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Recent Methods Available for Re-Refining of Lubricating Oil: A Review

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Abstract: ***Re-refining is the method for recovering a vital resource of mineral base oil, being as good as or better than the original base oil. During normal use, impurities such as dirt, metal scrapings, water or chemicals can get mixed in the oil or be generated due to oxidation. Therefore quality of such oil gradually decreases. Disposing the used oil directly creates dangerous/harmful effects. Re-refining with various processes done in order to overcome with such problems acid/clay treatment, vacuum distillation/clay treatment and solvent extraction/clay treatment done. This processes enhance the viscosity of used oil.***

Keywords: Dehydration, Hydro-treating, Lubricating oil, Re-refining, Vacuum distillation.

I. INTRODUCTION

Lubricating oil is the synthetic oil or petroleum oil consist essentially of complex mixtures of hydrocarbon molecules. They are composed of isoalkane having slightly longer branches and the mono cycloalkanes and mono aromatics which have several short branches on the ring [1]. Lubricating oils are viscous liquid widely used in industry for lubricating moving parts by reducing friction and wear by interposing a thin film of oil between metallic surfaces [7] and improve the efficiency of machinery and for fuel and energy saving [6]. When lubricating oils are used in service, they help to protect rubbing surfaces and promote easier motion of connected parts. In the process, they serve as a medium to remove high build up of temperature on the moving surfaces [1]. During normal use, impurities such as water, dirt, metal scrapings due to engine erosion or chemicals, varnish, etc., can get mixed in with the oil. Also, due to oxidation or thermal degradation, a lot of impurities are generated in lubricating oil, during its application in internal combustion engines. Therefore, the oil quality gradually decreases. Moreover, the metallic scrapings act as catalysts at the high combustion temperature and oxygen vicinity, and produce an asphalt-like sludge which increases the viscosity.

The used oil drained from engines, equipment and machineries contains a very dangerous material which affects the humans and environment too. Disposing the used oil pollutes environment to a great extent. Due to such reasons the disposal and recycling of waste oils become very important. Oil based goods are basically made out of hydrocarbons, for example mixes containing only carbon and hydrogen. The least difficult hydrocarbon particle is methane, CH_4. This essential particle is the fundamental constituent of petroleum gas. It very well may be reached out with the expansion of more carbon and hydrogen molecules, ordinarily shaping into longer chains. Four carbon molecules in a chain shapes butane, one of the fundamental constituents of LPG. The particles may additionally structure side chains off the fundamental chain, or structure into ring structures, for example, the benzene ring. Greasing up oils are only expansions of these fundamental hydrocarbon structures, containing from 20 to 70 carbon particles for every atom, frequently in an incredibly mind boggling game plan of straight chains, side chains and five and six membered ring structures.

II. RE-REFINING METHODS FOR USED OIL

A. Acid Clay Treatment

In acid clay process, used oil is typically filtered and then heated to remove debris, solid particles and water. In this process, the waste oil is treated with sulfuric acid. Sulphuric acid is a poly functional mineral acid which can act both as a sulphonating and an oxidizing agent. It can also act as a catalyst for some polymerization reaction of unsaturated hydrocarbons hence treatment of the used oil with sulphuric acid results sulphonation and oxidation of the degraded products [5]. This acid reacts conversely with oxygen compounds and some sulfur- and nitrogen-based compounds to form sludge. Further refining is done in order to remove unsaturated hydrocarbons. Even after refining, there would be still some color and odor present in the oil which is later removed by treatment with activated clay. This process requires approximately 0.4 lb of clay per gallon of oil. After clay is filtered from the oil, the final steps are neutralization and distillation of the oil if the raw material contains more than one grade of lube oil.The below fig.1 explain the acid clay treatment process of used oil, the process contain two distillation column in which atmospheric and vacuum distillation is done.It also include settling and filtration process before the distillation process.In the given fig.1,concentrated sulfuric acid is used for acid treatment

