Regeneration (Reuse) of Used Lube Oil

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ABSTRACT

Regeneration of used lube oil by different methods Solvent process, Sulphuric acid and Nitric acid. Regenerated oil shows the densities 870, 850 and 830 Kg/m^3 respectively which is nearer with the fresh oil has density 950 Kg/m^3. Viscosity is the important characteristic of lube oil. Regenerated oil with Solvent process, Sulphuric acid and Nitric acid has viscosity 54, 52 and 44 cPrespectively which is nearer with the fresh oil has viscosity 58 cP calculated at 40 o C. As per results the quality of regenerated by oil with solvent extraction process nearer to fresh oil. Sulphuric acid yields 80 - 85 % while Nitric acid yield 70 - 75%. Nitric acid can be used in place of Sulphuric acid and has proved to yield about 75 % since cost less to obtain used oil. Recycle of oil is economical process and reduce the environmental pollution produce from the used lube oil. Regenerated of used oil with solvent extraction by using MEK as solvent shows the yield up to 90% which is more than the oil regenerated from the different acid. In the solvent extraction we need separate column for solvent recovery. So cost of equipment to be increase. The major benefit of solvent extraction process gives higher yield and high quality product compares with acid treatment process and also reduce the sludge generation problem that produce by acid method. That will be reduce the degree and nature of contamination, environmental/health risks associated with disposal. With help of Activated charcoal we can removes the various impurities presents in the recycled used oil by using different acids. The major drawback to the acid/clay method is the difficulty of removal of the clay sludge.

Keywords – Used Lube Oil Regeneration, Methods use Solvent Extraction and Acid Treatment, MEK, Sulphuric and Nitric Acid, Environmental Pollution Reduction.

1. INTRODUCTION

The lubricating oil acts as a lubricating medium for various automobile parts such as engines and gearboxes. The primary function of lubricating oil is to reduce friction and to provide a heat transfer medium. It also inhibits corrosion and carries away the metal wear parts. The lubricating oil itself doesn't undergo any changes after use but it gets dirty due the addition of combustion products, degraded additives, water and other dust particles during its time inside the engine. The dirt added to the lubricating oil can be obviated and the oil can be restored to its original state. At present the used oil is disposed by pouring into ground, water bodies or used as fuel leading to serious environmental problems. Apart from the environmental problems, the refining of used oil can produce a valuable resource, which is wasted. This in turn increases the need to drill for more crude oil. [2].

The crude oil contains more impurities than the used oil and the production of lubricating oil from crude oil is much costlier than refining of used oil. In automobiles the lubricating oils are changed for every 5000 kilometers. During the time of oil inside the engine properties of the lubricating oil such as viscosity, specific gravity, flash point, pour point , gets reduced due to the continuous addition of heat. The additive gets degraded and goes into the oil in the form of sludge along with metal wear parts. Water goes into the oil as a result of combustion and finally the oil becomes unfit for use in automobile engines and needs replacement. [2].

1.1 Additives

Additives are added to lubricating oils to impart specific properties to the finished oil. The oils from refining by conventional methods are not satisfactory for use as lubricants. Lubricants are highly refined and their properties are improved by addition of chemicals.

1. Antioxidants

Antioxidants reduce the rate of oxidation of lubricating oils during its use, thereby reducing the formation of corrosive oxidized products.

2. Detergents

Detergents are added to the motor oil in order to improve engine performance and to prevent material from depositing on the engine pistons.

3. Antifoam Agents

Foaming of lubricants is an undesirable effect that can cause enhanced oxidation by the intensive mixture of oil with air.

4. Viscosity Modifiers

Viscosity improvers are a long chain, high molecular weight polymers that cause the relative viscosity of oil to increase at high temperatures than at low temperatures. The used additives are alkyl polymethacrylates or copolymers of olefins.

5. Pour-Point Depressant

These additives hinder the process of growth of the crystals of paraffin wax which form in oil at low temperatures. Polymethacrylates with low molecular masses usually used.

