0.8579g/cm$^3$ ) , (99.352,12.93mm$^2$/s ) , 208.5 C° , 0.0436% , 1.056%

# مستخلص البحث

يختص هذا البحث بمعالجة الراجع من زيوت محركات البنزين والجازولين ومن ثم تحديد بعض الخواص الفيزيائية والكيميائية للزيت المعالج ،حيث تم أخذ عينات الزيت من محطات تغيير زيوت المحركات وتمت معالجة الزيت بطريقتين،الأولى تعتمد على إضافة حامض الكبريتك المركز (98%) مع إستخدام جهاز الطرد المركزي والطريقة الأخرى تعتمد على إضافة الحامض وبدون إستخدام جهاز الطرد المركزي.وكانت نسبة الزيت المعالج بالطريقة الأولى 60%v/v والطريقة الثانية 59%v/v على التوالي.

أوضحت نتائج بعض الخواص الفيزيائية والكيميائية للزيت المعالج تحسين واضح في هذه الخواص حيث أن الخواص الفيزيائية والكيميائية التي تم تحديدها للزيت الراجع لمحرك البنزين هى : الثقل النوعي عند درجات حرارة (15,20,50 C°) ، اللزوجة عند (40,100 C°) ، درجة الوميض ، نسبة الكبريت ، نسبة الرماد ، وتركيز كل من عنصري الحديد والرصاص والنتاج هى : ($g/cm^3$ 0.8936,0.890, 0.8698 على التوالي)،(79.311, 11.195 $mm^2/s$) ، 135.5 C°، 0.8319%، 6.2% ، على التوالي.

وبالنسبة لزيت محرك البنزين المعالج بالطريقة الأولى ($g/cm^3$ 0.8576,0.881, 0.877 على التوالي)،(96.405,12.89$mm^2/s$)،207.5C°، 0.0843%، 3%، على التوالي.

وبالنسبة لزيت محرك البنزين المعالج بالطريقة الثانية ($g/cm^3$ 0.8675,0.8498 0.880, على التوالي) ، (96.115 ,12.687 $mm^2/s$) ، 207 C° ، 0.08425% ، 2.7%، على التوالي.

وذات الخواص للزيت الراجع لمحرك الجازولين هى : 0.8652,0.8855,0.889 على التوالي)، (88.001,11.016 mm$^2$/s) ، 125 C° ، 0.695% ، 1.23%، على التوالي.

وبالنسبة لزيت محرك الجازولين المعالج بالطريقة الأولى (g/cm$^3$ 0.8818,0.8783,0.8579على التوالي)، (99.352,12.93 mm$^2$/s)، 208.5C° ، 0.0436%، 1.07% ، على التوالي.

وبالنسبة لزيت محرك البنزين المعالج بالطريقة الثانية (g/cm$^3$ 0.8675 , 0.8498 , 0.880 على التوالي)، (98.97,12.807 mm$^2$/s)، 207.5C°، 0.044%، 1.056% ، على التوالي.

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# Chapter One

## 1-Introduction

# Introduction

## 1.1 crude oils:

### 1.1.1 Definition of crude oil:

Crude oil is naturally occurring, unrefined petroleum product composed hydrocarbon deposits and other organic material [1].

