Local Kaolinite Clay Efficacy as Adsorbent for Spent Oil Treatment

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Abstract- Disposed motor vehicle engine oil is an environmentally harmful waste according to Government regulations. This research evaluated the recycling of Spent Lubricating Oil to New Lubricating Oil using Adsorption technique. The processes include Pounding and Sieving of Kaolin, Impregnation, Neutralization, Drying and Activation and Adsorption. The regeneration investigation result showed changes in the color and metal components of the Spent Lubricating Oil. There was a variance in the weight of the Adsorbent and highest weight gain experiment removed black color and changed the spent oil to brownish yellow which is similar to Fresh Oil that has crystal yellow color. UV-Spectrophotometer was used for the color analysis. The metal impurities observed were Cr, Pb, Ca, Mg and Fe. There was reduction in the metal concentration at all weight ranging from 5g, 10g and 15g. Atomic Absorption Spectrophotometer was used to analyze the Metal content.

Indexed Terms- Indigenous Kaolinite, Spent Lubricating Oil, Adsorption, Activation

I. INTRODUCTION

Improper disposal of spent lubricants can cause air, soil and water pollution. These contaminations affect the longevity of local organisms due to harmful constituents in spent lubricants and require treatment of spent lubricants for reuse. Improper management and disposal of spent lubricants can have negative environmental impacts (Lam, Liewa, Jusoh, Chong, Ani, and Chase 2016). According to a United Nations report (2016), about 6 million people die annually due to air pollution. Combustion of spent lubricants creates aerosols and greenhouse gases in the environment. Scientists believe that in some geographic regions, such as West Africa, the diffusion of air pollutants may be proceeding at speeds of 10–12 meters per second (Emetere, 2017).

Spent lubricants come from a variety of human activities such as industry, mining, and automobile workshops. Improper handling and disposal endanger human health and the environment. In most of our cities, these liquid wastes are now dumped into the environment causing many problems. Spent Lubricants are dumped on the ground, under ditches, in landfills, and eventually absorbed by the ground or floats on the surface of the water. By recycling of this spent lubricant, the spent oil does not pollute the environment, it becomes more harmless and can be reused as new oil (Pinheiro, Quina, & Gando -Ferreria 2021). The treatment of spent lubricant oil can also create a healthy living environment for people. In addition, waste oil can be used as a lubricant in many ways, making waste oil a veritable raw material for industries that recycle waste oil as lubricants in a variety of equipment.

Recycling spent lubricants is therefore important. Compared to crude oil refining, it requires less energy and costs less and helps reduce environmental pollution of air, land and water. The most preferred option by professionals is to recycle consumer-generated waste oil (Jafari & Hassanpour, 2015). Numerous industries have commercialized the treatment of spent oil into reusable new oil.

Over the years, various recycling processes for spent lubricants have been developed. For example, distillation and vacuum distillation, de-metallization of spent lubricants, mixing of lubricants with basic solutions and phase transfer catalysts, solvent extraction techniques, passing of spent lubricant oils through adsorbent, clay, or activated clay beds for further purification, and decolorize for reuse.

Adsorption technology has been attracting attention in recent years because it does not produce acid sludge, unlike chemical treatment, and allows impurities to be collected in one place. It is suitable, inexpensive, renewable and readily available. Kaolinite minerals are soft substances rich in aluminum and silica with the chemical formula $Al_2Si_2O_5(OH)_4$ (Temidayo, Jacob, James, Moses & Francis, 2018).

