

Comparison between Different Methods of Waste Oil Recovery

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ABSTRACT: Lubricating oils are viscous liquids used for lubricating moving part of engines and machines. Lubricating oils are obtained from petroleum a finite product and with dwindling production from world oil reserves, is essential to recognize that all used oils should be collected for controlled disposals. Some products such as transformer oils and hydraulic oils, can be readily collected from large industrial concerns, regenerated to a recognized standard and returned to original source. Oil from automotive sources will include mono and multi-grade crankcase oils from petrol and diesel engines, together with industrial lubricants that have been inadequately segregated may also be included. Lubrication oil is used to provide a film between the moving parts of machines and engines to prevent wear with little or no loss of power.

KEYWORDS: Lubricating oil, petroleum products, purification of oil, and recovery of oil.

I.INTRODUCTION

Lubricating oils from petroleum consists essentially of complex mixture of hydrocarbon molecules. They are mostly composed of is alkenes having slightly longer branches and monocycloalkanes and mono aromatics which have several short branches on the ring. This hydrocarbon molecules generally range from low viscosity oils having molecular weights as low as a 250, up to very viscous lubricants with molecular weights as high as 1000. The carbon atoms range from 20 to 34. Lubricating oils are viscous liquid and are used or lubricating moving parts of engines and machines^[1]. Grease, which is a semi-solid, also belongs to this group. There are three major classes of lubricating oils, namely:

1. Lubricating greases.
2. Automotive oils.
3. Industrial lubricating oils.

When lubricating oils are used in services, they help to protect rubbing surface and promote easier motion of connected parts. In the process, they serve as a medium to remove high buildup of temperature on the moving surfaces. Further buildup of temperature degrades the lubricating oils, thus leading to reduction in properties such as: viscosity, specific gravity, etc. Dirt and metal parts worn out from the surfaces are deposited into the lubricating oils. With increased time of usage, the lubricating oil loses its lubricating properties, as results of over - reduction of desired properties, and thus must be evacuated and a fresh one replaced^[2]. With the large amount of engine oils used, the disposal of lubricating oils has now become a major problem. Many nations are now addressing the problem of environmental pollution posed by waste or used lubricating oils in their countries^[3].

The following three distinctive reasons explain the interest in the recycling of waste lubricating oil.

1. The need to conserve crude reserves.
2. Minimizing unemployment through the building/ construction of used lubricating oil recycling plant.
3. The elimination of environment pollution source of used lubricant. The basic principle remains the same and utilizes many of the following basic steps.
 - Removal of water and solid particles by settling.
 - Sulphuric acid treatment to remove gums greases, etc.
 - Water washing to remove to "soap".
 - Clay contacting to bleach the oil and absorb impurities.
 - Striping to drive off moisture and volatile Oils.
 - Filtering to remove clay and other solids.

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- Blending to specification

The objective of this research is centred mostly on obtaining a high quality production of lubricating oil from used lubricating oil by the re-refining of used lubricating oil, thereby reducing environmental pollution and also minimizing importation of lubrication oil. Oils originating from petroleum crude can be processed, blended and formulated to produce numerous ranges of products for many applications^[12]. The principal uses of oils are as fuels, lubricants, hydraulic and transmission fluids, heat transfer fluids and insulates. As fuels, oils cover a wider spectrum from light, highly mobile liquids, to heavy fuel oils of such low viscosity at ambient temperatures that they must be heated to enable their use^[13]. Several technologies are currently available and are used for the treatment and recycling of used oil. However, each one of these technologies has certain disadvantages and that keeps the door open for new ideas and new technologies to improve current efforts in used oil treatment.^[4]

Particulate and water removal from oil:

We have already seen contaminants in varieties of shape, size, materials, etc. They can be categorized:

- a) According to materials e.g. organic or inorganic
- b) According to form e.g. long or short, round or polygon, blunt or sharp, thick or thin, etc.
- c) According to size e.g. large or small from 1000 μm to 0.5 μm .
- d) According to hardness e.g. hard or soft.
- e) According to chemical property e.g. soluble in oil or insoluble under normal condition and with changing temperature.
- f) According to electrical property e.g. positive, negative or neutral.