1.2 FUNCTION OF OIL [3]

Lubrication of modern sophisticated machinery is very complex. In addition to normal functions of reducing friction, heat and wear.

1. Lubricant, i.e. form a fluid film between highly loaded moving parts.

2. Act as a coolant to remove frictional heat generated both within and outside of machine.

3. Receive and carry away and contaminants arising from 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.

6. Protect against rust and corrosion of precision parts made of various metals.

7. Resist aeration and foaming, which can cause malfunctions.

8. Resist or aid emulsion formation in wet system.

1.3 Scope for Recycling [5]

1. A large range of used oils can be recycled and recovered either directly in the case of high oil content wastes or separation and concentration from high aqueous content materials.

2. Certain types of waste oils and lubricants in particular can be processed for direct reuse.

3. The use of waste oils after treatment can be either a high energy content burning fuel.

4. Reclamation of used oils can give a product of comparable quality to the original.

5. The regeneration of used oils is obtain the highest degree of contaminant removal leading to the recovery of the oil fraction which has maximum viable commercial value.

6. Lube base stock comparable to highly refined virgin oil.

1.4 Sources of Lube oil Contamination [5]

1. The breakdown of the additives and their subsequent reaction

2. Soot and lead from engine blowby

3. Dirt and dust metal particles from engine wear

4. Residual gasoline or diesel fuels from incomplete combustion

5. Water from combustion and blowby vapors.

6. Water from rain water and Salt water ingress.

1.5 Environmental Pollution [12]

1. The contaminants in waste oil have adverse environmental and health impacts.

2. The presence of degraded additives and contaminants more toxic and harmful to health.

3. By-products of degradation render waste oils more toxic and harmful to health.

4. If put into storm water drains or sewers they can affect waterways and coastal waters.

5. When dumped in soil or sent to landfill they can migrate into ground and surface waters.

6. Uncontrolled used oils threat to plant and animal life which result in economic losses.

7. Used oil from internal combustion engines accumulates a variety of contaminants.

2. LITERATURE REVIEWS

In June 2013, by the experimental analysis Undone J.D and Bakare O.A, it prove that the three acids use effectively activated and remove the slug from the used Lubricating oil and return the oil to it quality form. The clay samples possess high adsorption properties which enabled the removal of impurities and the black color from the lubricating oil. From the results obtained Sulphuric acid yields 90 % while Nitric acid yield 70 % to 80 %. Nitric acid can be used in place of Sulphuric acid and has proved to yield about 75% and the cost less to obtain used oil. The process will reduce the degree and nature of contamination, environmental / health risks associated with disposal. As per analysis of different tests flash point, cloud point, pour point, viscosity index, Sulphur content and water content. Results shows that compared with the standard value of fresh lube oil and resultant oil from the analysis which is equal or more than virgin oil. [1].**As per experimental study solvent extraction process can** be used to recover quality base oil with 94 % yield from used lubricating oil. The yield is higher than thin film distillation/clay treatment (70 -

80 %) and Some modifications of thin film has claimed 90-95 % oil recovery but these processes are expensive and require skilled operations. Solvent extraction of used oil can be carried out at ambient temperature with cheap and low boiling point solvent MEK. If the sludge is allowed to sediment out the solvent to oil ratio is 3.8 while mechanical centrifuge can reduce this ratio to 2.6. To eliminate the use of mechanical centrifuge the ratio has been maintained at 3.8 at which free sedimentation occurs. The sludge from this process can be mixed with asphalt without any problem. It is a better process than the traditional acid/clay treatment which produces an acidic sludge. Due to low cost and low boiling point and ease of recovery of solvent MEK. Due to low boiling point and low cost MEK was preferred over 1-butanol. [4].