### 1.1.2 Petroleum or crude oil Composition:

Petroleum, or the crude oil, is the main source of a number of products that are essential to modernization. These include fuels for household, industrial, and transportation use, lubricants, and chemicals that are used as raw materials to manufacture a variety of synthetic products. Crude oils are classified as light, medium, and heavy, based on density, sweet or sour, based on sulfur level, low quality or high quality, based on wax content, or by geographical region. Petroleum, or crude oil, as it is recovered from the ground is primarily composed of organics and residuum, which are mixed with metals and the metal salts as contaminants. The organic portion of petroleum consists of saturated hydrocarbons, unsaturates, aromatics, asphaltenes, high molecular weight resins, and hetero-organic compounds containing sulfur, nitrogen, and oxygen atoms in their structures. Hydrocarbons are the major constituent of the crude petroleum. These compounds contain carbon and hydrogen atoms only and are classified into alkanes, alkenes, alicyclics, and aromatics. Alkanes, also known as paraffin*s*, are compounds with saturated linear or branched structures. The latter are also called iso-paraffins. They do not contain cyclic structures, or rings; hence they are sometimes referred to as acyclics. Alkenes, also known as olefins, are unsaturated molecules contain double bonds that do not occur to a great degree in crude petroleum but result from cracking or dehydrogenation reaction during certain refining processes. Naphthenes, also called alicyclics, are saturated compounds that contain five- or six-membered cyclic rings. Aromatics also contain cyclic rings, but these rings are aromatic that is, they contain conjugated double bonds alternating single and double bonds. When present in the crude oil, they are primarily based on the six-membered benzene ring. Average aromatics content of the most crude oils is around 50 %, but it can range from 25% in the light paraffinic crudes to 75 % in the heavy crudes. In the crude petroleum most compounds have composite structures; that is, they contain linear or branched hydrocarbon chains and rings in the same structure. Paraffins to naphthenes ratio varies widely among the crude oils from different sources and is used to classify them as paraffinic or naphthenic. Other components in the crude oils are undesired and must be removed during the manufacture of fuels and base oils. In addition to the simple hydrocarbon molecules described so far, crude petroleum contains compounds that have elements other than carbon and hydrogen, either in the side chain or in a ring. When nitrogen, oxygen, sulfur, or other elements, commonly found in petroleum, are present in cyclic structures, the compounds are called heterocyclics. Oxygen-containing compounds are usually noncyclic, such as carboxylic acids, and therefore are not classified as heterocyclic's. Sulfur- and nitrogen-containing compounds, on the other hand, are usually cyclic. Asphaltenes are very high molecular weight compounds with heterocyclic and aromatic structures [2].

**Table 1.1 Products from petroleum refining [3].**

| Product | Boling point C° | Boling point F° |
|---|---|---|
| Liquefied Petroleum Gas | −40 to 0 | −40 to 32 |
| Motor Gasoline | 30 to 200 | 90 to 400 |
| Kerosene, Jet Fuel | 170 to 270 | 340 to 520 |
| Diesel Fuel | 180 to 340 | 360 to 650 |
| Furnace Oil | 180 to 340 | 360 to 650 |
| Base Oils for Lubricants | 340 to 540 | 650 to 1010 |
| Residual Fuel | 340 to 650 | 650 to 1210 |
| Asphalt | 540+ | 1000+ |
| Petroleum Coke | Solid | ___ |

## 1.2 Base oils:

### 1.2.1 Definition of base oil:

Base oils are used to manufacture products including lubricating greases, motor oil and metal processing fluids. Different products require different compositions and properties in the oil. One of the most important factors is the liquid's viscosity at various temperatures. A crude oil is suitable to be made into base oil is determined by the concentration of base oil molecules as well as how easily these can be extracted. Base oil is produced by means of refining crude oil. This means that the crude oil is heated in order that various distillates can be separated from one another. During the heating process, light and heavy hydrocarbons are separated – the light ones can be refined to make petrol and other fuels, while the heavier ones are suitable for bitumen and base oils The refined petroleum mineral or synthetic material that is produced by a refinery to a required set of [4].

### 1.2.2 Base oil categories:

According to the American Petroleum Institute (API), base oils fall into five main groups [5].

**Table 1.2 show base oils categories:**

| Base Oil Category | Sulfur % | Saturates% | Viscosity Index |
|---|---|---|---|
| Group I | _0.03 | and or _90 | 80 to 120 |
| Group II | _0.03 | and _90 | 80 to 120 |
| Group III | _0.03 | and _90 | _120 |
| Group IV | All Polyalphaolefins | | _ |
| Group V | All others not included in the above groups | | _ |

## 1.3 Engine oil:

Almost all modern machines require the use of a lubricant. Lubricating oils are viscous liquids used for lubricating moving part of engines and machines. Lubricating oils from petroleum consists essentially of complex mixtures of hydrocarbon molecules. They are mostly composed of isoalkanes having slightly longer branches and the monocycloalkanes and monoaromatics which have several short branches on the ring.