A. OIL FUNCTION: Lubrication of modern sophisticated machinery is very complex. In addition to normal functions of reducing friction, heat and wear, the industrial lubricant is required to do many more jobs, it must^[5].

1. Lubricant, i.e. form a fluid film between highly loaded moving parts.
2. Act as a coolant to remove frictional heat- often very high, generated both within and outside the machine.
3. Receive and carry away and contaminants arising from both internal and external sources.
4. Act as a hydraulic medium in many applications.
5. Protect against wear of highly loaded parts, when the fluid film is very thin (boundary lubrication)
6. Protect against rust and corrosion of precision parts made of various metals.
7. Offer protect against the accumulation of deposits (sludge and varnish) in the lubrication system. Resist aeration and foaming, which can cause malfunctions.
8. Resist or aid emulsion formation in wet system.
9. Have ability to separate water coming from air breathing or other external sources.

The remaining functions involve properties not normally possessed by plain mineral oils. These functions can, however, be provided by the use of oil soluble chemicals Known as lube oil additives^[14].

B. RECYCLING AND RECOVERY: Recycling and re-refining of waste into virgin lubricating oil may be a suitable option for protecting the environment from hazardous waste. Another benefit associated with waste lubricating oils recycling could be the economic gain due to the high price of mineral oils^[6]

Stated in his patent that one problem inherent in reclaiming, and recycling processes of used lubricating oils is the fact that those oils are conventionally provided with additives such as detergents, dispersants, pour point depressant and viscosity index improvers^[7]. Oil is a complicated mixture of many components, and its behavior largely depends on its initial properties as well as the environmental conditions at the spill site. Oil spill recovery is complicated by the fact that the physical properties of the oil and its composition vary over a wide range, from very light fluids with low viscosity to very viscous oils with high asphalt and wax content that may become semi-solid when spilled in a cold environment^[8]. Different techniques are being used for this purpose, such as sedimentation, centrifugation, deep bed filtration, ultra-filtration, and evaporation^[9]. Previous works have indicated that the best discharge levels are obtained by combining several of the aforementioned techniques.^[10]

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II. RELATED WORK (METHODS)

A. OBJECTIVE

The aim of the work has been to identify the best processing conditions to separate base oil suitable for the formulation of new lubricants, avoiding the co extraction of oxidation products and metallic compounds^[15].

- 1) To provide an improved process for recycling lubricating oils
- 2) To reduce the pollution to the environment from discarded lubricating oils.
- 3) To reduce the depletion of nonrenewable resources used in making lubricating oils.
- 4) To provide improved elements and arrangements thereof in an apparatus for the purposes described which is inexpensive, dependable and fully effective in accomplishing its intended purposes.

B. LUBRICATING OIL PURIFICATION AND RECOVERY

The most widely used process for upgrading waste oils is the acid-clay process. In accordance with this process, waste oil is contacted with high strength sulphuric acid and the contaminants are removed in an acid sludge^[16]. The oil is thereafter contacted with decolorizing clay to absorb additional contaminants and color bodies. So far, in India, little or no effort is being made to recover and reuse this additive cocktail, which is normally sold by re-refiners to brick kilns for burning, thereby adding it to atmospheric pollution.

Methods for Waste Oil Recovery^[17] :

Sr No.	Process
1	Distillation Clay Method
2	Activated charcoal clay Method
3	Fuller's Earth Method
4	Acid Clay Method

Table No: 2.1 Waste oil methods

2.2.1. Distillation Clay Method: The sample was made moisture free by first carrying out atmospheric distillation. Distillation is a unit operation in which the constituent of liquid mixture are separated using thermal energy. Basically the difference in vapors pressure of different constituent at the same temperature is responsible for such separation. 200ml of waste oil was poured into the vacuum distillation flask. The pressure was increased slightly to subside the foam encounter. Mild heating was gently applied to remove the dissolved gases. The distillate obtained was weighed leaving a very dark and waxy residue. This lube oil stream was treated by packing 30gm of clay in a plugged funnel and allowing the lube oil to pass through the bed of clay was disposed off. This is vacuum filtration. Filtration is a unit operation in which separation of solid from suspension in liquid with the help of porous medium or screen which retains the solid and allows the liquid passed through is termed as filtration but there was vacuum filtration the filtration which operate with less than atmospheric pressure on the upstream side of the filter medium and atmospheric pressure on the downstream side of the filter medium are referred to as vacuum filtration.