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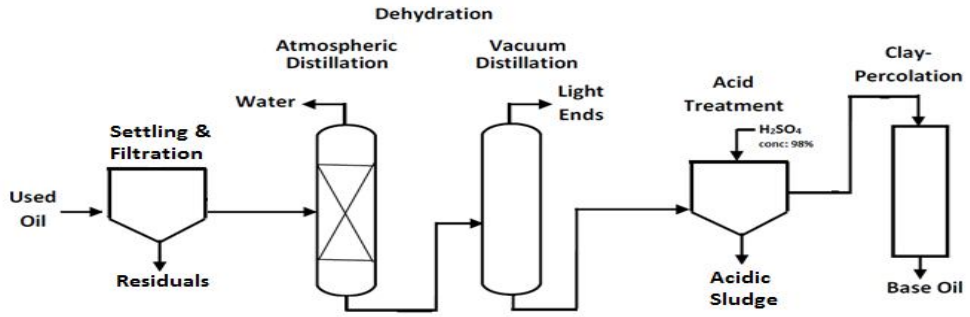

Fig-1 Acid/clay treatment process flow diagram

B. Vacuum Distillation Method

1) *Dehydration*: It is also called atmospheric distillation. Principle of vacuum distillation process is to drown out the atmospheric air from the apparatus to distil [8]. In this step water and light contaminants are removed from the used oil. And then used oil is distilled up to 200^0c and the light hydrocarbons are eliminated by fractionating under vacuum (5 mmHg). The residual fraction over 350^0c obtain. Vacuum distillation: Vacuum distillation: The dehydrated oil obtained is sent directly to a vacuum distillation
2) *Vacuum distillation:* The dehydrated oil obtained is sent to vacuum distillation zone at a temperature of 310ºC under pressure 15 mmHg [8]. The vacuum distillation produces a residue and at least one fraction of distilled oil, the range of the distillate which sent to hydrotreating is from (290 to360)^{0}c.
3) *Hydrotreating:* In this extracted oil feed into a trickle bed reactor in which heterogeneous catalytic processes under pressure occurring in liquid or gaseous phase carried out. The reactor contains catalyst bed of Ni/Mo that supported by silica alumina base. The process take place at the following operating conditions, temperature: 350ºC, pressure: 50 Kg/cm^2 and hydrogen to oil ratio: 300 L/L. Hydrogen gas stream is supplied to the unit from a hydrogen cylinder having a maximum pressure of 120 Kg/cm^2. The unit is first flushed with nitrogen to remove air, and then kept for 4 hours under a hydrogen gas pressure of 100 Kg/cm^2 to check any leakage. The catalyst bed is sulfided. The liquid feed and the hydrogen gas streams are injected under pressure at the top of the reactor, both cross the different zones of the reactor in down-flow direction. rectly to hydrotreating is from (270 to 320)ºC.

C. Solvent Extraction

Solvent extraction is used to improve the quality of lube distillate that is produced from a vacuum distillation process. The solvent is used to extract polar compounds, additives and color bodies. It removes the aromatics and increases saturates level.

The solvent extraction is carried out in following steps

1) *Dehydration:* This step in detailed discussed above in vacuum distillation process.
2) *Extraction:* In extraction methyl ethyl ketone (MEK) used as solvent for treatment. The MEK preferred because of their low boiling point, the lowest percent oil losses [4] and low cost. The dehydrated oil of initial boiling point of 320ºC was subjected to solvent extraction at 25ºC and atmospheric pressure, extraction is done in a mixer settler, the temperature of the system is maintained with help of thermostatic bath. Dehydrated oil and solvent are stirred for one hour to ensure proper mixing, and the subjected to sufficient settling. The solution of oil and solvent is separated and made free from any suspended particles by centrifugation. The solvent is recovered by distillation, as the MEK boiling point is 80ºC, to reuse it again.
3) *Hydrotreating:* This step was discussed in the vacuum distillation process.