A lubricant is a substance in introduced to reduce friction between surfaces in mutual contact, which ultimately reduces the heat generated when the surfaces move [6].

### 1.3.1 Properties of Engine oil:

A good lubricant generally possesses the following characteristics:

- High boiling point and low freezing point (in order to stay liquid within a wide range of temperature)
- High viscosity index
- Thermal stability
- Hydraulic stability
- Demulsibility
- Corrosion prevention
- High resistance to oxidation [7].

### 1.3.2 Types of Engine oil:

Broadly classify lubricants into engine lubricants and non engine lubricants. Engine lubricants are those that are used to lubricate components in an internal combustion engine. Non engine lubricants are those that are used to lubricate parts and mechanisms that help transfer power from the power source,
such as an engine, to parts that perform the actual work [5].

### 1.3.3 Classification of engine oils: [5].

**Table 1.3 classifications of engine oils**

| Engine oils | Non engine oils |
|---|---|
| Gasoline engine oils<br>Diesel engine oils<br>1. Automotive diesel oils<br>2. Stationary diesel oils<br>3. Railroad diesel oils<br>4. Marine diesel oils<br>Stationary gas engine oils<br>Aviation engine oils<br>Two-stroke cycle engine oils | Transmission fluids<br>1. Automatic transmission fluids<br>2. Manual transmission fluids<br>3. Power transmission fluids<br>Gear oils<br>1. Automotive gear oils<br>2. Industrial gear oils<br>Hydraulic fluids<br>1. Tractor hydraulic fluids<br>2. Industrial hydraulic fluids<br>Turbine oils<br>Miscellaneous industrial oils<br>Metalworking fluids<br>Greases. |

### 1.3.4 Engine oils Composition:

Typically lubricants contain 90% base oil (most often petroleum fraction, called mineral oils) and less than 10% additive. Almost all commercial lubricants are formulated oils, That is, they comprise base stocks_ and performance additives. When present in the proper concentration, these components impart the formulated lubricant properties necessary to perform effectively in the intended application. In addition to performing the principle functions of lubrication, cooling, containment/suspension, corrosion protection, and power transfer, the lubricant must also fulfill additional functions that are unique to the application. Lubrication is the base oil's or the base fluid's exclusive domain but for achieving the other functions the additives play a predominant role. Additives belong to two general classes: those that affect or impart to the physical properties of the base oil and those that improve the chemical properties of the base oil. The functions of some of these are briefly described below [5].

#### 1.3.4.1 Detergents:

These additives perform two major functions. They neutralize the acidic by-products of combustion and lubricant oxidation and keep the deposit precursors and contaminants, which have marginal oil solubility, in oil. This minimizes deposit formation on engine or transmission parts. It is their base reserve, or the total base number (TBN), that helps neutralize acids and the soap content that help suspend the polar products in oil. These materials are alkali metal or alkaline earth metal salts of organic acids, with or without the reserve base. Common Acids include alkyl benzene sulfonic acids, alkyl phenols, and fatty carboxylic acids [5].

#### 1.3.4.2 Dispersants:

These additives perform the same function as the soap component of the detergents. That is, they suspend polar contaminants of low oil solubility in the bulk lubricant. They do so by associating with these species via their polar ester or imides functionalities and keeping them dissolved in oil by associating with it via their non polar hydrocarbon chains. Dispersants are more effective in performing this function than detergents because of their higher molecular weight, that is, the higher hydrocarbon content. The suspended harmful products are removed when the oil is changed. Common dispersants are polyamine and polyhydric alcohol derived poly isobutylene derivatives [5].