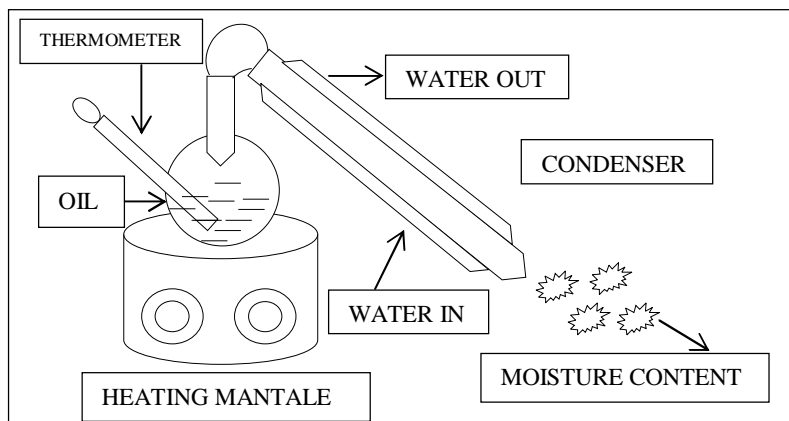


Fig No: 2.1 Experimental Set up for Distillation Clay Method

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2.2.2 Activated Charcoal Clay:

The waste lube oil was stirred homogeneously with the help of shaker 400ml of used lube oil was measured into separating funnel containing 200ml of Ethyl Acetate. The solution was left at room temperature for 24hr. there is formation of two layers. The Bottom layer consists of sludge which was removed. Upper layer consist of solution which is treated with activated charcoal for 30min. charcoal is used for adsorption. Adsorption is phenomenon of enrichment of chemical substances at the surface of solid. Then vacuum filtration was carried out by Clay. Filtration is a unit operation in which separation of solid from suspension in liquid with the help of porous medium or screen which retains the solid and allows the liquid passed through is termed as filtration but there was vacuum filtration the filtration which operate with less than atmospheric pressure on the upstream side of the filter medium and atmospheric pressure on the downstream side of the filter medium are referred to as vacuum filtration. After filtration, oil is used for calculating properties.

