Recycling and Improving the Viscosity Index of the Used Lubrication Oil

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Final Year

***Abstract* - Recently much effort has been focused on research and development of new types of lubricating oils to reduce wear, friction and corrosion in various applications. Hence the used oil has been recycled and reused. On the other hand, used oil has been classified as hazardous wastes by the Ministry of Environment and Forests. Government of India which demands its proper management to avoid serious threat to the environment and for economic gains. Used oil could be recovered or reprocessed and reused as base oil thus saving the use of virgin oil. The used oil has been refined and by adding suitable additives, the viscosity index and other properties of the used oil is improved. For the automobiles there is a need for changing the oil frequently, that used oil has been reclaimed and reused for further extent.**

Accordingly, this effort focuses on comparative study of four methods of recycling of used lubrication oils: acid/clay treatment, distillation/clay treatment and acid treatment and activated charcoal/clay treatment methods. Other results from the different tests showed varied degrees of improvement with the best results obtained using the acid treatment. By adding additives like glycerol and silicon polymers the properties of oil has been enhanced and the used oil is further used.

INTRODUCTION

Automotive oil recycling involves the recycling of used oils and the creation of new products from the recycled oils, and includes the recycling of motor oil and hydraulic oil. Oil recycling also benefits the environment increased opportunities for consumers to recycle oil lessens the likelihood of used oil being dumped on lands and in waterways. For example, one gallon of motor oil dumped into waterways has the potential to pollute one million gallons of water.

Recycled motor oil can be combusted as fuel, usually in plant boilers, space heaters, or industrial heating applications such as blast furnaces and cement kilns. Recycled motor oil can be distilled into diesel fuel or marine fuel in a process similar to oil re-refining, but without the final hydro treating process. The lubrication properties of motor oil persist, even in used oil, and it can be recycled indefinitely.

Used oil re-refining is the process of restoring used oil to new oil by removing chemical impurities, heavy metals and dirt. Used Industrial and automotive oil is recycled at re-refineries. The used oil is first tested to determine suitability for re-refining, after which it is dehydrated and the water distillate is treated before being released into the environment. Dehydrating also removes the residual light fuel that can be used to power the refinery, and additionally captures ethylene glycol for re-use in recycled antifreeze. Next, industrial fuel is separated out of the used oil then vacuum distillation removes the lube cut (that is, the fraction suitable for reuse as lubricating oil) leaving a heavy oil that contains the used oil's additives and other by-products such as asphalt extender. The lube cut next undergoes hydro treating, or catalytic hydrogenation to remove residual polymers and other chemical compounds, and saturate carbon chains with hydrogen for greater stability.

Final oil separation, or fractionating, separates the oil into three different oil grades: Light viscosity lubricants suitable for general lubricant applications, low viscosity lubricants for automotive and industrial applications, and high viscosity lubricants for heavy-duty applications. The oil that is produced in this step is referred to as re-refined base oil (RRBL).

The final step is blending additives into these three grades of oil products to produce final products with the right detergent and anti-friction qualities. Then each product is tested again for quality and purity before being released for sale to the public.

WORKING TECHNIQUES

This paper presents the brief explanation about the refining of the used oil and the improvisation of viscosity using additives. Waste engine oil is a high pollutant material that requires responsible management. Waste engine oil may cause damage to the environment when dumped into the ground or into water streams including sewers. This may result in groundwater and soil contamination. Recycling of such contaminated materials will be beneficial in reducing engine oil costs. In addition, it will have a significant positive impact on the environment. The conventional methods of recycling of waste engine oil either requires a high cost technology such as vacuum distillation.

FILTERATION

In the used hydraulic oil, impurities present may be physical or chemical. The properties of the oil is deteriorated due to the continuous usage. The physical impurity is wearer metallic parts and other impurities like water contamination, Sulphur content etc.

The first stage of filtration is removing the iron wear particles. For that the neodymium magnet is used. The magnetic power of the neodymium magnet is very high and the magnetic field is too strong. Hence it has an enough power to remove the small iron wear particles. The neodymium ball is allowed to roll inside the used oil container for about quarter hour, the small iron particles gets attracted towards the magnet. After that the magnet is removed and found the wear particles adhere the surface the magnet.

The next stage of filtration is removing micron level impurities by using the micron level pore filter. For that the simple filter that we use is the normal tissue paper. The four layer of the tissue paper is the good filter for the filtration process. The four layer of tissues give a very minute pore to allow only the fluid and to restrict the impurities. Again the oil is allowed to filter in the oil filter that uses in the compressor. This filtration process removes the physical impurities present in the used oil.

The final stage of refining is the solvent dissolving method in which the chemicals are used to remove the chemical impurities as sludge. Solvent extraction has replaced acid treatment as the method of choice for improving the oxidative stability and viscosity/temperature characteristics of base oils. The solvent selectively dissolves the undesired aromatic components (the extract), leaving the desirable saturated components. The solvent used is glacial acetic acid as it changes the color and removes impurities as a sludge in the bottom layer of the oil.

Fig: Continuous stirrer process

COLOR

Different categories of the hydraulic oil were pictured to show the color changes that the oil went through during the process. As shown in Figure 6.2, the base oil (column 9) has changed color and become highly opaque (column 6) due to the vigorous reaction with sulfuric acid. In contrast, the base oil did not show any change in color when mixed with acetic acid (column 7) due to its low

Reactivity of acetic acid with the base oil. The acetic acid has shown a high reactivity with the contaminants in the used oil, and columns 5 and 8 show the base oil results from treatment with sulfuric acid and acetic acid, respectively. It is obvious that the base oil resulting from acetic acid treatment is brighter and has a clear yellowish color.