### 1.3.4.3 Oxidation Inhibitors

These additives control the oxygen-initiated degradation of the lubricant. They belong to three general classes: hydro peroxide decomposers, free radical scavengers, and metal deactivators. Hydro peroxide decomposers promote the decomposition of the hydro peroxides either to innocuous materials or to free radicals. Common additives of this class include oregano-sulfur and oregano-phosphorus compounds. Free radical scavengers remove the free radicals that are primarily responsible for the oxidation chain reaction. Common additives of this class are zinc dialkyl dithiophosphates (ZDTPs), hindered phenols, and alkylated aryl amines. Metal deactivators complex with metallic captions, which are oxidation catalysts, and make them inactive. Poly functional polydentate compounds, such as
ethylenediaminetetraacetic acid( EDTA) and salicylaldoxime, are useful in controlling Oxidation by this mechanism[5].

### 1.3.4.4 Rust and Corrosion Inhibitors

These additives protect metal surfaces against the attack of oxygen, water, acids, bases, and salts. They achieve this by physically adsorbing on the metal surfaces via their polar functional group and by maintaining a resilient protective film on the surfaces by associating with the lubricant. Rust inhibitors are additives that protect ferrous metals and corrosion inhibitors are additives that protect nonferrous metals. Both types perform by coating the surfaces of the metal parts and forming a barrier between them and the environment [4] .

### 1.3.4.5 Friction Modifiers

These are additives that usually reduce friction. The mechanism of their performance is similar to that of the rust and corrosion inhibitors in that they form durable low resistance lubricant films via adsorption on surfaces and via association with the oil. Common materials that are used for this purpose include long-chain fatty acids, their derivatives, and the molybdenum compounds. In addition to reducing friction, the friction modifiers also reduce wear, especially at low temperatures where the anti-wear agents are inactive, and they improve fuel efficiency. Copyright by may also have the function of transmitting forces, transporting foreign particles, or heating or cooling the surfaces [5].

### 1.3.4.6 Anti-wear Agents and Extreme-pressure Additives:

These additives form extremely durable protective films by Thermo-chemically reacting with the metal surfaces. This Film can withstand extreme temperatures and mechanical Pressures and minimizes direct contact between surfaces, thereby protecting them from scoring and seizing. Typically, anti-wear (AW) agents have a lower activation temperature than the extreme-pressure (EP) agents. The latter are also referred to as anti-seize and anti-scuffing additives. Organ sulfur and organo-phosphorus compounds, such as organic polysulfide's, phosphates, dithiophosphates, and dithiocarbamates are the most commonly used AW and EP agents[5].

### 1.3.4.7 Foam Inhibitors:

Formation of foam in most lubrication applications is undesirable since it impedes lubrication, promotes lubricant oxidation, obstructs narrow passages, and reduces a lubricant’s cooling ability. Foam inhibitors are additives that reduce the foam-forming tendency of the lubricant. Common additives used to accomplish foaming control include polysiloxanes and styrene ester polymers. These materials have borderline oil solubility and perform by lowering the surface tension of the foam bubbles [5].

### 1.3.4.8 Viscosity Modifiers:

The viscosity of liquids decreases with an increase in temperature. Oil’s viscosity at high temperatures can drop to a low level that will make it lose its ability to maintain a lubricating film on surfaces. Viscosity modifiers are polymers that help a lubricant maintain its lubricating ability at high temperatures. They do so by increasing their molecular size, hence increasing association with the oil so that it does not flow away from the surfaces. These additives increase both the low-temperature viscosity and the high-temperature viscosity of the oil, but to a varying degree. They are often used to make multi-grade oils. Common polymers that are used in this capacity include polymethacrylates, olefin copolymers (OCPs), styrene-dine copolymers, andstyrene-estercopolymers [5].

