مجلة كلية التربية للعلوم الصرفة- جامعة ذي قار
Website: http://jceps.utq.edu.iq/ Email: jceps@eps.utq.edu.iq
المجلد 8، العدد 1، اذار 2018

Recycling of Used Car Oil by Acid Treatment Method

Dr. Ali Abdulkhabeer Ali Al- Yasiri

aranru79@gmail.com

Chemistry department, Science college, Thi-Qar University, Iraq

Abstract

In the present research, the characteristics of virgin car oil, oils waste of cars, local refined oil and recovery oil in the laboratory were evaluated and compered between them experimentally. In this work, Sulfuric acid was used to regenerate waste car oil. Various properties of different tests oils such as flash point, pour point , water content, specific gravity, ash content, viscosity and iron content were analyzed. The result acquired of tests oils in the present research are in good improvement at different degrees compared with virgin oil vehicle properties.

Spectra of UV-Vis. of virgin oil is similar to all other spectra of oils waste cars, local refined oil and recovery oil in the laboratory.

The results were applied practically and commercially by the United Company for Recycling Oils. The economic cost indicates that recycled oil is equal to 0.5 cents U.S dollar, while average prices for a liter of produced virgin oils by oil refining is equal to three US dollars.

Key words: Recycling, Used Cars Oils, Virgin Car Oil, Local Car Oil, Sulfuric Acid Treatment

Journal of College of Education for pure sciences(JCEPS)
Web Site: http://jceps.utq.edu.iq/ **Email:** jceps@eps.utq.edu.iq
Volume 8, Number 1, March 2018

Recycling of Used Car Oil by Acid Treatment Method

Dr. Ali Abdulkhabeer Ali Al- Yasiri

aranru79@gmail.com

Chemistry department, Science college, Thi-Qar University, Iraq

الخلاصة

في هذا البحث تم تقييم ومقارنة خصائص زيت المركبات الجديد، زيت المركبات المستعمل، الزيت المعاد محليا و الزيت المعاد مختبريا. تم استخدام طريقة حامض الكبريتيك المركز لإعادة تدوير مخلفات الزيوت المستعملة. تم تحديد بعض الخواص للزيوت المستخدمة في الدراسة مثل نقطة الوميض، نقطة الانسكاب، المحتوى المائي، محتوى الرماد، اللزوجة، و محتوى الحديد. أكدت النتائج المستحصلة للنماذج الزيتية بانها جيدة وبدرجات متفاوته مقارنة مع خواص الزيت الاصلي.

من خلال اطياف الاشعة فوق البنفسجية والمرئية ظهر تشابه الى حد ما في اطياف الزيوت المستخدمة، المعادة محليا والمعادة مختبريا مع الزيت المنتج من الشركة المصنعة.

تم تطبيق نتائج البحث عمليا وتجاريا من قبل شركة المتحدة لإعادة تدوير الزيوت .اشارت الكلفة الاقتصادية الى ان معدل سعر بيع لتر واحد من الزيت المعاد تدويره تساوي نصف دولار امريكي بينما معدل بيع لتر واحد من الزيوت الجديدة المنتجة بواسطة عمليات تكرير النفط يساوي ثلاثة دولارات امريكية.

الكلمات المفتاحية :اعادة التدوير، زيوت السيارات المستخدمة، زيت السيارات المعاد محليا، زيت السيارات المعاد مختبريا المعالجة بحامض الكبريتيك.