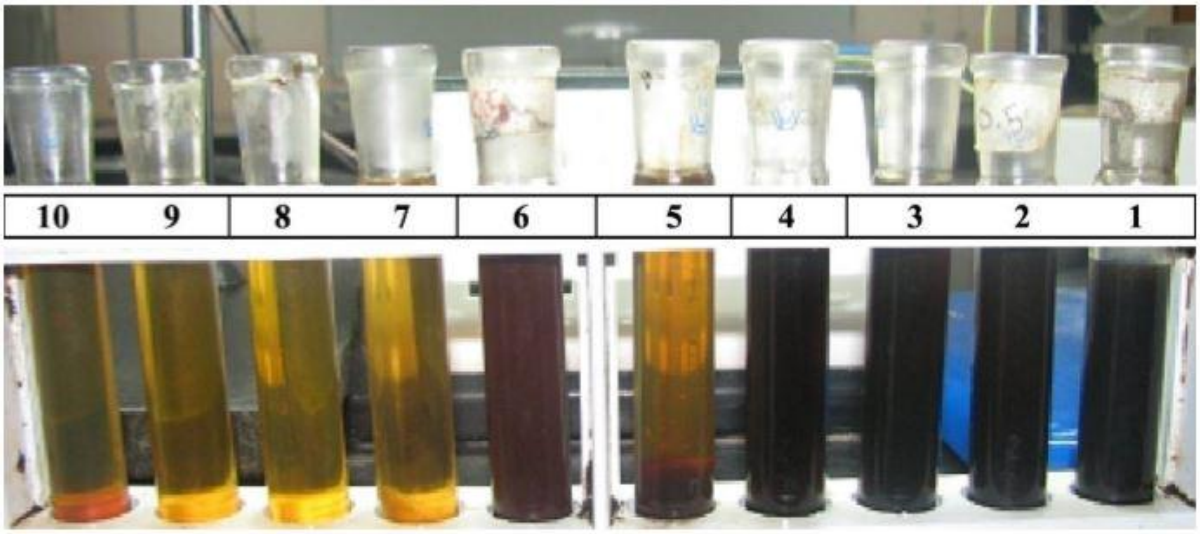

Fig: Color changes of various samples

The change in color shows the purity otherwise called as removal of impurities in the form of sludge. The results shows that acetic acid highly reacts with the used oil and removes the impurity.

Table: Metal content of different samples

No.	Samples	Cu (ppm)	Mg (ppm)	Cr (ppm)	Sn (ppm)	Pb (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cd (ppm)
1	Base engine oil (Ravenol, VSi SAE 5W-40)	0	72	0	0	0	0	1200	0	0
2	Marketed engine oil. Recycled from used engine oil by professional recycling companies using acid (H_2SO_4) clay method after adding the required additives	0	68	0	0	0	0	1050	0	0
3	Used engine oil (being in use for 2000–3000 km)	4.6	81	1.5	1.6	14.6	72	1280	1.5	1
4	Oil resulting from recycling the used engine oil by acetic acid (adding CH_3COOH + mixing + clay treatment + centrifugation) + vacuum distillation	0.4	0.8	0.2	0.2	0.4	0	41	0	0
5	Oil resulting from recycling the used engine oil by acetic acid (adding CH_3COOH + mixing + clay treatment + centrifugation)	1.6	3.2	0.7	0.7	3.2	3.2	81.6	0.5	0.4
6	Oil resulting from recycling the used engine oil by sulfuric acid (adding H_2So_4 + mixing + clay treatment + centrifugation)	0.9	2	0.4	0.6	4.5	1.2	54	0.2	0.1

DEHYDRATION

The oil is heated to 130°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. Higher the temperature, higher is the saturation point and hence more water held in solution, in the dissolved phase. Similarly, older the oil, higher is the level of water that can be dissolved. Water is a generator of other contaminants in the oil such as waxes, suspensions, carbon and oxide insoluble and even microorganisms, so it is removed by dehydration

ADDITIVES ADDED

Zinc Dialkyl Dithiosulphate is the common additive added to the lubricating oil. Methyl Ethyl Ketone (MEK) is a selective aromatic solvent employed in the solvent extraction process. The lubricating oil obtained by vacuum distillation 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 80oC 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 that of the base lubricating oil.

In this paper we use a water glycol as an additive which is easily available. The glycol has a good viscous property as it enhance the viscosity index. Glycol (IUPAC name: ethane-1, 2-diol) is an organic compound with the formula $(CH_2OH)_2$. It is an odorless, colorless, sweet-tasting syrup. This type consists of an actual solution of 40% water and 60% glycol. These solutions have high-viscosity-index values, but as the viscosity rises, the water evaporates. The operating temperature ranges run from −20°C to about 85°C. Hence the water glycol is so thick the mixture ratio is 10:1 of oil and glycol is used. The viscosity index increases tremendously by addition of water glycol.

CONCLUSION

Recycling of waste lubricants could result in both environmental and economic benefits. Re-refining of waste oil to manufacture base oil conserves more energy than reprocessing the waste oil for use as a fuel. The energy required to manufacture re-refined oil from used oil is only one-third of the energy required to refine crude oil to produce virgin base oil. Therefore, re-refining is considered by many as a preferred option in terms of conserving resources, as well as minimizing waste and reducing damage to the environment.

The management of used oil is particularly important because of the large quantities generated globally, the potential for direct re-use, reprocessing, regeneration and detrimental effects on the environment if not properly handled, treated or disposed off. Though dirty, used oil still contains the same properties that make it a valuable lubricant as well as an ideal product for recycling. Three different oil treatment technologies were studied and evaluated environmentally and economically.