### 1.3.4.9 Pour Point Depressants:

Petroleum base oil-derived fluids contain waxes, which at Low temperatures start to crystallize to form network structures. These structures absorb oil and impede its flow. Pour point depressants _PPDs_ prevent crystalline network formation and permit oil flow at low temperatures. Common PPDs include wax-alkylated naphthalenes and phenols, poly methacrylates, and styrene-ester copolymers In addition to the types of additives described here, there is additional type. Also, please note that not all lubricants contain all types of additives and in the same amounts. Typically, automotive lubricants contain more classes of additives and in greater amounts than industrial lubricants [5].

### 1.3.5 Desirable Engine Properties

For lubricants to perform effectively, must possess certain specific properties, which include suitable viscosity, Slipperiness, high film strength, low corrosively, low pour point, good cleansing and dispersing ability, no toxicity, and low flammability and volatility. In addition, the lubricant must not foam. It must also be capable of getting rid of air

(Oxygen) to minimize oxidation and maintaining its lubricating characteristics. As mentioned in the prior discussion, the lubricants are formulated by blending base oils with additives to meet a series of performance specifications. These specifications relate to the physical and chemical properties of the lubricant, when it is new and during use, and its ability to protect the equipment against damage during service. Previously, also stated that the base fluid is the largest component in a lubricant and its properties are likely to have the greatest effect on lubricant properties. Hence, it is important to choose base oil that by and large has the properties that are desired in a lubricant [5].

## 1.4 Important of treatment of Engine oils:

Reduces Pollution: Industrial waste today is the main source of all types of pollution. Recycling of industrial products such as cans, chemical, plastics helps to cut down pollution levels considerably, as these materials are re-used, instead of throwing them away irresponsibly.

Reduces Global Warming: Recycling helps to alleviate global warming and its ill effects. Massive waste is burned in heaps which produces large amount of greenhouse gas emissions such as CO2 and CFC's. Recycling ensure that the burning process is minimized and any waste is re-generated as a useful product with no or minimal harmful impact on the environment. Recycling produces less greenhouse gases as industries burn fewer fossil fuels for eco-friendly products.

Judicious and Sustainable use of Resources: Recycling promotes judicial and sustainable use of resources. This process ensures that there is no discriminate use of any material when available in plenty in the present. Recycling is encouraged at all levels, starting from school to corporate offices and at international levels. This means we can preserve all precious resources for our future generation, without any compromise in the present [8].

## 1.5 Physical and chemical testing for engine oil:

### 1.5.1Viscosity:

Viscosity is defined as the force acting on a unit area where the velocity gradient is equal at a given density of the fluid. Viscosity is strongly depending on the temperature. With increasing temperature, the viscosity has to be stated for a certain temperature. The most important fluid characteristic of a lubricant is its viscosity under the operation condition to which it is subjected in the unit. It is the characteristic of a liquid which relates a shearing stress to the viscosity gradient it produces in the liquid [6].

### 1.5.2 Specific Gravity:

Density of a substance is defined by mass per unit volume and in liquids, such as lubricants, is expressed as gram/ milliliter g/ml. Relative density, also known as specific gravity, is a measure of the density of a material relative to another material. Specific gravity of the liquids is equal to the density of the liquid divided by the density of water, and in gases, it is the density of the gas divided by the density of air. Specific gravity has no units [5].

### 1.5.3 Flash points:

Flash point is the lowest temperature at which the vapors' in air will burn momentarily if ignited by flame or spark. A decrease in flash point indicates contamination by dilution of lubricating oils with unburned fuel. Increasing of flash point indicates evaporation of the light components from the lubricating oil [9].

### 1.5.4 Electrical Conductivity:

Electrical conductivity is a measure of a material's ability to conduct an electric current. If the electrical conductivity of a lubricant is high, it indicates the presence of ions and ion forming materials, such as metals and metal-containing additives, water, and thermo-oxidative degradation products. In water-based lubricants, low electrical conductivity is desired since it is associated with metallic corrosion and the corrosion products promote oxidative degradation of the lubricant [5].

### 1.5.5 Pour Point:

The lowest temperature at which the fluid will flow when cooled under prescribed conditions. Pour point is an indicator of the ability of oil or the distillate fuel to flow at cold operating temperatures. Low pour point indicates good lubricating oil [9].