1. Introduction

Crude oils and its derivatives can be used to make engine oil (71.5 – 96.2 wt% of hydrocarbon). Chemical materials (additives) can be added to it for improving their positive properties [1]. The crude oils purpose in internal combustion engines are to lubricate moving parts, removing impurities, reducing friction, protecting against corrosion and wear, improve performance, and cooling engine. Waste oil can be defined as the degradation of the virgin lubricating components after use. It can be became dirty by contaminating materials like water, carbon residue, asphaltic compounds, ash, metals, etc. One of the public used ways for disposal used oil is burning to generate energy. This way and all other ways are inefficient and result in the wastage of environmental. An economical and appropriate alternative to burning is recycling used oil. Various routs have been developed for improving and reusing waste lube oils to either restore the virgin utility of the oil or remove the polluted oils to a level that they can turn into appropriate for sub- sequent employ. There are many techniques and methods using for recycling waste oils in different countries global like heating and filtration, refining by acid/clay treatment, recycling used oil by ionic liquid, acid treatment, etc. [2,3]
Many and multiple problems due to various sources of pollution can be occurred and lead to the deterioration of ecosystems and resources. Concept of environmental protection is linked to the preservation of these ecosystems and resources from depletion or extinction [4]. Low-quality oil, which has lost some of its properties or whole during the period of operation of motors and machines are called used oils. It is well known that the physical properties will be changed, such as viscosity, pH, color, smell , water content and mineral deposits. When the oil becomes expendable, it should be changed because it will affect the operation of the engines and machines by increasing corrosion and impurities [5].
The goal of recycling used oil is preservation of agricultural land, water dams and groundwater from the arrival of oils used to it. One gallon of used oil can contaminate a million gallon of drinking water [6]. Also, the recycling process oils can contribute to energy saving and the cost of production, where the cost of recycled oils are less than new material and require less energy [7].

2. MATERIALS AND METHODS

2.1. Sample Collection

Four tests samples of virgin, used, local and recovery oils have been analyzed in the present research. Samples of used engine oil of blended oil were collected from an oil service station. A virgin sample was obtained from Nexus GTX 10 W30, Korea formulated. Table (1) represents the characteristics

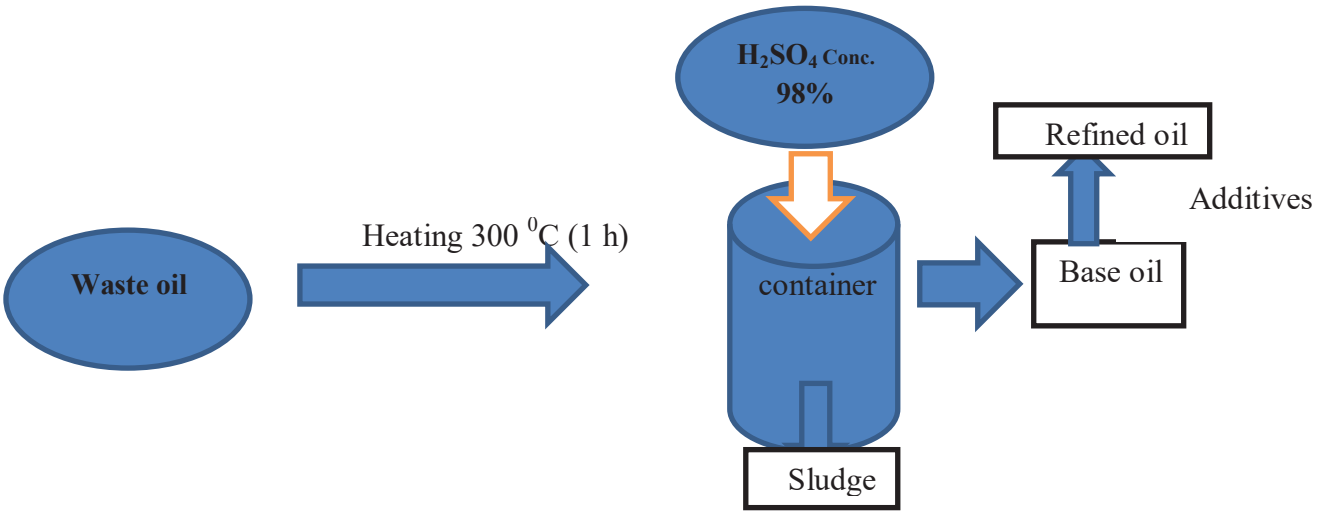
of the virgin oil onto the container, while a refined oil sample was obtained from local company of refined oils. All the solvents and reagents used in this work were of analytical grade.

Table (1): Characteristics of virgin oil.

properties	Units	value	Test method
SAE Grade	-	10W30	-
Specific Gravity@15 ^{0}C	-	0.87	ASTMD-4052
Viscosity@40 ^{0}C	mm^2/s	75.8	ASTMD- 445
Viscosity@100 ^{0}C	mm^2/s	11.8	ASTMD-445
Viscosity Index	-	135	ASTMD-2270
Flash point	^{0}C	210	ASTMD-92
Pour Point	^{0}C	-27	ASTMD-97
Base Number	Mg KOH/g	9	ASTMD-2896
Sulfated Ash	% wt.	0.92	ASTMD-874