In March 2015, Experimental studied by Merai Yash P proved that Methyl Ethyl Ketone (MEK) is a selective aromatic solvent employed in the solvent extraction process. The oil is heated to 130 ^{o}C in a closed vessel to boil off emulsified water and some of the fuel diluents. The point at which oil contains the maximum amount of dissolved water is termed the saturation point and then is mixed by agitation with MEK in ratio of 2:1. The lubricating oil and solvent mixture is allowed to settle in separator tank. The aromatic content and degraded additives present in the lubricating oil fraction will settle at the bottom and the lubricating oil fraction and solvent mixture layer forms at the top. Solvent mixture is again subjected to atmospheric distillation. The atmospheric distillation is carried out at temperature of around 80 ^{o}C which is the boiling point of MEK. The MEK vapor produced is condensed and is again used as solvent by blending with fresh solvent. The lubricating oil produced at this stage is similar to base lubricating oil. [5].

As per experimental analysis recycling process takes place at room temperature and shown that base oils and oils' additives are slightly affected by the acetic acid. By adding acetic acid or formic acid to the used oil two layers were separated, a transparent dark red colored oil and a black dark sludge at the bottom of the container. The base oils resulting from other recycling methods were compared to the results of the fresh oil and the comparison showed that the recycled oil produced by acetic acid treatment showed excellent results in the properties of the oil comparable to the fresh oil. The advantage of using the acetic acid or formic acid is that it does not react or only reacts slightly with base oils. [6].

Solvent extraction process for recycling of used lubricating engine oil. Three solvents: 1-butanol, 2-propanol and mixtures of 1-butanol-ethanol were considered. Each solvent was used to segregate impurities in the form of sludge at different extraction factors considered. The performances of the solvents determination by Percent Sludge Removal (PSR) and Percent Oil Loss (POL). POL decreased with the extraction temperature and increase in SOR can improve reduction in POL. Butanol has least POL at extraction temperature 45^{o}C at follow by propanol and mixture of butanol and ethanol. The maximum PSR at butanol as solvent at extraction temperature 45 ^{o}C and50 ^{o}C the PSR were 11.4 and 11.9 respectively at SOR 6:1 and contact time of 30 minutes. The POL continued to drop between SOR 2:1 and 2.8:1. The optimum PSR and POL was obtained at solvent to oil (SOR) ratio 3:1. extraction temperature 45 ^{o}C with

contact time 30 Min. The increase in amount of PSR was gradual at solvent to oil ratio (SOR). [7]

Re-refining of waste lubricating oil by solvent extraction is one of the potentialtechniques. The advantages of solvent extraction technique practically offers from environmental and economic points. Selection of composite solvent and technique to upgrade the used lubricant oil into base oil has been made. The composite solvent 2-propanol, 1-butanol and butanone have two alcohols that make a binary system reasonably effective. The performance of the composite solvent in the extraction process for recovering waste lubricating oil. The key parameters considered were vacuum pressure, temp. and the weight ratio of solvent to waste lubricating oil. [8].

The performance was investigated on the PSR (Percentage Sludge Removal) and POL (Percent Oil Loss). The best results were obtained using composite solvent 25% 2-propanol, 37% 1-butanol and 38% butanone by a solvent to oil ratio of 6:1 The most excellent oil recovery by extraction was obtained using solvent to oil ratio 6:1 are ash reduction and 68% oil recovery and removal sludge from the waste oils. The base oil re-generated possesses the physical properties that are required for the formulation of new lubricants. Distillation of solvent treated oil shows that there are no major differences in oil l properties and the fullers' earth gave a good color result. [8].

Solvent used and the mixing ratio applied for different runs has shown significant effects on the yield of recovered oil. A Maximum yield of 72% was obtained for Rubia Tir 7400 using 2-Propanol solvent and mixing ratio of 6:1, whereas minimum recovery yield of 55% was obtained using n-Butanol and 4:1 mixing ratio. For Quartz 20W-50 a maximum yield of 73.4 was obtained using 2-Propanol solvent and mixing ratio of 6:1 whereas minimum recovery yield of 50 % was obtained using n Butanol and 4:1 mixing ratio. The metal contaminants and chlorine are considerably reduced in the base oils for both lubricants. As per study it can be concluded that used lubricating motor oil can be refined using solvent extraction method and reduces environmental contaminations. [9].