III. RELATED WORK CARREIED OUT FOR RE-REFINING PROCESS

P. M. James et.al. conducted the study, with used engine oil by vacuum distillation and extraction through additives for the re-refining of the engine oil carried out in four main steps- dehydrating water stripping, fuel stripping, filtration through carbon membrane and liquid extraction to remove the water light fuel resistive aromatics carbon waves and to submit additives to improve the properties of engine oil. Followed by these processes we can obtain the oil having properties similar to that of unused engine oil. The process gave the desired volume of re-refining oil with kinematic viscosity 512.14cst @40^0 having calorific values of 8537.7981 Cal/gm .

Mohammad Shakirullah et.al. in their study, adopted the aluminum sulphate sodium silicate acid base technique and solvent treatment process- CCl4-alcohol method, Dodecane-alcohol method and Toluene-alcohol method for the re-refining of used lubricating oil drained from the automotive engine of Shell Rimula-C (SAE 50) and Castrol GTX (SAE 20W-50) after an engine run of about 2000 km. It was found that effective recovery can be obtain when the used lubricant was mixed with Dodecane Toluene and CCL4 in a ratio of 1:3:3:3. The yield of the process 72% of re-refined neutral lubricating oil base stock with kinematic viscosity 86% cst for aluminum sulphate-sodium silicate acid-base methods, 75% cst for CCl4 alcohol method, 83% cst for Dodecane-alcohol method and 84% for Toluene-alcohol method recovered at 37.8^0c respectively.

H. Bridjanian et.al. made study on modern recovery methods is used oil re- refining, by using the hea3ting the used oil up, vacuum distillation for the separation of gas oil, passing the base oil through a guard bed and hydro-treating of the obtained base oil. In their experiment, a spent middle distillate hydro-cracking catalyst (HC-102) was used. The comparison made between the re-refined oil and SAE30 base lube oils shows that the approximate much similarities, re-refined oil with kinematic viscosity 9.63 c.st @100^0c and viscosity index 92. Moreover, almost no harmful or useless byproduct hydrocarbon is produced via this method.

A Comparative Study of Recycling of Used Engine Oil using extraction by Composite Solvent, Single Solvent, and Acid Treatment Methods carried out by Rashid Abro et.al. They were collected the samples of used engine oil of heavy vehicles, light vehicles and blended oil from transport office. The solvent extraction divided into single solvent and multicomponent solvent and the solvent where recovered by vacuum distillation and then acidified material was neutralized with caustic soda of 20% solution and filtered to remove precipitate in result of neutralization. The filtration gave the clear re-refined useful product oil, where the viscosity values of refined engine oil by composite solvent method, single solvent method and acid treatment are 94cp, 98cp and 92cp respectively at room temperature.

A comparative study of recycling of used lubrication oils using distillation, acid and activated charcoal with clay method was carried out by Udonne J.D. The procedure for the purification of used lubrication oil consists of filtration of the oil before subjected to treatment by collecting 2L of the used lube oil of two samples respectively. The re-refined oil was blended with fresh oil, test showed that viscosity increased from 25.5 for used lube oil to 86.2 for distillation, 89.10 for acid/clay treatment and 80.5 is for activated/clay treatment. This is compared with 92.8 cst for fresh lube oil. Other results from the different tests showed varied degrees of improvement with the best results obtained using the acid/clay treatment.

A comparison of waste lubricating oil treatment techniques were made by Motshumi J. Diphare et.al. with the help of reprocessing, re-refining and incineration of waste lubricating oil. Refining by distillation, reprocessing by simple dehydration/filtration and lastly incineration by burning in furnace. Re-refining of waste oil to manufacture base oil conserves more energy than reprocessing of waste oil for use as a fuel. The comparison shows that re-refining is the most effective technique as it yields oil with viscosity of 85.8 c.st. which is close to 92.8 c.st. that of virgin oil as compared to 80.2c.st. from reprocessing at temperature 38^0c.

IV. CONCLUSION

This paper has given a review that re-refining of lubricating oil is must to prevent environment pollution. The above study discuss different methods of re-refining process. It has been noted that the solvent extraction method is more capable than other types. Thus for future progress in the solvent extraction method, more work will need to be done with better solvent.