2.2. Method of Treatment

Caustic Soda (BDH chemicals Ltd poole, England) and Sulphuric acid (98% con., scharlau, Spain) were used as reagents. Works have been completed using acid treatment method. Filtration process of five liters of used oil was achieved to delete impurities using a filter paper, Buchner funnel, filtering flask and vacuum pump. The dehydration of water and elimination of volatile materials in used oil were completed by heating processes to 300 ^{0}C. Waste oil was cooled to 20 ^{0}C [7]. Sulfuric acid (98% conc.) and raw material were mixed at the ratio of 9 : 1 (oil : acid) as shown in fig. (1). After the stirring and heating processes, the mixed samples were centrifuged (Sigma, 2-6E, Germany) as soon as at a speed of 3000 rpm for a 20 min. Two layers were formed after 20 h. The upper layer was clear oil and the lower layer was acidified material. Caustic soda of 20% solution was used to neutralize acidified material and filtered to eliminate precipitate in the result of neutralization. Funnel separating gave pure liquid containing the wanted product that was evaluated.



2.3. Oils properties

Different properties of the virgin, used, local and recovery oils were determined by ASTM standard methods [8].

Flash point (D92)

(10) ml of vehicle oil was introduced into a (100) ml beaker, after that a thermometer inserted. A bunsen burner was placed under a beaker. At intervals, a flame was brought to set the temperature. A flash will appear on the surface of the oil sample at a certain temperature while the oil sample was heated in the beaker.

Pour point (D97)

(10) ml of the vehicle oil was put in a container. The sample was put in a cooling bath to cool and then to form certain paraffin wax crystal. When the sample does not flow when tilted, the container is held horizontally for 4- 5 sec to check the movement of sample surface. Further chilling was sustained until sample stop to flow. This temperature is named the pour point temperature.

Specific gravity

The hydrometer was used to measure the specific density by determining the density of the material. The value of density was observed and recorded at 40^{0}C (D1298).

Ash content (D874)

After cooling process, Sulphuric acid was used to treat ash content (Sulphated ash), and then heated at 780 ^{0}C, where a constant mass is obtained. The remained ash is weighted in finally step.

Iron content

Atomic Absorption Spectrometer (PG-990 Optic System. Wavelength Range: (190nm - 900nm), Monochromator: Czerny-Turner configuration, Spectral Bandwidth: 0.1nm, 0.2nm, 0.4nm, 1.0nm,

2.0nm, Wavelength Accuracy: 0.25nm. Wavelength Repeatability: 0.15nm .Baseline Stability: 0.005A/30 min. Data processing .Analytical method: flame, graphite furnace and hydride) was used to analyze Iron content in all oil samples. Determination method: calibration curves using to determine.

Viscosity (D445)

Digital viscometer from Brookfield company (USA) used to measure the viscosity at two different temperatures (40 ^{0}C and 100 ^{0}C).

Water content

Distillation Apparatus was used to determine water content in vehicle oil. 200 ml of sample in container was put on hot plate. When the oil sample is heated, existing water in the sample oil vaporizes. Water vapor is collected in a graduated tube after the condensation process. The volume of collected water by distillation process can be considered as a function of the total volume of sample. Percentage of the collected water (W%) can be calculated by the following method:

$$W\%\ (H_2O) = \text{Volume of water trapped} / \text{Volume of sample} \times 100$$

2.4. UV-Vis. Spectroscopy

Spectra of the double beam UV-Vis. of various oil samples were recorded in the range of 200-600 nm by using spectrometer [T90 + UV/Vis. spectrometer, PG Instrument Ltd] and chloroform as solvent.

3. Results and Discussion

In this section, some physico-chemical properties of oil tests were presented and discussed.

3.1 UV-Vis. Spectroscopy

Spectra of UV-Vis. Figs. (2, 3, 4, 5) illustrate the UV-Vis. spectra of virgin, recovered oils by acid treatment, local refined oil and used oil respectively. A maximum peak (λ_{max}) was observed nearly at 316nm in all the spectra. The absorbance of recovered oils is nearly similar to the absorbance values of the virgin oils. The absence of a significant change in the composition and nature of the lubricant oil during use in an engine and in the method of recycling used oil, may explain the similarity of the virgin, used and recovered oils in UV-Vis. Spectra.