The experimental work for a design batch process for re-refining of used lubricating oils using a composite solvent technique. The composite solvent includes 1-Butanol, 2-propanol and Methyl Ethyl ketone in the ratio of 2:1:1. This composite solvent is observed to have more advantages over the traditional singular acidic, basic and alcoholic solvents. The solvent to oil ratio taken is 3:1 which is the optimum ratio considering cost and other factors. The process was found to be cost effective and efficient with a recovery of 75.6% with 95% solvent recovery. Comparison of various solvents was done with composite solvent and recovery of oil was obtained. Batch process for the composite solvent extraction was designed and cost estimation was carried out. The batch process was found to be economically feasible. [10].

In 2013, Experimental analysis shows by SterpuAncaelena and Dumitru Anca, the best oil recovery and ash reduction by extraction were obtained using optimum evaluated solvent to oil ratio of 4 to 1 with solvent composition of 25% 2-propanol, 50% 1-butanol and 25% MEK were 49% ash reduction and 92% oil recovery. The solvent to oil ratio larger than 4:1 will lead to dissolution of some contaminants in the solvent and considered to be the best solvent to oil

ratio used for treatment of used lubricating oil. The percentage of oil recovery for the solvent to oil ratio of 6:1 is further improved, but for the ratio values higher than 6:1, the operation was considered economically not feasible. The solvent extraction and vacuum distillation steps were used to remove higher molecular weight contaminants. [13].

In 2018, by experimental studied by Srisuda Nithettham and Emma Asnachinda shows that single solvent extraction methanol shows the largest extraction yield at 99.8% (1:1 of WEO to solvent ratio). Results show that solvent with high hydrogen bonding tends to separate sludge form base oil better than those having hydrocarbon and acetone group. For mixed solvent system, extraction of WEO using butanol: toluene (1:3 of WEO to mixed solvent ratio) demonstrates the best efficient extraction at 97.5% yield. WEO to mixed solvent ratio on the extraction yields, the results reveal that the extraction yields are improved from 68-84% to 88-98% when increasing in WEO to mixed solvent ratios from 1:1 to 1:3 for all types of mixed solvents. the more amount of mixed solvents does not further enhance the extraction yields. It can be seen that the extraction yields decrease to 74-92% when using WEO to mixed solvent ratio at 1:4, representing the limitation of extraction system. Extracted oil characteristics 0.855-0.910 g/cm^3 for density, 15-83 centistoke for viscosity.[14].

3.1 Re -Refining of Used Oil [5]

Re-fining is the use of distilling or refining processes on used lubrication oil to produce high quality base stock for lubricants or other petroleum products. The use of this method has increased tremendously in developed countries, some countries reaching up to 50% of the country's need for lubricating oil. Most of the sceptics regard the process as some sort of simple filtration. The re-refining process used at Dominion Oil is a highly sophisticated operation using the most modern plant available in the world today. The process used is in many ways similar to that used to refine crude petroleum. Consideration of the composition and refining of crude will give a better understanding of the re-refining process and highlight the similarities. The re-refiner's job is to remove all the aforementioned contaminants and restore the oil to its original condition. The important point to note is that the technology used by Dominion Oil is identical to that used to refine crude petroleum.

3.2 Refining Using Solvent Extraction [9]

The used lubricating oil refining process commonly used today includes three distillation stages, followed by a solvent extraction process. The distillation stages (dehydration, fuel stripping and vacuum distillation) produce distilled oil, fuel and asphalt products. The distilled oil is then goes to solvent extraction to yield finished base oils.

Step 1 Pretreatment

The used lubricating oil contains different types of solid materials so first it must be removed. Used motor lubricating oil is stored for several days to allow large suspended particles to settle under gravity. This means there is a need to perform a pretreatment process such as settling or filtration using vacuum filter. Hence, the used oil is filtered.

