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COMPARATIVE STUDY OF THE DIFFERENT METHODS OF PURIFYING USED MOBIL OIL USING DIFFERENT ACIDS AS WASHING AGENTS

[1]F. O. UGWELE, [2]T. O. CHIME

Department of Chemical Engineering, Enugu State University of Science and Technology

Abstract: **This research studied the purification of used mobil oil by acid/clay, acid/charcoal and acid/clay/charcoal methods; and each method used three different acids (sulfuric acid, hydrochloric acid and acetic acid) as washing agents respectively. Both used and purified oil samples were characterized to determine their physicochemical properties for easy comparison with those of the fresh and standard oils respectively. The results obtained indicated that during usage, properties of fresh mobil oil such as specific gravity and sulphur content increase while viscosity, flash point and fire point decrease. The deviation of these properties from normal revealed that the oil got contaminated with worn out metal parts, dust particles and other impurities during use; which meant while the lubricating property of used mobil oil decreases, its polluting effect or ability increases. The purification processes using any of the methods was successful in recycling the used oil as indicated by the fact that the physicochemical properties of purified mobil oil tends to be closer to those of the fresh oils. The effectiveness of all the methods was compared and it showed that acid/clay method using sulfuric acid is both the best method and acid; since it gave the most acceptable purified mobil oil.**

Keywords: **Lubricating oil, Mobil oil, Purification, Acid/clay method, Sulfuric acid.**

1. INTRODUCTION

Crude oil is a naturally occurring complex mixture from which many components called 'fractions' could be obtained by a process called "fractional distillation." Lubricating or engine oil is the most crucial fraction of crude oil because it is applied in all engines, vehicles, machines and automobiles (Doaa et al., 2017). They are viscous liquids used for lubrication of moving parts of various combustion engines, automobiles and machines (Benito et al., 2002); in order to reduce friction between moving and connected parts, protect rubbing surfaces against wear, minimize temperature build up on the moving parts, prevents corrosion and keep the engines neat, cool and active (Udonne 2011; Ogbeide 2011). However, during the operation of engines, the temperature of oil increases beyond normal, and this degrades the oils; Moreover, dirt particles, contaminants from the surrounding air and worn out metal parts from the surface of the engines are deposited into these oils. All these are capable of causing the oils to lose their vital lubricating properties, making them unsuitable for further use as well as increasing their chances of polluting the environment when spilled in the floor (Hamad et al., 2005; Jha, 2005; Isah et al., 2013). Thus, the major differences between fresh and used engine oils arise from the contamination of the fresh oil during application since oil hardly wears out but only gets contaminated after use. Houssien et al. (2013) has opined that the chemical composition of lubricating oils is always preserved for a long time due to high chemical stability of the heavy compounds contained in the oil. The base oil left behind after a fresh lubricating has been used in engines and automobiles is known as used engine oil. These used engine oils are characterised by the presence of high impurities and contaminants and therefore can cause serious environmental hazards if carelessly disposed in the environment. It is considered a source of environmental pollution. It can pollute the streams, groundwater,

lakes, rivers and oceans; leading to death of aquatic organisms and unavailability of good water for drinking and other purposes. Used engine oil is among the most available liquid waste in Nigeria that should be regenerated for possible re-use and to reduce environmental hazards. Waste oil can be a very valuable resource especially with the increasing advancement in technology and growth of industrial sector in the country. There is need to regenerate the oil by purifying using adequate purification processes. To regenerate used oils simply means to remove unwanted materials to make them pollution free and to increase their usefulness. Recycling of used oils is not a new idea; it dates back to 1930 (Emam and Shoaib, 2013). Regeneration of used oil is important because it guards against the environment pollution which may have resulted from disposing the oil, minimizes cost of engine oils, ensures the sustainability and availability of engine oil since fossil fuels and crude oil reserves are rapidly depleting. In this research, acid refining method, using three different acids as washing agents, were used in purifying used Mobil engine oils. The performances of the acids used were evaluated and the physicochemical properties of the different samples of the purified mobil oils using different methods were compared to determine both the best method and washing agents respectively.

2. MATERIALS AND METHODS

2.1 Materials:

Used mobil oil collected from mechanic workshop at Nsukka, cotton wool, sulphuric acid, hydrochloric acid, acetic acid, sodium hydroxide, activated clay, activated charcoal, distilled water.