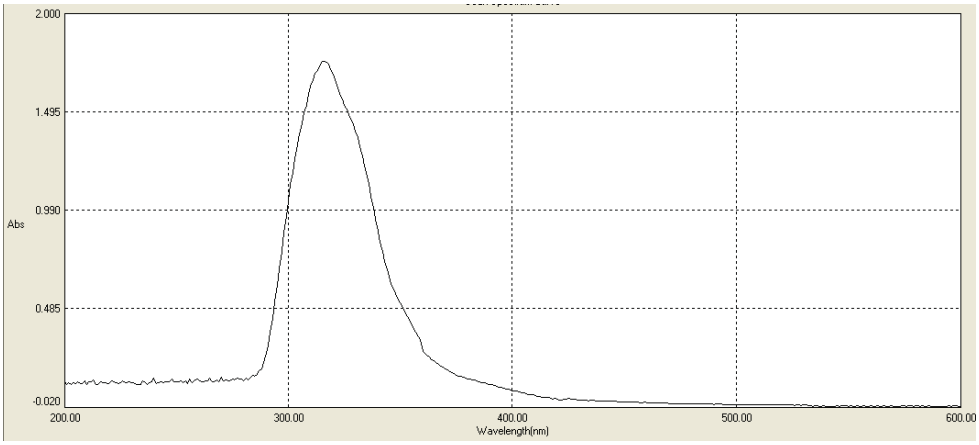


Fig (2): UV-Vis spectra of virgin oil.

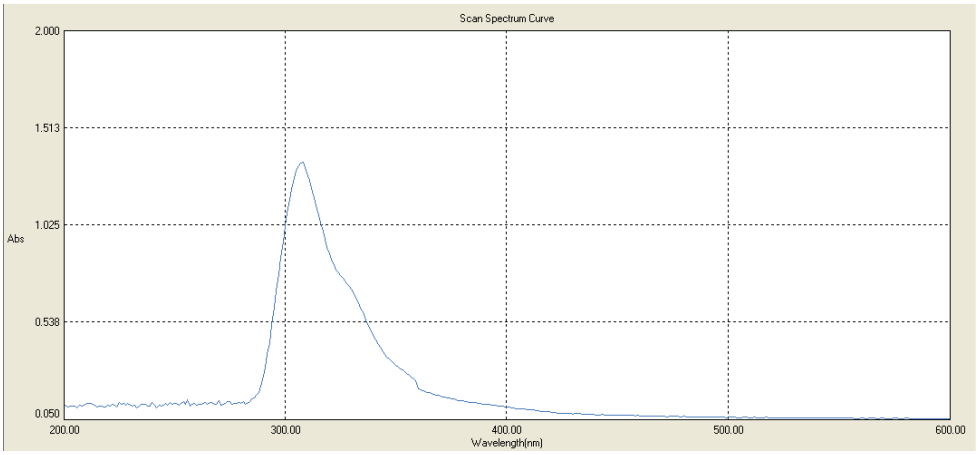


Fig (3): UV-Vis spectra of refined oil by acid treatment.

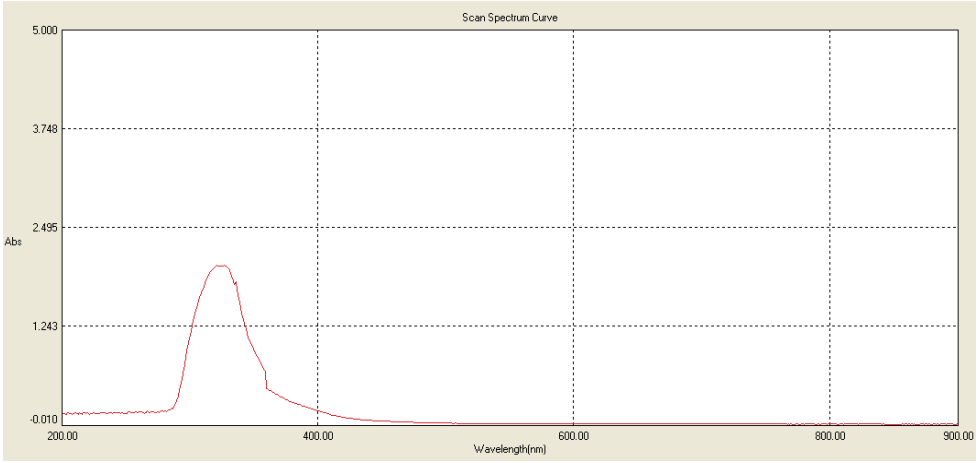


Fig (4): UV-Vis spectra of local recovery oil.