Step 2 - Dehydration

Then after the pretreatment of the used oil it must be dehydrated in order to remove the water in the used oil. The oil is heated to 130 –140 ^{o}C in a closed vessel to

boil remove the water that has been mixed into it. and some of the fuel diluents. The point at which oil contains the maximum amount of dissolved water is termed the saturation point.

Step 3 - Diesel stripping

The dehydrated used oil is then fed continuously into a vacuum distillation for fractionation at a temperature of above 240 ^{o} C. Lighter oils boil off first and are removed. Other heavier components will do not boil in the conditions used. The dehydrated oil is then fed continuously into a vacuum distillation plant for fractionation.The fractions obtained are as follows

a. Light fuel and diesel - The light fuel oil produced at a temperature of 140°C. The light fuel oil can be used as fuel source for heating. Dominion Oil produces enough diesel from the used oil feedstock to run all the burners and boilers, giving total self-sufficiency in fuel.

b. Lubricating oil - At 240 °C the lubricating oil fraction is obtained. The bulk of the feedstock will distill off in the plant to produce a lubricating oil fraction.

c. Residue -The remaining oil at this temperature (240 °C) contains the dirt, degraded additives, metal wear parts and combustion products like carbon and most of the lead and oxidation products. Then it is collected as residue. The residue is in the form similar to that of tar, which can be used as a construction material.

Step 4 Extraction and Distillation

A liquid extraction process then removes any aromatic components from the oil. By this stage the oil is similar to virgin base oil. Solvent such as n-Butanol and 2-Propanol are selective aromatic solvents uses in the solvent extraction process. Lubricating oil fraction obtained by vacuum distillation mixed by agitation with the solvent. The lubricating oil and solvent mixture allowed to settle in the separation flask for 4 hrs. The aromatic content and degraded additives present in lube oil fraction settle at the bottom and the lubricating oil fraction and solvent mixture layer forms at the top. Then by distillation oil and solvent to be separated. The lubricating oil produced is similar to virgin oil.

3.3 Acid Treatment [1]

Recycling of waste engine oils treated using by acetic acid or formic acid. A recycling process was developed which eventually led to comparable results with some of the conventional methods. The recycled oil the potential to be reused in cars' engines after adding the required additives. The recycling process takes place at room temperature. It has been shown that base oils and oils' additives affected by acetic acid. By adding acetic acid to the used oil two layers were separated, a transparent dark red colored oil and a black dark sludge at the bottom of the container. The base oils resulting from other recycling methods were compared to the results of the fresh oil. The comparison showed that the recycled oil produced by acetic acid and formic acid treatment shows excellent results.

Stages of Acid Treatment

1. Addition and Mixing

Take known quantity of used engine oil was measured by measuring cylinder and transferred into a 500 ml beaker. Add acids (acetic acid and formic acid) was measured in a separate 50 ml beaker. The regulator hot plate was switched on and the measured base oil was placed on top. The temperature of used engine oil was

maintained at 40- 45 ^{o} C. At this temperature the acids introduce in used oil with stirring of mixture for 10 min.

2. Sedimentation /Decantation

After acid treatment acidic oil allowed to settle 24 hrs. to form sediment at the bottom of the beaker. After this the acidic-oil was properly sediment and decanted into another beaker using piece of cloth while the acidic sludge at the bottom of beaker.

3. Bleaching

The acidic oil in the beaker was subjected to bleaching. The oil was placed on a regulator hot plate and the temperature was maintained at a temperature of 110°C. 6 wt.% of activated bleaching earth was introduced into the oil and the mixture was continuously stirred for 15 minutes. At the end of the bleaching step oil was neutralized.

4. Neutralization

The bleached oil was neutralized to adjust the pH of the oil to neutrality. At this step, 4 wt.% of the oil of sodium hydroxide was introduced into the bleached oil by taken into consideration the pH of the bleached oil at a given point in time. The bleached oil was neutralized with a continuous manual stirring for 10 minutes. At the end of the neutralization stepsoil was allowed to sediment in the beaker for 24 hours and was decanted.