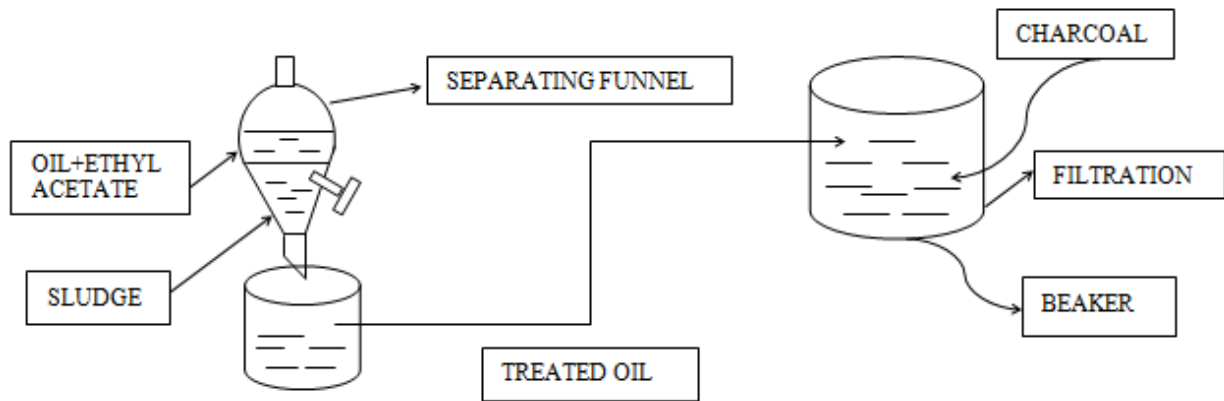


Fig No: 2.2 Experimental Set up Activated Charcoal Clay Method

2.2.3 Fuller's Earth Method:

The waste oil gets filtered by centrifugation for 30min at 1000 rpm.the liquid portion was decanted off. The decanted liquid was treated with fuller's earth for 1hr. Fuller's earth is used for adsorption purpose based on phenomenon of enrichment of chemical substances at the surface of solid. Then vacuum filtration was carried out by Clay. Filtration is a unit operation in which separation of solid from suspension in liquid with the help of porous medium or screen which retains the solid and allows the liquid passed through is termed as filtration but there was vacuum filtration the filtration which operate with less than atmospheric pressure on the upstream side of the filter medium and atmospheric pressure on the downstream side of the filter medium are referred to as vacuum filtration. Clay is used to improve the colour of oil.

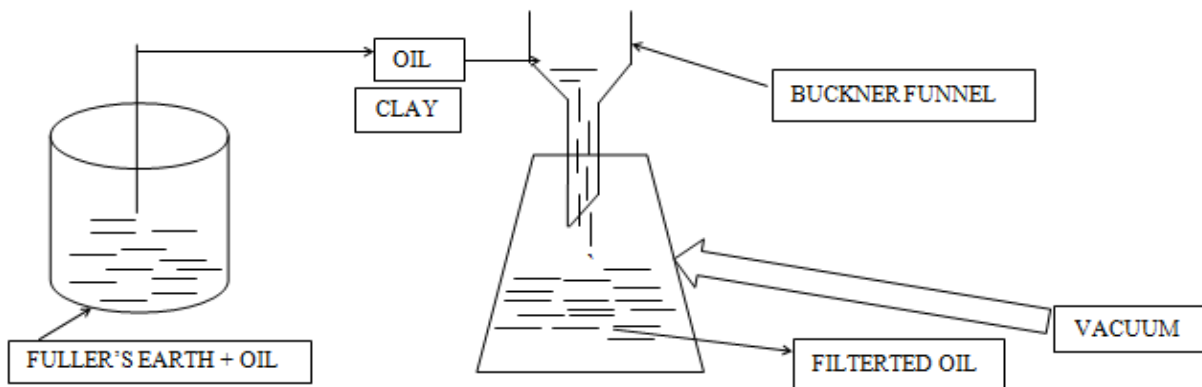


Fig No: 2.3 Experimental Set up Fuller's Earth Method

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2.2.4 Acid Clay Method:

The sample was further filtered by centrifugation for 20 min at 1800 rpm. The suspended particles settled in the waste oil at bottom of flask and the liquid portion was decanted off. The decanted liquid was thermally pre-treated to degrade some of the additives and reduce the workload of the acid. 100 ml of pre-treated oil was measured in separating funnel and treated with 10 ml of 98% conc. H_2SO_4 in separating funnel with mixture strongly agitated. Agitation refers to the induced motion of the material in a circulatory pattern inside tank or vessel, it was then allowed to settle for 48hr. after which two layer/phases were formed, the sludge was removed from the bottom of separating funnel. After which 100ml solution of 10% NaOH. was added to neutralize the acid it was then allowed to settle for. About 30min. without agitation. The alkaline phase, which is formed at the bottom, was removed and the lube oil washed with hot water. The oil was heated with an elemental burner while connected with a vacuum pump.