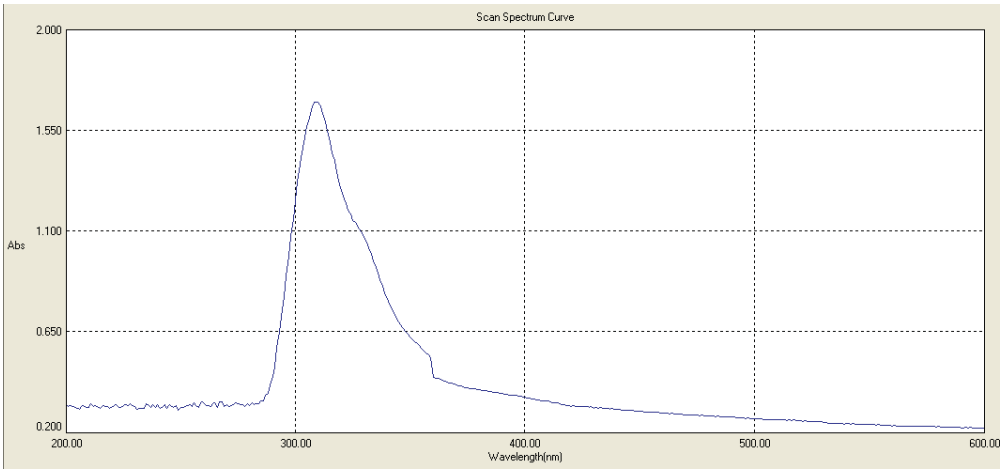


Fig (5): UV-Vis spectra; of used oil

3.2 Viscosity

One of the main characteristics of engine oils is viscosity. The resulted products from polymerization and oxidation processes in the lubricant engine lead to increase the viscosity of used lube engine oil, while the presence of contamination in it will lead to decrease the viscosity [9]. This explains why the viscosities values of virgin, used, refined and recovery oils are higher or lower than another in the present work as cleared in figure (6).

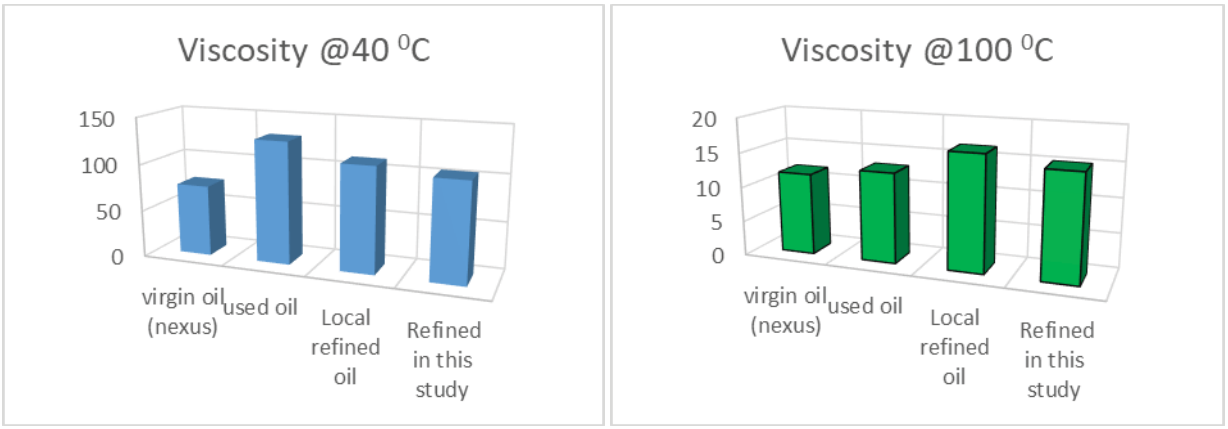


Figure (6): Viscosity of different tests oil at 40 ^{0}C and 100 ^{0}C.

3.3 Flash point

The flash points of virgin lube oil (Nexus), used lube oil, local refined and refined oil in the present study are 210°C, 135°C,169 ^{0}C and 188 ^{0}C respectively as shown in figure (7). That is clear, the lowest value of flash point is 135 ^{0}C of used engine oil. Presence of light fuels in oil cause the decrease in flash point value [10].