5. Sedimentation /Decantation

During this stage, the oil was allowed to settled in the beaker for 24 hours and was decanted into another beaker, while the residue at the bottom of the beaker was discarded.

6. Filtration

The sediment oil was finally filtered using a filter cloth and the filtrate was collected in a filtration flask and was observed to be clear the residue.

4.EXPERIMENTAL ANALYSIS

4.1 Regeneration of Used Lube Oil by using Different Acid

4.1.1 Materials

1. 98% Sulphuric Acid (H_2SO_4)
2. 93% Nitric Acid (HNO_3)
3. 10% NaOH
4. Activated Charcoal
5. Used Lube Oil

4.1.2 Experiment Procedure

Treatment with different Acids (Sulphuric Acid, Nitric Acid and Acetic Acid) and Activated Charcoal and Alkali (lime) to be used for the neutralization process of acid which added in the treatments process.

1. Filtration

Filter the One liters Used lubricating Oil by using filter cloth to remove impurities such as sand, metal chips, micro impurities that contaminated lube oil.

2. Acid Treatment

Before acid treatment preheat the oil at temperature 100-120 ^{o}C to degrade some of the additives and reduce the work load of the acid. Take 100 ml of the pre- heated oil into beakers for the first sample and similarly Second beaker of 100 ml used oil. The temperature of the used engine oil was maintained at 40 - 45 ^{o}C. At this temperature the 98% conc. Sulphuric acid (10 ml) in first beaker and 93% conc. nitric acid in second beaker introduce with stirring of the mixture for10 min.

4.1.2 Sedimentation

The oil samples were measured into a separating funnel and acids sludge was discharged at the bottom

of the separating funnel and allowed to settle 4 hours to form sediment at the bottom of the beaker. The acidic-oil was properly sedimented and decanted into another beaker while the residue (acidic sludge) at the bottom of the beaker was discarded.

4.1. 3 Neutralization

100 ml solution of 4-10% NaOH (Caustic soda) was added to each sample to neutralize the acid of the two oil samples. In the neutralization steps the oil was allowed to sediment in the beaker for 4 hours and was decanted into the beaker while the residue at the bottom of beaker was discarded.

4.1.4 Bleaching using activated Carbon

At the end of the acid treatment step if the acidic oil is to be bleached using activated carbon (charcoal). The temperature was increased and maintained at a range of 130 oC–140 ^{o}C. The activated carbon and hydrated lime was used.

4.1.5 Sedimentation /Decantation

In this stage the oil was allowed to sediment in the beaker for 4 hours and was decanted into another beaker while the residue at the bottom of the beaker was discarded.

7. Filtration

The sedimented oil was finally filtered using a filter cloth and the filtrate was collected in a filtration flask and was observed to be clear while the residue.Finally the refined lube oil obtained for analysis. Calculate the % yield of treated oil with acids.

4.2 Regeneration of Used Oil by using Solvent Extraction

4.2.1 Materials

1. Solvent MEK (Methyl Ethyl Ketone)
2. Filter Cloth
3. Activated Charcoal

4.2.2 Experimental Procedure

1. Filtration

Take 1L Used lubricating Oil and Filter it by using filter cloth to remove impurities such as sand, metal chips, micro impurities that contaminated lube oil.

2. Choice of Solvent

The choice was due to the difficulties in recovery of this solvent again that results in great lose in solvent which leads to high cost. The MEK low boiling point and low cost and the solvent was of analytical grade. The dehydrated oil was subjected to solvent extraction at 25 oC and atmospheric pressure.

3. Mixing

Take solvent to oil ratio 2:1, 3:1 and 4:1 and mixed it in used lube oil by continuous stirring up to 10 min. The extraction of dehydrated oil by MEK solvent to oil ratio lower than 5:1 leads to dissolution of some contaminants forming material which was considered to be undesirable.