2.2 Methods:

Different samples of used mobil oil were purified using three different methods with three different acids. The three methods used are: Acid/clay method, Acid/charcoal method and Acid/Clay/charcoal method. Each method applied sulphuric acid, hydrochloric acid and acetic acid respectively as washing agents. The following are the purification steps undergone by each method:

2.2.1 Treatment of acid

300ml of used mobil oil was measured into a 500ml of beaker using a measuring cylinder. Then 30 ml of each acid was poured separately into a 50ml beaker. The regulator hot plate was switched on and the 300ml of used mobil oil in the beaker was placed on top. The used engine oil was heated for about 5minutes and temperature until 45-50^{o}C was attained; after which each acid was gently poured and the whole continuously mixture stirred for 10 minutes.

2.2.2 Sedimentation/Decantation

At the end of the acid treatment step, the acidic oil was allowed to settle 24 hours to form sediment at the bottom of the beaker. After this period, the acidic-oil mixture was properly decanted into another 500 ml beaker using a piece of cloth while the residue (acidic sludge) at the bottom of the beaker was discarded.

2.2.3 Bleaching

The oil was kept in an electric oven and the temperature was maintained at 100-110^{o}C. Then 20g of activated clay was added into the oil; and the mixture was carefully and stirred constantly for 10minutes. The bleached oil's pH was determined using the pH meter. After this, the bleached oil was subjected to neutralization.

2.2.4 Neutralization

The neutralization was achieved by adding 100ml of the solution of 15% Caustic soda (NaOH) to the bleached oil contained in the beaker. The mixture was continuously stirred for 10 minutes. Then the neutralized oil was allowed to settle for 24 hrs in a beaker without agitation; after which it was decanted into another beaker while the residue at the bottom of the beaker was discarded. Also the pH of the decanted oil was taken and noted to check if neutralization was completed.

2.2.5 Filtration

The sedimented oil was finally filtered using a filter cloth and the filtrated oil was collected in a filtration flash and was noted to be clear, while the residue was discarded.

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3. RESULTS AND DISCUSSIONS

3.1 Characterization of fresh, used and purified mobil oils.

The physicochemical properties such as specific gravity, viscosity, flash point, fire point and sulphur content of the fresh, used and purified mobil oils were determined and compared. Any slight changes in the physicochemical properties are indications of changes in the lubricating properties of the oils. Normally, the specific gravity and sulphur content of the used mobil oil tend to be higher due to deposition of combustion product such as water, fuel, wear metal, dust particles and oxidation product during usage; while viscosity, flash point and fire point of the used mobil oil tend to reduce.

Specific gravity:

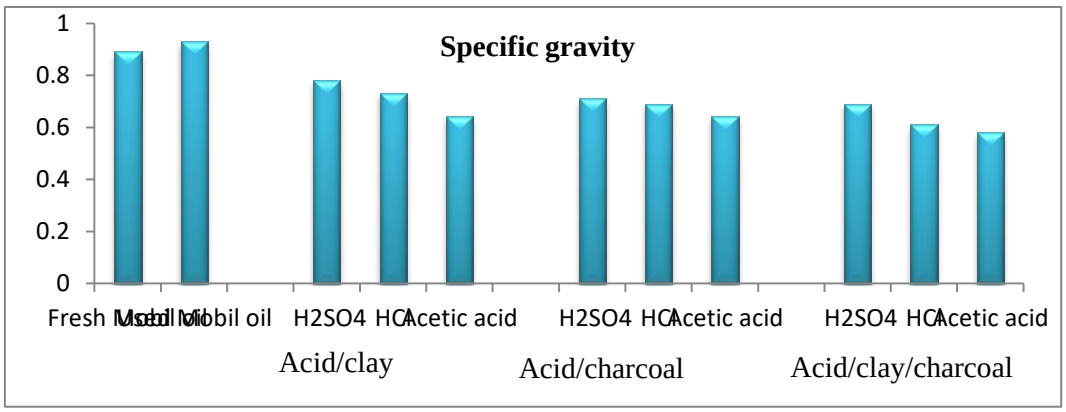

Fig 1: Specific gravity of fresh, used and purified Mobil oil samples obtained by different purification methods