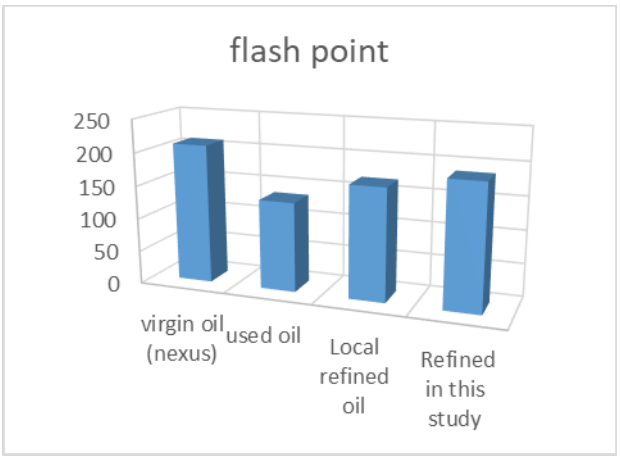


Figure (7): flash point of oil tests

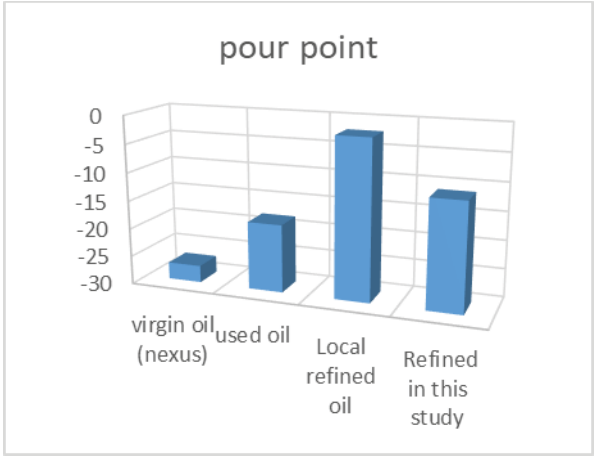


Figure (8): Pour point of oil tests

All flash point values of all tests are explain in the above figure (7). Light fuels in the used engine oil is responsible of the low value of flash point of it.[10]

3.4 Pour point

Pour point apparatus was used to analyze pour points of tests. The obtained results of experiments of pour point in the above figure (8) illustrates that the minimum value was -27 of virgin oil, while maximum value was -2 of local refined oil. Pour point value of refined oil in the present work was -11and it was -18 of used oil. Generally, the increase or decrease in pour points depends on the nature of refining method of lubricant oil [11].

3.5 Iron content

Engine of car practically consists of iron, lead and aluminum. The metallic parts of these metals are presented in used engine oil in in very small amounts during the combustion of any fuel in the engine chamber [12]. Iron content is reduced by sulphuric acid method from 63 ppm of used oil in car engine to 17.4 ppm as shown in figure (9).

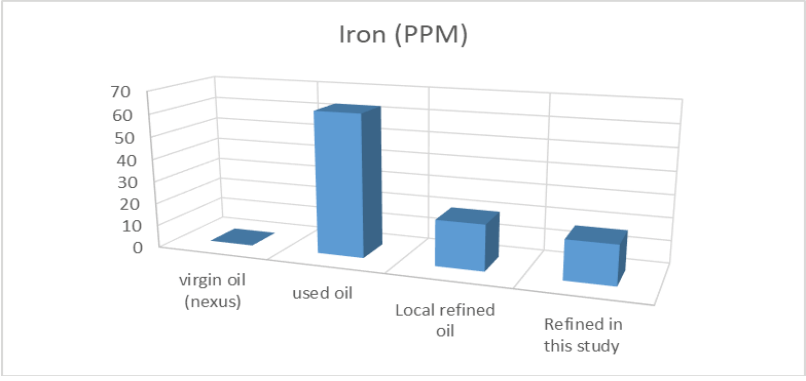


Figure (9): Iron (in PPM) content of oil tests.

3.6 Specific gravity

Digital hydrometer was used to analyze specific gravity of all oil samples. Specific gravity value of used lube oil is higher than all values of virgin, local refined oils and refined oil in the present study as observed in fig.(10). The type and nature of contaminations determine the higher or lower value oil engine specific gravity [13].