### 1.5.6 Ash content:

Ash is the amount of the incombustible material present in a Lubricant. It is measured by burning the oil under prescribed Conditions .Which is the ash that results from mixing the oil with sulfuric acid and then Burning it in a high-temperature furnace and then determinate the ash by weighting before and after the burning [5].

### 1.5.7 Sulphur content:

This test is known or called sulphur analysis. 5 ml of the test sample was introduced into a burette and attached to the spectrophotometer clip. When the position is achieved, the radiation bottom is allowed to emit its rays from X- ray tubes. The excitation effect is proportional to the concentration of sulphur in the sample [6].

## 1.6 Instruments:

### 1.6.1Atomic absorption spectrometer:

Atomic Absorption Spectrometer (AAS) is used to analyze heavy metals as well as other trace metals in different samples after preparation with a suitable method like digestion and dissolution. The technique makes use of absorption spectrometry to assess the concentration of an analyte in a sample. It requires standards with known analyte content to establish the relation between the measured absorbance and the analyte concentration and relies therefore on the Beer-Lambert Law. In short, the electrons of the atoms in the atomizer can be promoted to higher orbital's (excited state) for a short period of time (nanoseconds) by absorbing a defined quantity of energy (radiation of a given wavelength). This amount of energy, i.e., wavelength, is specific to a particular electron transition in a particular element. In general, each wavelength corresponds to only one element, and the width of an absorption line is only of the order of a few picometers (pm), which gives the technique its elemental selectivity. The radiation flux without a sample and with a sample in the atomizer is measured using a detector, and the ratio between the two values (the absorbance) is converted to analyte concentration or mass using the Beer-Lambert Law [10].

**Aim of this study:**

-Treatment of used engine oils by acid treatment process

-Analysis of the used engine oils before and after treated.

# Chapter Two

## 2- Materials, Instruments and Methods

# Materials, Instruments and Methods

## 2.1 Material:

- Sulphuric acid concentrated (98%)
- Hydrochloric acid (assay 35%)
- Sodium hydroxide

### 2.1.1 Samples:

The test samples of used lube oils (Fuchs motor oil from a car that travel car 2000 km) and ( national motor oil that travel  car 3100 km)were collected  from an oil service station. The used lubrication oil was collected from used oil dumps of a car mechanic.

## 2.2 Instruments:

- Centrifuge device ( jouan C412)
- Furnace
- Flash point and fire point test (DSY-001A, GB/T 3536 ASTM D92)
- Sulfur – in – oil analyzer " horiba" (SLFA-2100)
- Viscometer (SVM 3000)

- Density meter (DMA 4500)
- Atomic absorption spectrometer( shimadzu AA6800)

## 2.3 Methods:

### 2.3.1 Methods of treatment:

#### 2.3.1.1 Method A:-

20 ml of concentrated sulphuric acid was added to 200 ml of used engine oil and warmed up in water bath for 15 minutes at 70 C°, then left for 3 days .the upper layer of the sample was washed 5 time by distilled water using separation funnel , sodium hydroxide was added while stirring in water bath at 70C°temperature.

#### 2.3.1.2 Method B:-

20 ml of concentrated sulphuric acid was added to 200 ml of used engine oil and warmed up in water bath for 15 minutes at 70 C° temperature then the sample was transferred to set centrifuge device at (4000rpm) for an hour and washed 5 time by distilled water using separation funnel then sodium hydroxide was added while stirring in water bath at 70 C° temperature.

### 2.3.2 Method of analysis:

#### 2.3.2.1Method of determination of specific gravity:

5 ml of sample was placed into density meter by injection at temperature 50, 20, 15 $C^0$.