4. Extraction

Take mixture of oil and solvent in the separating funnel and allowed to settle for 24 hrs. After settling shows the two separate phases one containing oil-solvent phase md another containing impurities or sludge. Sludge removed from bottom of separating funnel and after that oil-solvent phase removed.

Effect of Settling Time - Amount of sludge removal increases by increasing settling time. Rate of settling was maximum during initial 12 hours. However it continued up to 24 hours. Impurities aggregate and form sludge which sediments out.

5. Separation oil and solvent by distillation

The solvent was as the MEK can recovered by distillation B.P. 80 ^{O}C. Solvent removed from the top of distillation column which is condensed in condenser and can be recycle for extraction. Oil to be recover from the bottom of distillation column.

6. Removal of Color and Impurities

With the help of activated charcoal some impurities and color can be removed from the regenerated oil. Calculate the yield of oil and also calculating the various properties of oil like density, Specific gravity and Viscosity of Oil.

5. RESULTS AND DISCUSSION

5.1 Regeneration of Used Lube Oil by using Different Acid

4.1.1 Materials

1. 98% Sulphuric Acid (H_2SO_4)
2. 93% Nitric Acid (HNO_3)
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3. Sedimentation

The oil samples were measured into a separating funnel and acids sludge was discharged at the bottom of the separating funnel and allowed to settle 4 hours to form sediment at the bottom of the beaker. The acidic-oil was properly sedimented and decanted into another beaker while the residue (acidic sludge) at the bottom of the beaker was discarded.

4. Neutralization

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6. Sedimentation /Decantation

In this stage the oil was allowed to sediment in the beaker for 4 hours and was decanted into another beaker while the residue at the bottom of the beaker was discarded.

7. Filtration

The sedimented oil was finally filtered using a filter cloth and the filtrate was collected in a filtration flask and was observed to be clear while the residue (filter cake). Finally the refined lube oil obtained for analysis. Calculate the % yield of treated oil with different acids.

4.2 Regeneration of Used Oil by using Solvent Extraction

4.2.1 Materials

1. Solvent MEK (Methyl Ethyl Ketone)

2. Filter Cloth

3. Activated Charcoal

4.2.2 Experimental Procedure

1. Choice of Solvent

The choice was due to the difficulties in recovery of this solvent again that results in great lose in solvent which leads to high cost. The MEK low boiling point and low cost and the solvent was of analytical grade. The dehydrated oil was subjected to solvent extraction at 25 oC and atmospheric pressure.

2. Filtration

Take 1L Used lubricating Oil and Filter it by using filter cloth to remove impurities such as sand, metal chips, micro impurities that contaminated lube oil.

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Effect of Settling Time - Amount of sludge removal increases by increasing settling time. Rate of settling was maximum during initial 12 hours. However it continued up to 24 hours. Impurities aggregate and form sludge which sediments out.

5. Separation oil and solvent by distillation

The solvent was as the MEK can recovered by distillation B.P. 80 ^{O}C. Solvent removed from the top of distillation column which is condensed in condenser and can be recycle for extraction. Oil to be recover from the bottom of distillation column.

6. Removal of Color and Impurities

With the help of activated charcoal some impurities and color can be removed from the regenerated oil. Calculate the yield of oil and also calculating the various properties of oil like density, Specific gravity and Viscosity of Oil.

RESULTS AND DISCUSSION

5.1 Analysis of Various Properties of Regenerated Lube oil

5.1.1 Density of Oil

Density of a substance is equal to the mass of a substance divided by the volume of the substance. The temperature at which the density is been measured must be known for density changes as temperature changes.

Density = Mass of oil / Volume of oil

5.1.2 Specific Gravity

Specific gravity is the ratio of the density of the material to density of the equal volume of water. Specific gravity can be calculated by using specific gravity bottle.

5.1.3 Viscosity

A decrease in the viscosity of engine oil indicates that the oil is contaminated. Lubrication oils are identified by the Society of Automotive Engineers (SAE) number. The greater or higher the SAE viscosity number and the heavier or more viscous the lubricating oil. 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. As the temperature increase viscosity decrease. Viscosity can calculated using viscometer.

