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USED LUBRICANT OIL PURIFICATION WITH ACID AND CLAY METHOD

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Abstract. The power generation industry from every production process certainly produces non-toxic and hazardous waste and toxic and hazardous waste. One of the toxic and hazardous waste of used lubricating oil. This scientific work aims to analyze the characteristics of used lubricating oil to be used as raw material for purification and to determine the most optimal quality of the purified lubricating oil from the addition of acid and bentonite clay. The research method starts from a preliminary test by knowing the characteristics of used lubricating oil, followed by activation bentonite clay with hydrochloric acid, preparation of used lubricating oil with hydrochloric acid, adsorption process with the addition of hydrochloric acid and bentonite clay as adsorbent and the mass variation is 10 gr, 15 gr, and 20 gr with the temperature variation is 85°C, 95°C, and 105°C in order to obtain 9 variations. After the purification process is carried out, the characteristics of the lubricating oil are obtained with optimum conditions of 9 variations, namely 20 gr bentonite clay and the temperature is 105°C (B20T105) so the conclusion are obtained based on the results of the purification analysis, namely the parameters of water content, specific gravity, and total acid number still meet the standards for the use of lubricating oil. As for the kinematic viscosity, it still does not meet the standards for the use of lubricating oil.

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1 Introduction

Industry that is progressing rapidly so that it improves the economy in every country, this is caused by the high public need for a product. As for the product in the form of electricity is a business field in the form of services needed every day to support daily life. Every electricity produced in 2020 is in level of 1.09 kWh/capita which is equivalent to 95% of the target determined by the government in the amount of 1.142 kWh/capita [1].

The power generation industry in Indonesia has various capacities and if calculated nationally is 72.750,72 MW [1]. Every the production of power plants certainly has a generator engine that requires oil lubricant. The use of lubricating oil for a certain period of time can cause changes from chemical composition to the contained composition such as temperature will occur improvement [2]. According to [3], lubricating oil replacement is used lubricating oil that contains heavy metals, namely Pb or lead. Heavy metal contamination in nature is the addition of lead that reaches the chain food and cause pollution in soil, water, and air and is one of the cause problems for the environment. So that management is needed in accordance with the rules recommended by the government [4]. The used lubricating oil includes waste containing hazardous and toxic materials.

A large amount of lubricating oil is required for management activities, processing, and further processing or utilization aimed at reducing presence of used lubricating oil. According to [5], used lubricating oil can actually still work recycleor recycled with the reduction of hazardous and toxic waste as intended needs to be carried out through material substitution, process modification and/or use of environmentally friendly technology. To reduce and utilizing used lubricating oil as for one way is by purification with hydrochloric acid with bentonite as adsorbent. Scientific work aims to analyze characteristics of used lubricating oil to be used as raw material for purification and determine the quality of the lubricating oil purified from the addition of acid and bentonite clay as the adsorbent so that it is expected to solve the problem of used lubricating oil is quite high.

2 Method

2.1 Sample

The research was conducted in one of the power generation industries as a sampling site, analysis of the initial and final characteristics of used lubricating oil done in the laboratory. For refining lubricating oil with the addition of hydrochloric acid and bentonite clay carried out at Trisakti University, Department of Environmental Engineering, Faculty of Landscape Architecture and Environmental Technology located at the Environmental Laboratory. The sampling method in this study is a method whose samples were taken from all generator engines.

2.2 Data Collection

The existence of observations regarding problems in the field can be carried out in the process preparation of scientific papers alluding to the purification of used lubricating oil as a raw materials and collecting secondary and primary data. Primary data that used are observation, interviews, and laboratory testing. While secondary data data obtained indirectly such as references in the form of books, scientific journals, modules published in the last 10 years that are both national and international as one of the references that contains research on keywords that can be used as search reference purification, used lubricating oil, acid method, and bentonite clay.

2.3 Data Analysis Method

The data analysis method was carried out in the preliminary test stage which aims to determine the content of used lubricating oil before refining. Next activation preparation bentonite clay and lubricating oil with hydrochloric acid. Then lubricating oil and bentonite clay the adsorption step can be carried out, namely by the variation of temperature and weight of bentonite clay so obtained 9 different variations of temperature 85 ^{o}C, 95 ^{o}C, and 105 ^{o}C and the mass of bentonite 10 gr, 15 gr, and 20 gr.

The final stage is the product analysis stage where the characteristics of the lubricating oil are known the result of purification is water content, water content testing aims to determine how much water content in used lubricating oil and carried out using the ASTM E 6304-07 method. Kinematic viscosity, this test aims to determine the viscosity of a material to the flow and carried out by the ASTM D 7042 method at a temperature of 40°C. Formula kinematic viscosity calculation.

$$v = Ct \quad (1)$$

Where:

v = kinematic viscosity (mm^2/second)

C = viscometer calibration constant (mm^2/$second^2$)

t = flow time (seconds)

Specific gravity a ratio of the density of a liquid to the density of water at a certain temperature, usually the temperature used is 15°C. On the determination of specific gravity can be done using the ASTM D 7042 method. Calculation formula specific gravity.

$$SG = \frac{\rho \text{ aliran}}{\rho \text{ air}} \quad (2)$$

Where or density is a measure of a mass concentration or mass to volume ratio. Where the density of a liquid is getting higher the higher the mass value of each volume.

$$\rho = \frac{m}{v} \quad (3)$$

Where:

ρ = Density (gram/cm^3)

m = Mass of sample (gram)

v = Sample volume (cm^3)