#### 2.3.2.2 Method of determination of Viscosity:

The samples obtained by various methods. They were heated one after the other to attain a temperature of 100°C and 40 C°. The bulb of the clean viscometer was filled by sample while immersed in a thermostat**.**

#### 2.3.2.3Method of determination of Flash point:

75 ml of the sample was introduced into a 100 ml beaker and then a thermometer inserted. A beaker was placed on a bunsen burner. A flame source was brought at intervals to determine the temperature at which a flash appears on the surface of the sample while the lube oil in the beaker was heated.

#### 2.3.2.4 Method of determination of sulfur:

5 ml of the sample was introduced into cup and attached to the X-ray spectrometer clip.

#### 2.3.2.5 Method of determination of ash contents:

5g of the sample was weighted in the crucible then heated completely burring in flame and placed in a furnace for 6 hours at 650 C°.

#### 2.3.2.6 Method of determination of metal contents:

5g of the sample was weighted in the crucible then heated completely burring in flame and placed in a furnace for 6 hours at 650 C°. The sample was dissolved by hydrochloric acid (assay 35%) in conical flask capacity 50 ml and completed by distilled water till the mark, then it was analyzed heavy metals (Pb, Fe) using atomic absorption spectroscopy .

# Chapter Three

## 3-Results and Discussion

# Results and Discussion

## 3.1 Results:

### 3.1.1The percentage of competency:

By method A= 59%

By method B=60%

### 3.1.2 Results of treated benzene engine oils:

**Table 1.4 results of treated benzene engine oils:**

| Properties | Used engine oil | Method A | Method B |
|---|---|---|---|
| Density ($g/cm^3$) | 0.91 | 0.8675 | 0.887 |
| Viscosity at 40 C° ($mm^2/s$) | 79.311 | 96.115 | 96.405 |
| Viscosity at 100 C°($mm^2/s$) | 11.195 | 12.687 | 12.89 |
| Flash Point C° | 135 | 207 | 207.5 |
| Ash Content (%) | 6.20 | 3.00 | 2.70 |
| Sulphur percentage (%) | 0.8319 | 0.0843 | 0.08425 |
| Metal Contents (ppm) | | | |
| Pb | 10.3 | 0.91 | 0.82 |
| Fe | 55 | 0.83 | 0.75 |

### 3.1.3 Results of treated diesel engine oils:

**Table 1.5 results of treated diesel engine oils:**

| Properties | Used engine oil | Method A | Method B |
|---|---|---|---|
| Density ($g/cm^3$) | 0.8855 | 0.875 | 0.8783 |
| Viscosity at 40 C° ($mm^2/s$) | 88.001 | 98.97 | 99.352 |

| | | | |
|---|---|---|---|
| Viscosity at 100 C°(mm$^2$/s) | 11.016 | 12.807 | 12.93 |
| Flash Point C° | 125 | 207.5 | 208.5 |
| Ash Content (%) | 1.23 | 1.07 | 1.056 |
| Sulphur percentage (%) | 0.695 | 0.044 | 0.0436 |
| Metal Contents (ppm) | | | |
| Pb | 8.70 | 0.86 | 0.73 |
| Fe | 49.00 | 0.79 | 0.65 |

## 3.2 Discussion:

### 3.2.1 Result of fresh base oil:

**Table 1.6 result of fresh base oil:**

| Properties | Fresh base oil |
|---|---|
| Density ($g/cm^3$) | 0.89 |
| Viscosity at 40 C° ($mm^2/s$) | 105 |
| Viscosity at 100 C°($mm^2/s$) | 15.1 |
| Flash Point C° | 215 |
| Ash Content (%) | - |
| Sulfur percentage (%) | - |
| Metal Contents (ppm) | |
| Pb | - |
| Fe | - |

Treatment of used engine oil was done by using two methods depending in using of sulfuric acid .some of physical and chemical properties of engine oil was measured before and after treatment process of treated oil by using (method A or method B). Results show there is no different in physical and chemical properties and there is no big different between the process of treated oil and base oil according to above table. Also result shows improvement in most of physical and chemical properties of engine oil.

Density of treated engine oil was reduced than the density of used engine oil.

Viscosity of treated engine oil was increased than the viscosity of used engine oils this result due to the removing of oxidative agent like esters and ketones.