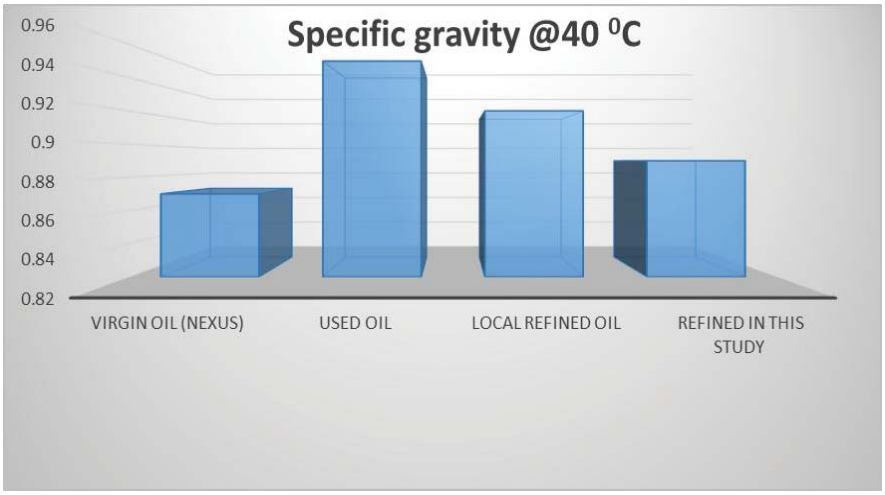


Figure (10): Specific gravity of oil tests.

3.7 Ash content

Ash content of virgin lube oil, used engine oil, local refined oil and refined oil in the present work was 0.01, 3.1, 0.91 and 0.72 respectively. Treatment by Sulphuric acid reduced ash content of used engine oil from 3.1% to 0.72% as shown in figure (11).

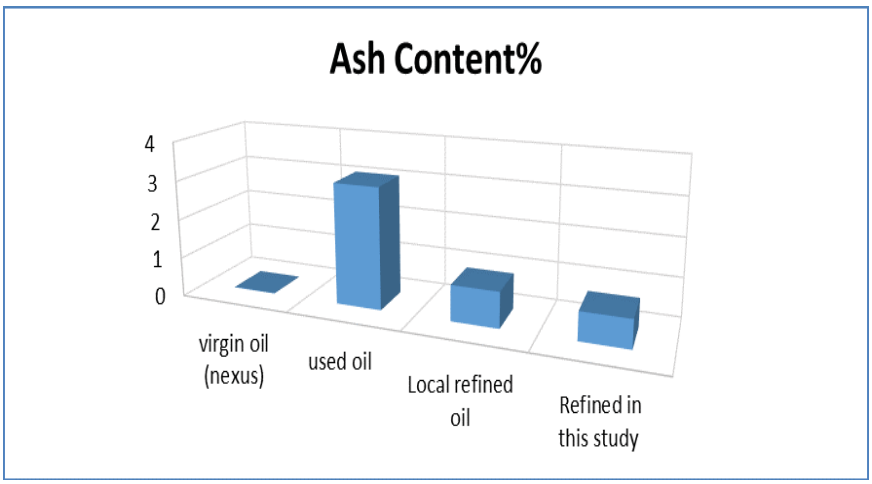


Figure (11): Ash content of oil tests.

3.8 water content

Amount water content of all type of samples have been analyzed in the lab. As explained in fig. (12). According to [14] It is very difficult to avoid traces of water in the engine oils of all systems, but

must not exceed more than 0.5 suggested for the different marks of oil and application. Traces of water in lube can be arose from all types of engine parts and maybe even from the presence of water in the radiator. Gear tooth and bearing problems in cars can be placed due to formation of emulsion, resulting from the increased presence of water, which affects the viscosity of the oil.