Density of a substance depends on a number of factors such as changes in temperature, presence of impurities mainly aromatic compounds, etc. Density decreases as temperature increases and increases as the impurity of the material increases. For the engine oil, an increase in the amount of aromatic compounds in the oil would lead to an increase in its density and hence specific gravity. In similar way, presence of saturated materials in oil would result to a lower specific gravity. Thus, used engine oil could have lower or higher density depending on the nature of contamination. Figure 1 shows that the specific gravity of the oil increases during usage but decreases during purification. According to Udonne (2011), used engine oils have higher specific gravities because of the deposition of impurities such as metals and degraded products during usage. The specific gravity of the purified mobil oil is lower than that of the used mobil oil because of the removal of most the contaminants in the oils during purification.

Sulphur content:

Sulphur analysis test was carried to determine the sulphur content of the used and purified mobil oils as shown in Figure 2.

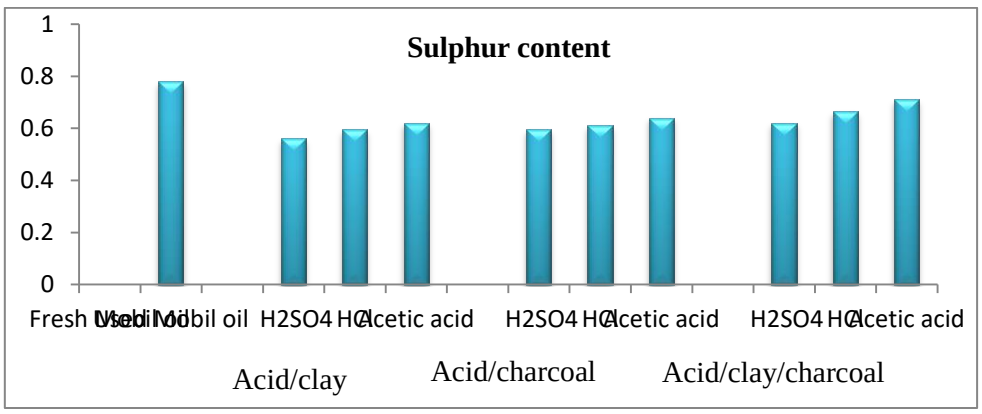

Fig 2: Sulphur content of used and purified Mobil oil samples obtained by different purification methods

As noted earlier, used mobil oil has high sulphur content. This could be attributed to the presence of wear between the moving parts of the engine or machine (Udonne, 2011). Sulfur reacts with the metal to form compounds of low melting point. Corrosion in engines is caused by mineral acids formed by the oxidation of sulphur compounds in fuel in internal combustion engines with refined oils; those hydrocarbons that were inherently unstable will have been oxidized during use (Rincon, 2005). On treatment, the sulphur content of the oils reduces due to the reduction of the wear. Thus, all the purified oils have lower sulphur contents than their corresponding used oil. However, used mobil oil purified using sulfuric acid has the lowest sulphur content.

Viscosity:

The viscosities of the fresh, used and purified mobil oils were determined using viscometer.

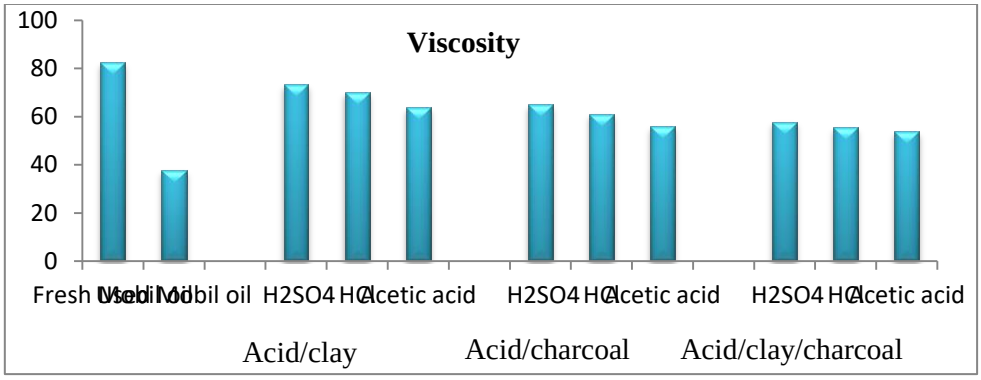

Fig 3: Viscosity of fresh, used and purified Mobil oil samples obtained by different purification methods

Viscosity, as the most important property to be considered in lubricating oil, is a state function of density, temperature and pressure (Abu-Elella et al., 2015). Eman et al. (2012) noted that viscosity is proportional to the strength of the oil film.