5.2 % Yield of Regenerated Used Oil

Yield of oil that produce from the used oil is depends on the value or amount of used oil feed. Yield of oil can be calculated by using amount of oil produce from the used lube oil and total amount of oil and sludge produce after dehydration of the both sludge and oil. With dehydration water removal from the oil and sludge.

5.2.1 % Yield of oil

% Yield of oil = [Amount or Weight of oil produce / Amount of Total Product] * 100

(Weight of Total Product = Oil + Sludge)

1. % Yield by using H_2SO_4 = 80 - 85%
2. % Yield by Using HNO_3 = 70 - 75%
3. %Yield by Using Solvent Extraction= 85 - 90%

5.3 Properties of Fresh and Used Oil

Sr. No.	Properties	Fresh Oil (4T-20W40)	Used Lube Oil
01	Density (Kg/m^3)	950	860
02	Viscosity @ 40 ^oC(cP)	58	32
03	Specific Gravity	0.95	0.860

Table No.5.1 Properties of Fresh and Used Oil

5.4 Properties of Regenerated Oil

Sr. No.	Method Use	Density (Kg/m^3)	Viscosity @40^oC(cp)	% Yield
01	Treatment 98% H_2SO_4	850	52	80 - 85%
02	Treatment 93% HNO_3	830	44	70 - 75%
03	Solvent Extraction MEK	870	54	85 - 90%

Table No.5.2 Properties of Regenerated Oil

CONCLUSION

Sulphuric acid yields 80 - 85 % while Nitric acid yield 70 - 75%. Nitric acid can be used in place of Sulphuric acid and has proved to yield about 75% since cost less to obtain used oil. Recycle of oil is economical process and reduce the environmental pollution produce from the used lube oil. Different acids followed by adsorption with activated charcoal method requires Low overall cost, low energy and less retention time. From the experimental analysis of different acids the Sulphuric acids have high yield compares with Nitric acid and hydrochloric acid.Regenerated of used oil with solvent extraction by using MEK as solvent

shows the yield up to 90% which is more than the oil regenerated from the different acid. In the solvent extraction we need separate column for solvent recovery. But according to Yield and the quality of regenerated oil is better than the acid treated used oil. Selected solvent has lower B. P. hence, it can easily separate and can recycle to the system. Solvent treated process produce less sludge comparative with acid treated process.That will be reduce the degree and nature of contamination, environmental/health risks associated with disposal. With help of Activated charcoal we can removes the various impurities presents in the recycled used oil by using different acids. The major drawback to the acid/clay method is the difficulty of removal of the clay sludge.

SCOPE AND BENEFITS

1. Recycle or Reuse of oil can reduce cost of oil.
2. This process reduce environmental pollution produce due to used oil mixed with soil and water.
3. Recycle can produce the oil which id equal or better than the virgin oil.
4. Recycle is cost saving and beneficial process which produce the low sludge.
5. Recycle helps to complete the demands of lube oil supply.
6. Recycling or reuse of the used lube oil helps to reduce pollution and cost of oil.
7. As per the feature need this process are economical and ecofriendly.
8. The use of this method has increased in developed countries reaching up to 50% of the country's need for lubricating oil.
9. Recycling and re-refining of waste into virgin lubricating oil may be a suitable option for protecting the environment from hazardous waste.
10. Recycling process prevent ground water contamination and pollution.
11. Recycling process reduce treatment cost.

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NOMENCLATURE

AAS - Atomic Absorption Spectrometry

AC – Activated Carbon/ Charcoal

cP – Centi Poise

MEK - Methyl Ethyl Ketone

PSR - Percent Sludge Removal

PDA - Propane De-asphalting Process

POL - Percent Oil Loss

SAE - Society of Automotive Engineers

TAN - The Total Acid Number

TBN - Total Base Number

WEO – Waste Engine Oil