II. METHODOLOGY

2.1 MATERIALS AND METHODS

The materials used in this study are lubricating oil, gasoline, sodium hydroxide (Merck), kaolinite clay, and hydrogen phosphate (Merck) 4-mesh screen. All chemicals used are analytical grade and fresh distilled water. The instruments used in this study were an oven, a UV spectrophotometer, and an Atomic Absorption Spectrophotometer (AAS) (Perkin Elmer PinAcle 900T). The materials used in this research were similar to (Riyanto *et. al.*, 2018)

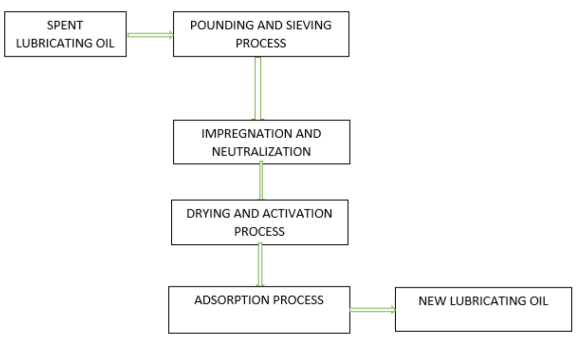

FIGURE 1:BLOCK DIAGRAM OF THE WHOLE PROCESS

2.2 POUNDING AND SIEVING PROCESS

Kaolinite Clay was bought from clay seller. Kaolin clay was subjected to pounding process using mortar and pestle as tools. Sieving is the process of separating a sample based on its particle sizes by subjecting it to mechanical screening. The pounded kaolinite clay was sieved using sieve and the bigger particles were re-pounded and re-sieved to give the desired particle sizes. Used clays have a low iron content, are generally white or slightly whitish in color, and are composed of hydrous aluminum silicates. ($2H_2O.Al_2O_3.2SiO_2$) and several additional minerals

2.3 IMPREGNATION AND NEUTRALIZATION PROCESS

Activated clay was prepared from kaolinite clay using chemical activation method. 400g of the powdered kaolinite clay were impregnated with 1M solution of H_3PO_4 and left in the room temperature for 24 hours. The solution was further neutralized with NaOH, ensuring that the pH is 7.0 and left in the room temperature for 48 hours. The solution gave 3 layers: Clear solution layer, Colloid Solution Layer and Sludge solution layer. After decanting of the first layer and part of the second layer, remaining part of the second layer and last layer was stirred vigorously to give a blended layer.

2.4 DRYING AND ACTIVATION PROCESS

The impregnation and neutralization final solution formed a gel from which one needs to remove the watery part of the solution and this was done by drying. The solution was dried using two drying steps namely, Sun-drying and Oven-drying. It was firstly subjected to sun-drying before oven-drying. After drying, the activated clay was re-pounded and sieved to give the smallest particles 0.0017inches.

2.5 ADSORPTION OF SPENT LUBRICANT OIL USING KAOLIN

The spent Lubricant Oil was gotten from Commercial Vehicle Drivers. It was taken for Color and Metal Analysis at Integrated Research Lab before adsorption process was carried out on it. Spent Lubricant oil was decolorized by allowing it to pass through adsorbent filled column. The type and particle size of adsorbent, the ratio of adsorbent to oil, the type of solvent and the ratio of solvent to oil that passed through the column were all varied. 5g of Activated clay was put into a 100 mL burette. Thereafter, 15 mL of spent lubricating oil was poured into the burette and 45 mL of petrol to dissolve and reduce the viscosity of the spent lubricating oil, in other to allow the spent lubricant oil to flow. The same volume of spent lubricant oil and gasoline were used for the three weights of adsorbent used. After that, it was stirred evenly and left for 3 hours to start dropping from the burette. The experiment was repeated thrice to ensure the color changed using a varying quantity of activated clay quantity ranging from 5g, 10g and 15g. The three solutions were exposed openly for 72 hours for gasoline to evaporate and become viscous. After which it was taken for color analysis and metal analysis using UV Spectrophotometer and Atomic Absorption Spectrophotometer (AAS).

FIGURE 2: IMAGE OF THE WHOLE PROCESS

Where A: pH Meter measured after neutralizing the kaolinite clay.