Flash point of treated engine oil was increased than the flash point of used engine oils.

Sulfur percentage was decreased in treated oil comparing to used oil. High percentage of sulfur causes corrosion in the engine because formation of acids by oxidation of sulfur components.

The percentage of ash was decreased in treated oil comparing to used oil due to the remove of some element by precipitate it using acid. The percentage of metals (Pb, Fe) were decreased in treated oil comparing to used oil due to it is ability of forming precipitate.

# Conclusion Recommendations

## 3.3. Conclusion:

The study proved that the acid-clay treatment is a process that can effectively remove contaminants from used lubricating oil. The recovered oil has a comparable quality with the fresh oil indicating the possibility of reusing it.

Used oils for both benzene and gasoline engine oils were treated using two methods and the result showed in method A for benzene engine oils the percentage of the oils terminated from the first method 59% v/v and, the second one 60% v/v. The properties of benzene engine oil treated by first method is ( 0.880 , 0.8675 , 0.8498 g/cm$^3$ ) , ( 96.115 , 12.687mm$^2$/s ) , 207 C° , 0.08425% , 3%.

properties of benzene engine oil treated by second method is ( 0.881 , 0.877 , 0.8567 g/cm$^3$ ) , ( 96.405 , 12.89 mm$^2$/s ) , 207.5 C° , 0.0843% , 2.7%.

The properties of gasoline engine oil treated by first method is (0.881,0.875,0.850g/cm$^3$ ) , (98.97,12.807mm$^2$/s ) , 207.5 C° , 0.044% , 1.07%.

properties of gasoline engine oil treated by second method is ( 0.8818,0.8783,0.8579g/cm$^3$ ) , (99.352,12.93mm$^2$/s ) , 208.5 C° , 0.0436% , 1.056%.

The treatment of used engine oils will reduce environmental concern which it has so far posed. It will also reduce the demand for engine oils rich crude which is a finite resource

### 3.4. Recommendations:

Support and develop treating used oils to reuse it in order to minimize pollution find new efficient method

Try to recycle any industrial, agricultural and chemical waste to maintain the environment.

During experiment, proper safety equipment should be strictly applied to avoid possible irritations on eyes, skin and breathing system.
A study on different recycling techniques is necessary to practically evaluate and compare efficiencies to recommend the best method for implementation

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## 3.5 Figures:

Figure 3.5.1Steps of wash the sample after treatment

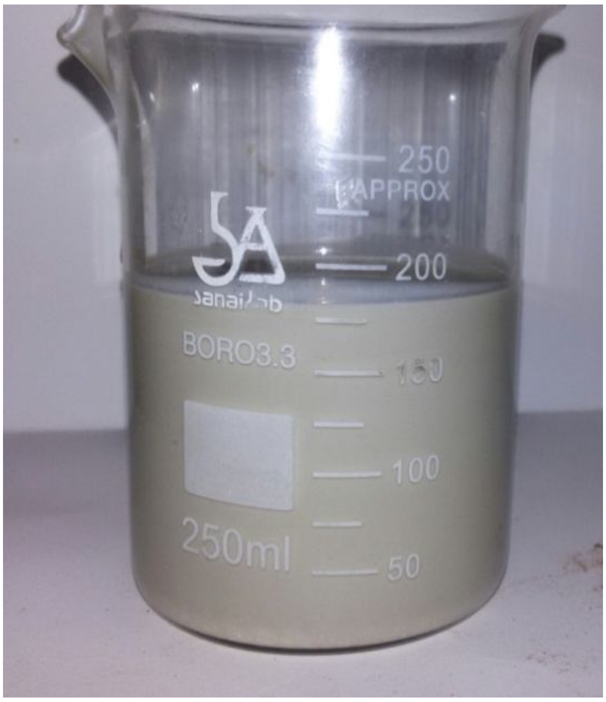

Figure 3.5.2 Sample after washed

Figure 3.5.3 Final product