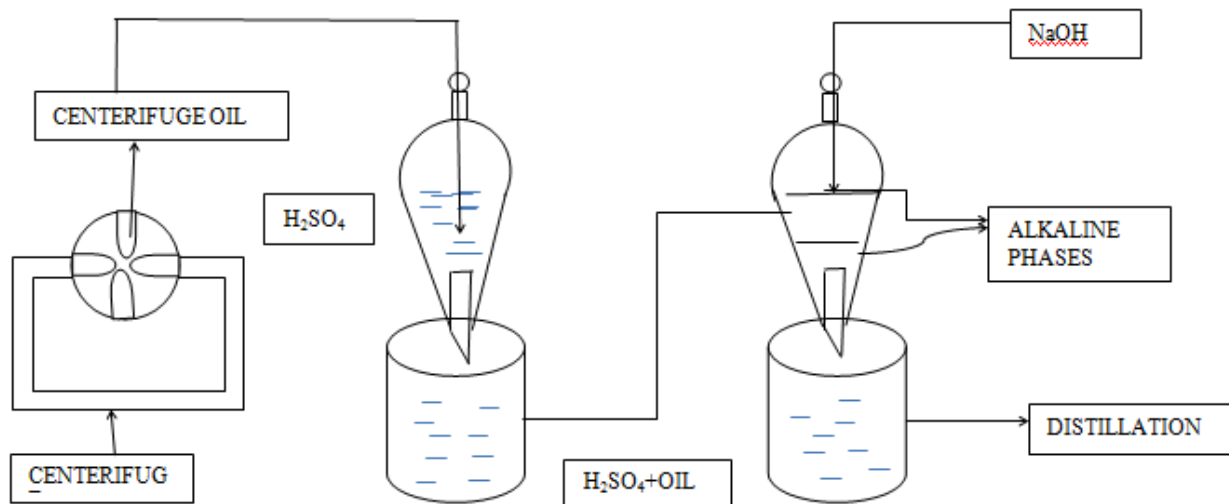


Fig No: 2.4 Experimental Set up Acid Clay Method

III .EXPERIMENTAL PROCEDURE

Test carried out on all this four method i.e. distillation clay, activated charcoal clay fuller earth and acid clay method including specific gravity, viscosity, flash point, pour point, acid value. Results from the different tests showed varied degrees of improvement with the best results obtained using acid clay method on comparing with fresh oil.

Pre-treatment of the waste oil, by filtering it to remove any solid impurity particles of dirt, carbon, soot, etc. The sample was further filtered by centrifugation for 20min. at 1800rpm. The suspended particles settled in the used oil at the bottom of the flask and the liquid portion decanted off. The decanted liquid was thermally pre-treated to degrade some of the additives and reduce the workload of acid. 500ml of pre-treated oil was measured in a separating funnel and treated with 50ml of 98% conc. H_2SO_4 in a separating funnel with the mixture strongly agitated, it was then allowed to settle for 48hr. after which two layer were formed. Bottom layer consist of sludge and upper layer consist of treated oil. The sludge was removed from the bottom of separating funnel. After which 500ml solution of 10% NaOH was added to neutralize the acid, it was then allowed to settle for about 30min without agitation. The four alkaline phases were formed, at the bottom, as shown in following figure.

the upper layer is Of oil and remaining three layer consist of alkaline phases which Was removed and the lube oil washed with hot water 2 times (15ml). The oil was heated with an elemental burner while connected with a vacuum pump (ie. vacuum distillation). The remaining oil was clay treated using clay packed in a funnel with filter paper. This procedure is carried out improve the colour of oil. in this way we have get fresh oil.

Slurry contains used oil contaminants, including metals and some oil additives. The real problem is disposal of this slurry. This can only be done by drying it to a solid waste and disposing the resultant solid matter in a land-fill. This process is expensive as it requires energy inputs to remove the water. This acidic oil is mixed with clay to remove

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mercaptans and other contaminants and to improve oil colour. 30-42 % of acid sludge can be combusted, whereas the remaining portion is called combustion residual

Disposal of Wastes Gene rated. The oil-saturated clay is generally sold off to brick kilns for burning as it is saturated with at least 20% by weight of oil. Considerable economy is possible if this clay is processed to recover the oil as well as regenerate the clay for use again. Typically, the process of regenerating the spent clay involves the following steps.

- Treating the clay with a solvent to extract the oil from the clay.
- The solvent is processed to recover the oil extracted and have the solvent ready for reuse
- The clay is reactivated by acid treatment. The regenerated clay is then fit for use and the acid is recovered for reuse.

IV. EXPERIMENTAL RESULT

We have carried out four methods the different results was obtained from all this four method our aim is to recovered waste oil by using methods so we have collected all results as per methods:

A. DISTILLATION CLAY METHOD: The following table shows result of Distillation clay method, in distillation clay method. Simple distillation was carried out. Distillation is carried out to remove moisture and remaining oil is passed through clay via filtration .clay improving the color of oil. Then we get oil which is pure and it is use for calculating properties. The properties of oil are not match with the fresh oil so this method is not useful for waste oil recovery.