B: After 48 hours kept in a room temperature
C: The column where adsorption took place
D: Spent Lubricant Oil
E: Treated Lubricant Oil

III. RESULTS AND DISCUSSION

3.1 *Effect of kaolin on color in waste lubricating oil after process*

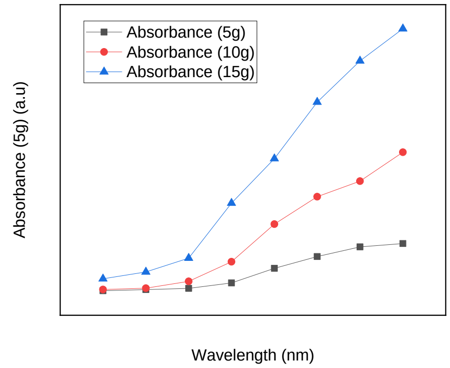

FIGURE 3: EFFECT OF KAOLIN ON COLOR IN SPENT LUBRICANT OIL AFTER ADSORPTION PROCESS

The color of 1.5g of their activated carbon of Riyanto *et. al.*, report which was brownish yellow is similar to 15g of activated clay of this research study. The focus of this research is to see the color change of the spent lubricant oil and it was passed through a UV Spectrophotometer in which wavelength of 350-700nm were used and absorbance was gotten for the wavelength. The absorbance values for 5g are (0.0025, 0.0075, 0.0125, 0.0355, 0.0965, 0.1457, 0.1862, 0.2003)a.u. The absorbance values for 10g are (0.0078, 0.0132, 0.0421, 0.1241, 0.2815, 0.3962, 0.4615, 0.5824)a.u. The absorbance values for 15g are (0.0526, 0.0814, 0.1390, 0.3692, 0.5556, 0.7921, 0.9644, 1.0992)a.u. The result of this research was similar to (Riyanto, Astuti & Putri 2018).

3.2 *Effect of Activated kaolin clay on metals in spent lubricant oil after process*

Sample	After treating with kaolin (mg/kg)				
	Cr	Pb	Fe	Mg	Ca
Spent Lubricant Oil	6.08	174.82	410.60	302.72	1022.13
5g Activated Kaolin	1.19	53.13	86.56	22.39	18.69
10g Activated Kaolin	1.00	36.89	15.26	58.14	12.88

15g Activated Kaolin	0.66	22.86	3.18	93.18	6.99
ASTM Standard	0.12	16.00	2.76	870.80	1103.00

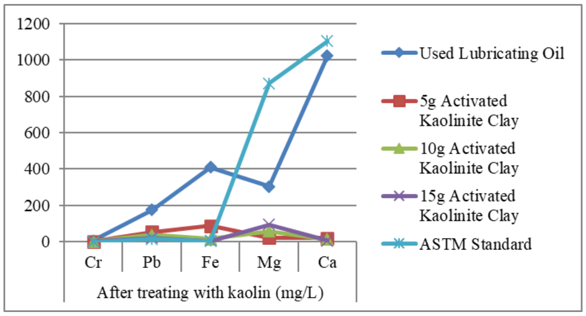

FIGURE 4: EFFECT OF KAOLIN ON METALS IN SPENT LUBRICANT OIL AFTER ADSORPTION PROCESS

Metal impurities analysis of Cr, Pb, Fe, Mg and Ca in the spent lubricant oil was recorded before and after treatment with the three weights of the adsorbents. Concentrations of Ca and Mg metals of the treated lubricants for 15g of adsorbent were shown to be in the range for new lubricant based on ASTM D5185 standard. Cr, Pb and Fe metal concentrations for 15g of adsorbent were not concordant with ASTM D5185 quality standards. The results of this study differed from those of the study by (Riyanto et. al., 2018).

CONCLUSION

After treatment with 15g of adsorbent, the new lubricant has a color of brownish yellow which is still one of the accepted colors for Lubricants. The metal concentrations were reduced at 15g which is an indication that at higher weights like 25g and 30g, most of the metal impurities would have been removed. This indicates that as the amount of activated kaolin clay increases, the adsorption capacity of the clay in the spent lubricants oil increases. In conclusion, activated clay as an adsorbent is a suitable material for the treatment of spent lubricants, especially for color and metal concentration reduction.

