INNOVATIVE TECHNOLOGY FOR CLEANING USED MOTOR OILS

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Abstract. *The advantage of using the acetic acid is that it does not react or only reacts slightly with base oils. The recycling process takes place at room temperature. It has been shown that base oils and oils' additives are slightly affected by the acetic acid. Upon adding 0.8 vol% of 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 this paper.*

Keywords: *waste recycling; waste engine oils; engine oils.*

INTRODUCTION

The conventional methods of recycling of waste engine oil either requires a high cost technology such as vacuum distillation or the use of toxic materials such as sulfuric acid. These methods also produce contaminating by-products which have highly sulfur levels, especially in the Kurdistan region/Iraq. Lubricant oils have been used primarily for reducing friction between moving parts of various machinery or equipment, minimize material wear, improve the efficiency of equipment /machinery and for fuel and energy savings. Access to lubricants is essential to any modern society and not only does lubrication reduce friction and wear by interposition of a thin liquid film between moving surfaces, but it also removes heat, keeps equipment clean, and prevents corrosion. One of its important applications includes gasoline and diesel engine oils [1].

MATERIALS AND METHODS

A recommended solution for this issue is the recovery of the lubricating oil from the waste oil. Recycling processes using nontoxic and cost effective materials

can be an optimum solution. Acid-clay has been used as a recycling method for used engine oil for a long time. This method has many disadvantages; it also produces large quantity of pollutants, is unable to treat modern multigrade oils and it is difficult to remove asphaltic impurities [2]. 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, especially alkanes, as a separate phase (the raffinate) [3]. In one study [4] a mixture of methyl ethyl ketone (MEK) and 2-propanol was used as an extracting material for recycling used engine oils. Although the oil resulting from this process is comparable to that produced by the acid-clay method, its cost is high.

RESULTS AND DISCUSSION

Vacuum distillation and hydrogenation are two other methods that can be used for recycling used engine oil [2]. The Kinetics Technology International (KTI) process is a combination of vacuum distillation and hydrofinishing. This method removes most of the contaminants from the waste oil. The process starts with atmospheric distillation to eliminate water and light hydrocarbons. This is then followed by vacuum distillation at a temperature of 250 °C. The final stage is hydrogenation of the products to eliminate the sulphur, nitrogen and oxygenated compounds. This stage is also used to improve the color and odor of the oil. The product can be of quality standard (Gp.I) with a yield of approximately 82% and minimized polluting by-products. The disadvantage of this method is the high investment cost [2].

In this research glacial acetic acid was used for recycling used engine oils. The method provides a lower cost process in comparison with the conventional methods due to the low cost of the acid and the moderate conditions of the process. The recycled oil obtained by this method has been shown to have potential for reuse as an engine lubricant.

For the purpose of this study a series of experiments have been carried out for two kinds of collected oils. The oils were collected from car oil change shops and

from personal cars after 3000 to 3500 km in use. The type of base oil used in this study is Ravenol (VSi SAE 5W-40), manufactured in Werther, Germany. In order to confirm the ability of glacial acetic acid to separate the base oil from the contaminated substances many random experiments were carried out. The first experiment was carried out with the oils collected from the shops. The oil was heated to a temperature of over 250 °C for one hour, for the purpose of evaporating the water and the volatile substances in the used oil. This is to mimic the procedure used by the acid-clay method. The oil was then cooled to room temperature (16 °C, winter) and then equal amounts of this oil (10 mL) were added to a number of beakers. Different quantities of glacial acetic acid were then added to the used oils in the beakers. The amounts of the acid added were 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, and 2 mL to each 10 mL sample. These samples then mixed at 600 rpm for half hour and heated on a hot plate stirrer (LabTech, ES35A-Pro) to a temperature of 25 °C. The beakers were open to the atmosphere. Then the oils resulting from the stirring and heating were centrifuged (Sigma, 2-6E, Sigma Laborzentrifugen GmbH, Osterode am Harz, Germany) immediately for a quarter hour at a speed of 3000 rpm. No separation was observed after this process, besides the absence of change in the treated used oil color. This may be due to the heating which may result in evaporation of acetic acid. This may also be due to the low period of interaction between the acid with the used oil.

The third experiment was undertaken using covered beakers and the mixing process was performed for one hour at room temperature. The mixture was then left at room temperature for 24 hours before being placed in the centrifuge. Two layers were separated, a clear reddish lubricant oil layer and sludge at the bottom of the test tube. The lube oil separated from the sludge easily because the sludge was concentrated at the end of the test tubes. Both the lube oil and the sludge were weighed. In order to measure the weight of the sludge, the test tube was heated and then the sludge was removed from the tube using pieces of cotton. The cotton has been weighed in advance and the cotton with the sludge was dried in an oven (Memmert, UF110, Schwabach, Germany) at 50 °C for 24 hours. After drying, the

weight of the sludge was confirmed to be 0.2 to 0.4 gm/10 gm sample of the used oil. The balance used in weighing is from Denver Instrument (Denver, S/SI-603, Denver, CO, USA).

The results indicated that the amount of sludge increased as the amount of acid added to the samples increased, up to a certain limit. Up to the 1.0 mL acid added/10 mL used oil the sludge collected was black in color, rigid and compacted in a small area in the bottom of the test tube after the centrifugation process. The sludge changed significantly after increasing the acid volume above

1.0 mL/10 mL used oil. The sludge became more like an emulsion and yellow in color, and it also occupied a quarter of the test tube. The experiments done with the first kind of the lubricant oil (the oil collected from the shops) were repeated for the second kind, personal cars lubricant oils of the Ravenol brand (VSi SAE 5W-40) collected after being in use for 3000 to 3500 km. The treatment procedure performed was similar to that applied for the oil collected from the shops. The experiments carried out using the used oil from personal cars gave better results regarding the clarity compared to the treated used oil collected from the oil-change shops.

CONCLUSION

This research has shown that used engine oil can be recycled by using glacial acetic acid. This method produces base oil comparable to that produced using conventional methods. Optimum conditions for recycling used engine oil using this method are room temperature and atmospheric pressure. The process for recycling is simple, as it only requires mixing at room temperature, settling, centrifugation and finally mixing with kaolinate. The base oil produced by the glacial acetic acid method is of comparable quality to that produced by the acid-clay method. Also, it has a potential to be reused in cars' engines after adding the required additives. The glacial acetic acid has shown almost no reaction with base oils, in contrast to sulfuric acid, however it reacted vigorously with the used oil. This clearly indicates that acetic acid is not affecting the original structure of the oil. Furthermore, this is most advantageous of using acetic acid in recycling of used oil.

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