METHOD	Density (Kg/cm ³)	Viscosity	Flash Point	Pour Point	Acid Value
Distillation Clay	0.848	36.71	210	-13	0.113

Table: 4.1 Distillation Clay Method

B. CHARCOAL CLAY METHOD: Charcoal clay method is | mixture of ethyl acetate plus lube oil which is set for one day after that oil is treated with charcoal for adsorption but after 30min oil get adsorb charcoal so when this oil is passed through clay via vacuum filtration the color of oil not get improve else it disturb the color of oil. This oil is use for calculating the properties of oil so result obtained from properties are not get match with properties of standard oil. so this method is not useful. For waste oil recovery. Table shows result of charcoal clay method.

METHOD	Density (Kg/cm ³)	Viscosity	Flash Point	Pour Point	Acid Value
Activated Charcoal	0.8056	39.95	197	-14	0.2085

Table: 4.2 Charcoal Clay Method

C. FULLER'S EARTH METHOD: Fuller's earth is use for adsorption purpose we have consider fuller's earth is a method for recovery of waste oil. in fuller's earth method we have add fuller's earth in oil and it remain for 1hr after that it send into the clay filtration, it require more time to pass through the clay and this method was increase the weight of oil as it contain some traces of fuller's earth. Same way we have calculated the properties which are not match with properties of standard oil hence this method was not useful for waste oil recovery. Following results was obtained from fuller's Earth Method.

METHOD	Density (Kg/cm ³)	Viscosity	Flash Point	Pour Point	Acid Value
Fuller's Earth	0.8076	30.97	205	-12	0.14

Table: 4.3 Fuller's Earth Method

D. ACID CLAY METHOD: Acid clay is an important method among the all methods this method involve more operation and process as compare to others in this method we use centrifuged oil and this oil is treated with sulphuric acid after that it mix with sodium hydroxide so Neutralization is carried out .then it treated with water so for removal water distillation is carried out. Also it have high flash point as compare to others, and less pour point. The property's

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value obtained from acid clay method is match with that of standard oil .so we have consider it as best method for removal of waste oil table shows result of acid clay method.

METHOD	Density (Kg/cm ³)	Viscosity	Flash Point	Pour Point	Acid Value
Acid Clay	0.896	45.17	212	-9	0.22

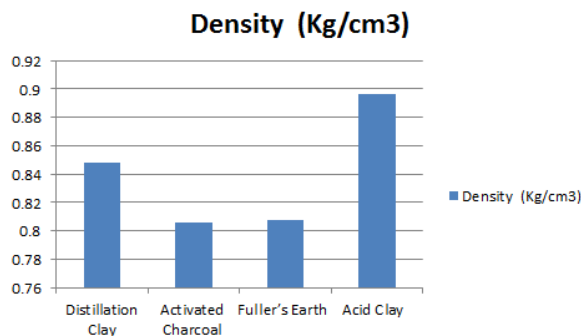
Table: 4.4 Acid Clay Method

E. COMPETITIVE STUDY:

METHOD	Density (Kg/cm ³)	Viscosity	Flash Point	Pour Point	Acid Value
Distillation Clay	0.848	36.71	210	-13	0.113
Activated Charcoal	0.8056	39.95	197	-14	0.2085
Fuller's Earth	0.8076	30.97	205	-12	0.14
Acid Clay	0.896	45.17	212	-9	0.22

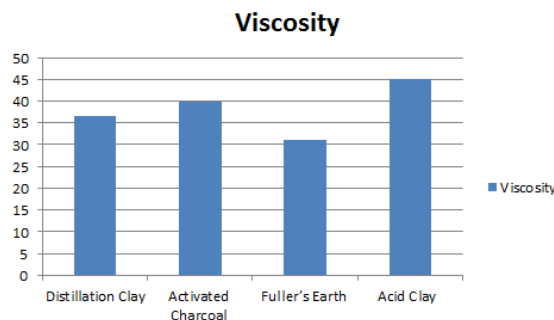
Table: 4.5 Competitive Studies of all four methods

F. DENSITY: DENSITY of a substance is equal to mass of substance divided by the volume of the substance. Density =Mass (m)/Volume (v).Density is one of the most important properties of oil samples for several reasons It is an indicator of crude oil quality. It can be preciously measured easily



Graph No: 4.1Effect of Lube Oil on Density

G. VISCOSITY: 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 characteristic of a liquid which relates a shearing to viscosity gradient it produces in the liquid.