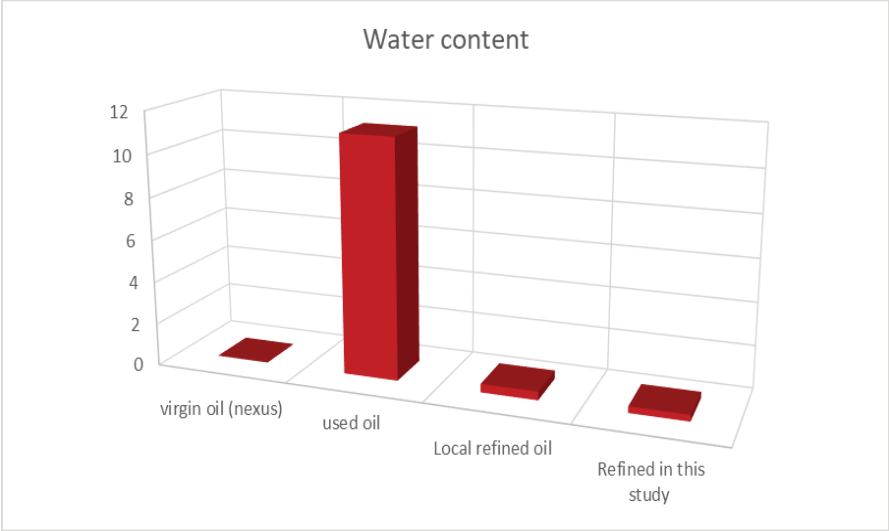


Figure (12): Water content of oil tests.

Conclusion

In the present work, many phycico-chemical properties were presented to recovery the essential properties of lube oils after using it in the engine by sulphuric acid method. From the experimental results, Sulphuric acid treatment of waste lube oils considers good rout to reuse oils and reduce contamination of environmental. This method also considers cheap method compared with other methods.

References

1. Mohammed Rafie R. , Ibrahim Inaam A.R. , Taha Alladdin H. , McKay Gordon (); Waste lubricating oil treatment by extraction and adsorption, , Chem.Eng. J., Elsevier publications, **220**, 343-351(2013).
2. Shakirullah Mohammad, Ahmad Imtiaz, Saeed Mohammad, Khan Mohammad Arsala, ur-Rehman Habib, Ishaq Mohammad and Shah Amjad Ali, Environmentally Friendly Recovery and Characterization of Oil from Used Engine Lubricants, Journal of the Chinese Chemical Society, **53**(2), 335-342 (2006).
3. Prabakaran B., Zachariah Zachu Thomas, Production of Fuel from Waste Engine oil and Study of performance and emission characteristics in a Diesel engine, International Journal of ChemTech Research,India, **9**(5), 474-480 (2016).

4. Dupont Ryan, Ganesan Kumar, Theodore Louis; Pollution Prevention: Sustainability, Industrial Ecology, and Green engineering, 2ed, Taylor&Francis Group, CRC Press,USA, 608(2017).
5. Riazi M. R.,Characterization and Properties of Petroleum Fractions, Philadelphia, USA, 1ed, 427 (2005).
6. Filho J. L. A., Moura L. G. M., and Ramos A. C. S.,Liquid-liquid extraction and adsorption on solid surfaces applied to used lubricant oils recovery, Brazilian Journal of Chemical Engineering, Brazil, **27**(4), 687–697 (2010).
7. Hamawand Ihsan, Yusaf Talal, and Rafat Sardasht, Recycling of Waste Engine Oils Using a New Washing Agent,Energies, **6**(2), 1023-1049(2013).
8. Briant Jean , Denis Jacques , Hipeaux Jean-Claude, lubricant properties analysis and testing, 432 (2000).
9. Scapin M. (2007); Recycling of used lubricating oils by Ionizing, linking hub, Elservier.com/retrieval/pii/30969806X0700182X.
10. Rincón Jesusa , Cañizares Pablo ,García María Teresa Regeneration of used lubricant oil by polar solvent extraction, Ind. Eng. Chem. Res., **44**(12),4373-4379(2005).
11. Awaja Firas and Dumitru Pavel , Design aspects of used lubricating oil redefining, 1ed,Elsevier publications, Netherlands, 114 (2006).
12. Boyde Steve, Green Lubricants. Environmental benefits and impacts of lubrication, Green Chemistry, **4** (4), 293–307 (2002).
13. Abro Rashid, Chen Xiaochun , Harijan Khanji , Dhakan Zulifqar A. and Ammar Muhammad , A Comparative Study of Recycling of Used Engine Oil Using Extraction by Composite Solvent, Single Solvent, and Acid Treatment Methods. http://dx.doi.org/10.1155/2013/952589(2013).
14. Udonne J. D, A comparative study of recycling of used lubrication Oils using distillation, acid and activated charcoal with clay methods, Journal of Petroleum and Gas Engineering, Nigeria, **2** (2), 12-19 (2011).