Figure 3 reveal that the viscosity of the used engine oils is far lower than that of their corresponding fresh oils. This could be due dilution with light fuel (Ajemba, 2012). Isah et al. (2013) also suggested that apart from the effect of dilution with light fuel, the decrease in viscosity of the used oils may also be attributed to the degradation or thermal cracking of the fresh oils during application. In addition, the fact that the oil gets heated up during use could lead to reduction in viscosity since it is inversely proportional to temperature. Figure 3 also indicated that the viscosity of the mobil oil increased during purification. The higher viscosity in purified oils is also an indication that the purification processes tend to restore the properties of the oils. Thus, the purified oils have higher viscosity than the used oils due to the fact that the arrangement of molecules is unperturbed because of chemical treatment and filtration (Isah et al., 2013). Also, according to Abu-Elella et al. (2015), this could be due to the conversion of the impurities in the used oils by the acids, and further removal by filtration. Finally, purified mobil oil using acid/clay method with H_2SO_4 as a washing agent has advantage over other methods.

Flash point:

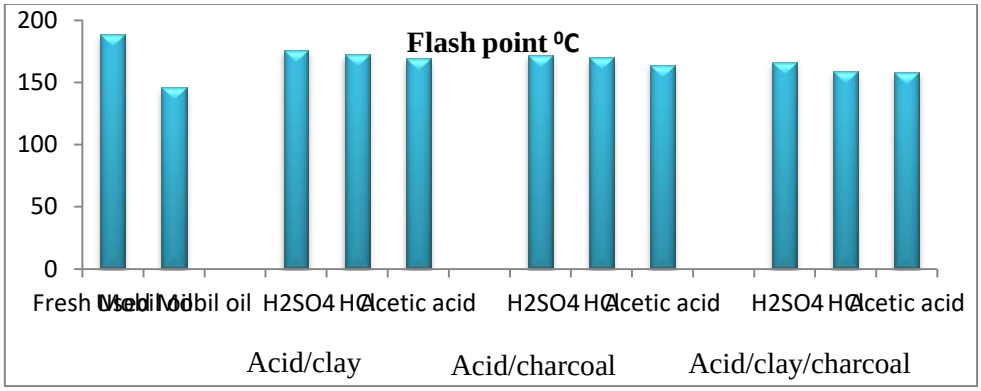

Fig 4: Flash point of fresh, used and purified Mobil oil samples obtained by different purification methods

The flash point of oils is found to rise with rising molecular weight (Lenoir, 1975). A close look at figure 4 showed that the flash point of used oils is lower than that of the fresh and purified oils respectively. According to Abu-Elella et al. (2015), a low flash point of engine oils indicates that they have been contaminated with volatile materials like gasoline. So the low flash point of used mobil oil suggested that it has been infected by impurities such as oxidation products and fuels (Lenoir, 1975). The flash points of purified oils are higher than that of their used oil counterparts because the purification processes succeeded in reducing the amount of contaminants in oil. Thus, the purification of the used oils tends to take their flash points closer to those of their fresh oil counterparts.

Fire point:

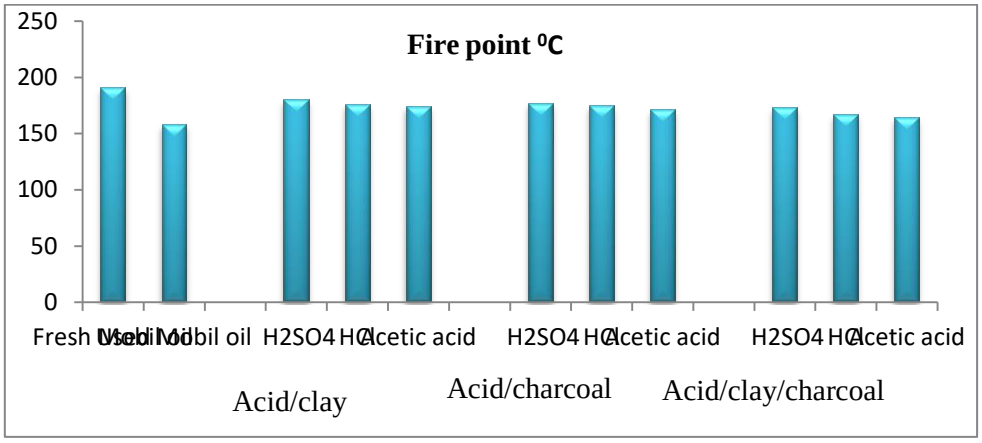

Fig 5: Fire point of fresh, used and purified Mobil oil samples obtained by different purification methods