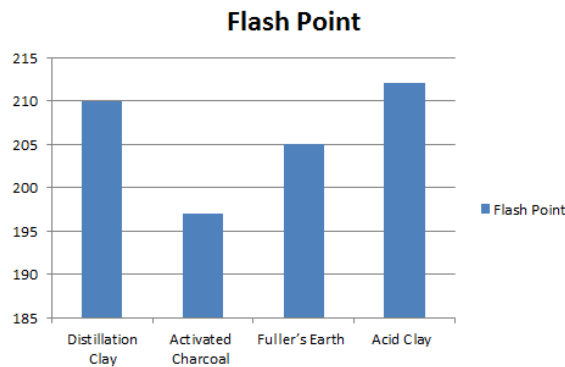
Graph No: 4.2 Effect of Lube Oil on Viscosity

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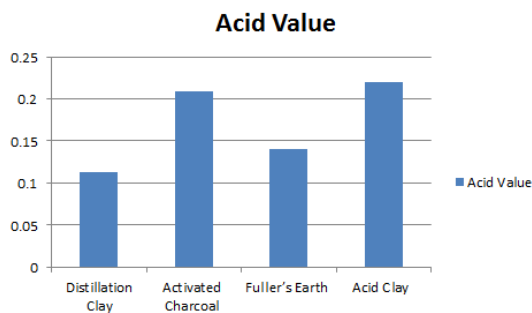
H. FLASH POINT:Flash point is the minimum temperature at which an oil gives off sufficient vapor to form an explosive mixture with air. The flash point test gives an indication of the presence of the volatile compound in oil and is the temperature to which the oil must be heated under specific condition to give off sufficient vapor to form a flammable mixture with air. There is various method of determining flash point of oil as contained in ASTMFlash Pont, open cup is the temperature at which a flash appears on surface of sample when small flame specified size is passed crosses the cup at regular temperature interval while the oil is in the cup is being heated at a specific rate.



Graph No: 4.3 Effect of Lube Oil on Flash Point

I. ACID VALUE:It is the number of milligrams of potassium hydroxide required to neutralize the free acid present in 1gm of an oil.

$$\text{Acid value} = \frac{\text{burette reading} * \text{Normality of KOH} * \text{Equivalent weight of KOH}}{\text{Sample volume} * \text{specific gravity}}$$



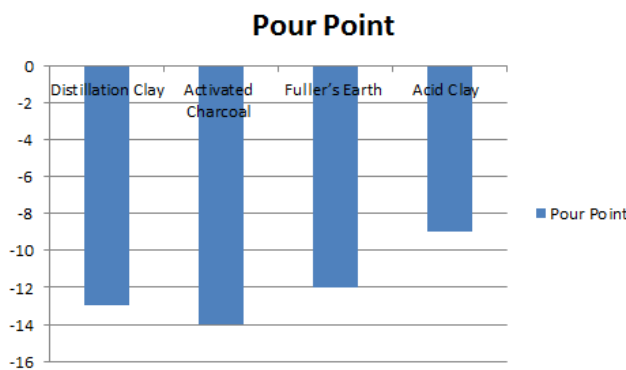
Graph No: 4.4 Effect of Lube Oil on Acid Value

J. POUR POINT: Pour point is not measure of the temperature at which the oil ceases to flow under service condition; of specific system it is very important to user of lubricant in low temperature environment.

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Graph No: 4.5 Effect of Lube Oil on Pour Point

V .CONCLUSION

The results presented in this paper, that the four methods effectively removed contaminants from used lubricating based oil and returned the oil to quality essentially equivalent to oil produced by fresh lube oil stocks overall the refining method using acid clay proves the best option, judging from the result obtained..We conclude that acid-clay treatment method will be better to carry out and to reduce the environmental pollution and to save our natural resource. In future we will carry out analysis on refining oil using gas chromatography.

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