REFERENCES

[1] Emetere, M. E. (2017). *Investigations on aerosols transport over micro-and macro-scale settings of West Africa*. Environmental Engineering Research 22 (1), 75-86.

[2] Emmanuela, K. B., Terza, A. B., Anthony, N. P. A., & Michael, K. F. (2022). Re-refining Used Engine Oil in Ghana Using Solvent Extraction and Acid-Clay Treatment. *Hindawi International Journal of Chemical Engineering* Article ID 6344409, https://doi.org/10.1155/2022/6344409

[3] Ikenyiri, P. T. and C. P. Ukpaka C. P. (2016). Overview on the effect of particle size on the performance of wood based adsorbent. *Journal of Chemical Engineering and Process Technology*, 7(5). doi:10.4172/2157-7048.1000315

[4] Jafari, A. J., & Hassanpour, M. (2015). *Analysis and comparison of used lubricants, regenerative technologies in the world*. Resource Conservation and Recycling, http://dx.doi.org/10.1016/j.resconrec.2015.07.026

[5] Kamal A. and Khan F. (2009). Effect of Extraction and Adsorption on Re-refining of Used Lubricating Oil, *Oil & Gas Science and Technology* – Rev. IFP, Vol. 64, No. 2, pp. 191-197

[6] Lam, S.S, Liewa, K.K., Jusoh A.A, Chong C.T., Ani, F.N., Chase H.A. (2016). *Progress in waste oil to sustainable energy, with emphasis on pyrolysis techniques.* Renewable and Sustainable Energy Reviews 53:741–753

[7] Nabil M, Abdel-Jabbar, Essam A.H, Al Zubaidy, Mehrab Mehrvar. (2010). Waste Lubricating Oil Treatment by Adsorption Process Using Different Adsorbents. *International Journal of Chemical and Biological Engineering*; 3(2)70-73

[8] Pinheiro CT, Quina M.J and Gando-Ferreira L.M. (2021) Management of waste lubricant oil in Europe: A circular economy approach. *Crit. Rev. Environ. Sci. Technol.* 18: 2015–2050.

[9] Riyanto, Astuti T.A, D.J Putri .(2018). *The effect of treatment with activated carbon on the metal content in reuse of lubricating oil.*

https://doi.org/10.1051/matecconf/201815401018

[10] Riyanto, B. Ramadhan, D. Wiyanti. (2018). *Treatment of Waste Lubricating Oil by chemical and Adsorption process using Butanol and Kaolin*. Materials Science and Engineering 349 012054

[11] Temidayo E.O, Jacob A.S, James A.O, Moses E.E, Francis B.E, (2018). A review on Treatment methods of Used Lubricating Oil, *International Journal of Civil Engineering and Technology* (IJCIET) Volume 9, Issue 12, December, pp. 506–514, Article ID: IJCIET_09_12_056

[12] Udonne, J. D. et al. (2016). Recycling used lubrication oil using untreated, activated and calcined clay methods. *Journal of Engineering and Applied Science*. 11(6), 1396-1401

[13] UN-Report (2016). http://www.un.org/sustainabledevelopment/blog/2016/09/vastmajority-of-world-6-76-billion-people-living-with-excessive-air-pollution-un-report/

[14] Zen N, El-Berrichi F.Z, Abidi N, Duplay J, Jada A, Gasmi B. (2018). Activated kaolin's potential adsorbents for the removal of Derma Blue R67 acid dye: kinetic and thermodynamic studies. *Desalination and Water Treatment,* 112 196-206

[15] Zendehdel, M. A. Barati, and H. Alikhani. (2011). *Removal of heavy metals from aqueous solution by poly (acrylamide-co-acrylic acid) modified with porous materials*. Polymer Bulletin, vol. 67, no. 2, pp. 343–360, 2011.