Just like the cases of flash points, the fire points of the used mobil oil are generally lower than those of their corresponding fresh and purified oils respectively. This decrease is still attributed to the presence of impurities in the oils. During purification, there is removal of engine oil contaminants; thus leading to an increase in the fire point of the purified oils. Furthermore, acid clay method using H_2SO_4 gave the best result.

4. CONCLUSIONS

The results clearly indicated that used mobil oils can be effectively regenerated at low cost for further use; and also revealed that acid refining methods such acid/clay method, acid/charcoal method and acid/clay/charcoal method using sulphuric acid, hydrochloric acid and acetic acid as was washing agents are effective means of purifying used engine (mobil) oils. From the results of the physicochemical analysis carried out, it is conspicuous that among the acid refining methods and three acid washing agents used, acid/clay method using sulphuric acid gave the most acceptable result since used mobil oil purified by that means has the least the sulphur content, viscosity, flash point, specific gravity and fire point values that are closer to their corresponding fresh oil counterparts. Furthermore, the ease at which the impurities and dark colour of the used mobil oil were removed revealed that the activated clay/charcoal used in this research has good adsorption properties.

REFERENCES

[1] Abu-Elella R., Ossman M. E., Farouq R. and Abd-Elfatah M. (2015).Used Motor Oil Treatment: Turning Waste Oil into Valuable Products, International Journal of Chemical and Biochemical Sciences, 2015, 7 p. 57-67.

[2] Ajemba R. O. (2012). Enhancement of Physicochemical Properties of Nteje Clay to increase its Bleaching Performance using Acid Activation, International Journal of Engineering Research and Application, 2(4), p. 281-288.

[3] Benito, J. M., Ríos, G., Ortea, E., Fernández, E., Cambiella, A., Pazos, C. and Coca, J., (2002) Desalination, 147, 5-10.

[4] Doaa, I. O., Sayed, K. A. and Afaf, R. T. (2017).Recycling of used engine oil by different solvent.Egyptian Journal of Petroleum 27, 221–225

[5] Emam, Eman, A. and Shoaib, Abeer, M. (2013). Re-refining of used lube oil by solvent/clay and acid/clay – percolation processes. ARPN journal of science and Technology 2(11), pp 1034 – 1041.

[6] Hamad, A., Al-zubaidy, E., and Fayed, M.E. (2005).Used lubricating oil recycling using hydrocarbon solvent.J-Unviron. Manage. 74, 153–159.

[7] Houssien A. Kheireddine, Mahmoud M. El-halwag, Nimir O. Elbashir, Clen TechnEnviron Policy 15 (2013) 35–44.

[8] Isah, A. G., Abdulkadir, M., Onifade, K. R., Musa, U., Garba, M. U., Bawa, A. A and Sani, Y.(2013). Regeneration of Used Engine Oil. Proceedings of the World Congress on Engineering 2013, Vol I, WCE, London, U. K.

[9] Jha, M.K. (2005). Re-refining of used lube oils: an intelligent and eco-friendly option.Indian Chemical Engineering, vol. 473, pp. 209-211

[10] Lenoir, J.M. Predict flash points accurately. Hydrocarb. Process. 1975, 54, 153–158.

[11] Ogbeide, S. O. (2011). An Investigation To The Recycling Of Spent Engine Oil Journal of Engineering Science and Technology Review 3 (1), 32-35

[12] Udonne J.D (2011). A comparative study of recycling of used lubrication oils using distillation, acids and activated charcoal with clay methods. Journal of petroleum and gas engineering.

[13] Rincon J, Canizares P, Garcia M.T (2005), "Use engine Oil recycling using mixture of polar solvents". Ind. Eng. Chem. Res. 44. Pp 7854 – 7859.