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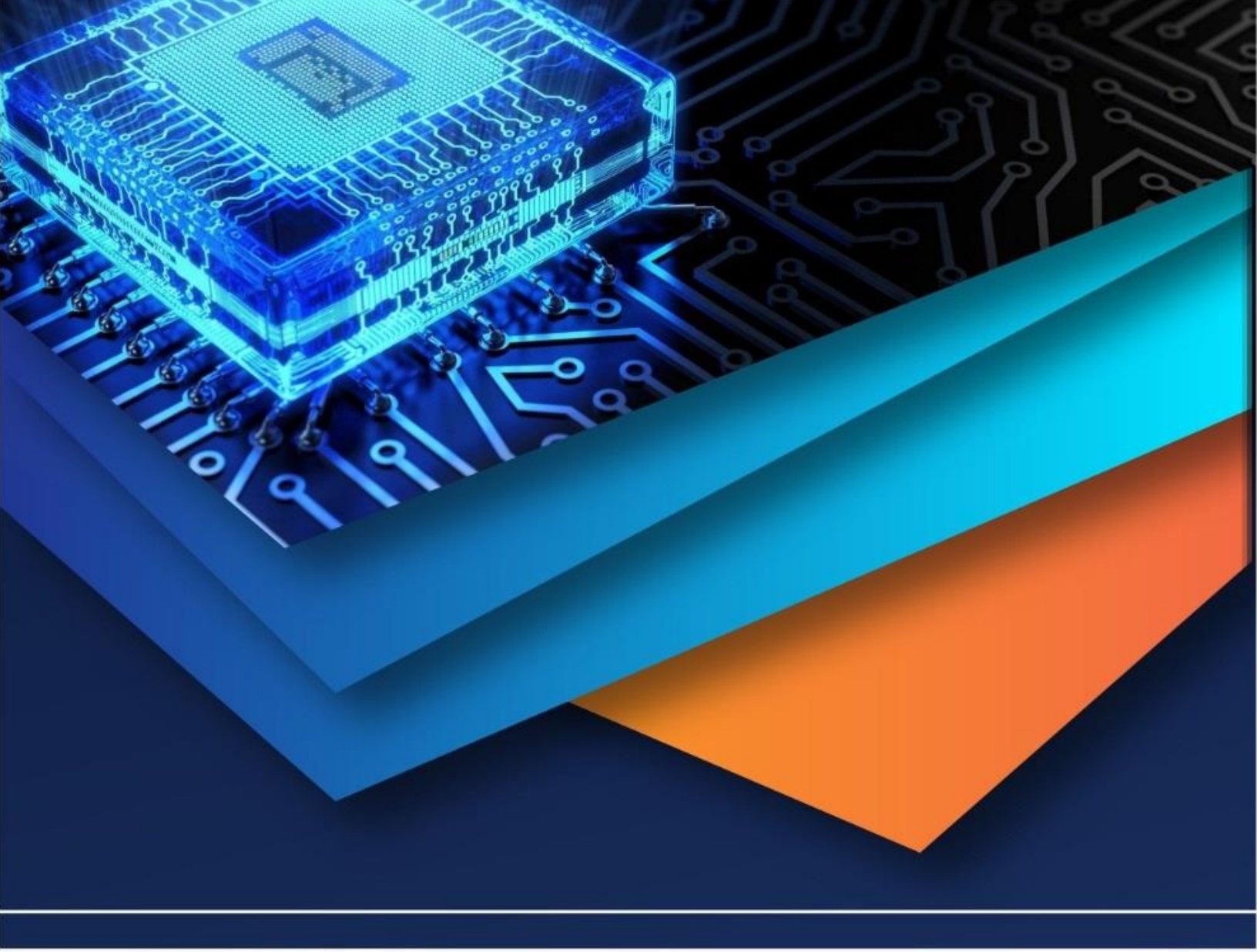

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