Total Acid Number (TAN) is the sum of the values of a concentration of acid in the oil lubricant. Determination Total Acid Number (TAN) can be performed using the ASTM D-974 method. Below is the formula for calculating total acid number:

$$\frac{\text{mgr KOH}}{\text{g minyak}} = \frac{(A-B) \text{ x N x Mr KOH}}{W} \quad (4)$$

Where:

A = Volume of used KOH solution or sample solution (ml)

B = Volume of used KOH solution or blank solution (ml)

N = Concentration of KOH solution

W = Mass of sample (grams)

Mr KOH = 56,1 gr/mol

For calculate the normality value of KOH can use the formula, namely:

$$N\ KOH = \frac{((C)gr)\ x\ (valensi\ as.\ oksalat)}{(Mr\ as.\ oksalat)\ x\ (Volume\ (D))} \quad (5)$$

Where:

((C) gr) = Weight of oxalic acid ($C_2H_2O_4.2H_2O$) used (sample solution)

Oxalic acid valence = 2

Titration volume (D) = Volume of 0,1 N KOH solution used (ml converted to liters)

Mr. oxalic acid = 126 gr/mol

3 Results and Discussion

3.1 Characteristics of Used Lubricating Oil

Used lubricating oil produced by the power generation industry is a raw material for raw material for purification. The initial characteristic test aims to determine the characteristics that owned through laboratory tests and it is known the physical properties of used lubricants and the physical properties analyzed for this characteristic test phase in the form of water content, kinematic viscosity, specific gravity, and total acid number. Table 1 is the result of the analysis of the characteristics of the waste used lubricant.

Table 1. Used Lubricant Oil Characteristics result

No	Parameter	Units	Analysis of Result			
			Repeat 1	Repeat 2	Average	Standard
1	Water content	ppm	147,000	140,000	143,500	Max 1000*
2	Kinematic viscosity	cSt	37,362	37,307	37,335	Min 41,4 Max 50,6
3	Specific gravity	cSt	0,902	0,903	0,902	Max 0,9*

No	Parameter	Units	Analysis of Result			
			Repeat 1	Repeat 2	Average	Standard
4	*Total Acid Number*	mg KOH/ gr	0,392	0,407	0,400	Max 0,4*

Note: *Standards for the use of used lubricating oil in the power generation industry

Based on table 1, the results of the characteristic test of used lubricating oil waste it refers to SNI 7069.9:2016 for kinematic viscosity parameters and for parameter standard with an asterisk means the standard used refers to utilization of used lubricating oil in the power generation industry.

The water content parameter which has an average value of 143,500 ppm and when compared with the standard used is still far below the maximum limit of 1000 ppm. This matter need to be considered because the characteristics of the water content have the aim of knowing the content of water in lubricating oil [6]. High water content can reduce or changing the thickness of the lubricating oil layer on the engine [7].

The kinematic viscosity is 37,335 cSt which indicates that it is still below the standard used is a minimum of 41,4 cSt and a maximum of 50,6 cSt. Kinematic viscosity value obtained must be adjusted to facilitate the rotation of the lubricant so that it can move freely [8]. The value of the kinematic viscosity that decreased due to the presence of a large number of carbon chains but was interrupted due to long use of lubricating oil causing carbon and used lubricating oil settles [9].

Specific gravity with the value obtained is 0,902 cSt which where the value is still above the maximum limit of 0,900 cSt. The temperature in the engine when operating for a long time makes the engine temperature increase and causes the value to increase viscosity will decrease [10]. Score specific gravity tall one caused by an increase in impurities in the engine so that it can interfere with the when the machine is running [11].

Total acid number contained in used lubricating oil obtained a value of 0,4 mgKOH/gr that the value is still above the standard, namely 0,4 mgKOH/gr. Total acid number(TAN) is affected by a decrease in stability by the charge of oxygen quite

high in oil [12]. The cause of the high value total acid number (TAN) which is an increase in oxidation due to the presence of metal particles that into lubricating oil and temperature when production activities are carried out [13].

3.2 Characteristics of Adsorbent Bentonite Clay

Bentonite clay is a type of natural clay that has a soft and smooth texture so that when mixed with a solution can form a paste. According to [7], adsorbent bentonite clay have the ability to purify the process when compared use of zeolite and activated carbon. According to [14], bentonite clay as adsorbent activation is required which aims to increase its adsorption capacity. Ability bentonite clay can enlarge the space between layers after processing acid activation and activation bentonite clay can be done with hydrochloric acid (HCl) or sulfuric acid (H_2SO_4) [15]. When the activation process is carried out bentonite clay. It looks like bubbles are seen when a solution of hydrochloric acid (HCl) is added as the main ingredients so that it can be seen in figure 1 the reaction resulting from mixing HCl solution with bentonite clay classified as high and in accordance with SNI 2436:2008 [16].

Fig. 1. Bubbles

The activation process obtained the form of bentonite clay before activation with after activation, there is a change in color and figure 2 is an image of the bentonite clay.

(a) (b)

Fig. 2. Bentonite clay : (a) Before Activation (b) After Activation

Figure 2 shows the results of the adsorbent bentonite clay which is activated by an acid solution chloride (HCl). The 1,6 M hydrochloric acid solution used in this study was based on research [17] that by activating hydrochloric acid (HCl) is more effective compared to the use of sulfuric acid (H_2SO_4) as a solution for activationbentonite clay and has the advantage that it can reduce the volume of sludge residue in the oil lubricant.

3.3 Process of Refining Used Lubricant Oil

Purification of used lubricating oil with the addition of hydrochloric acid allowed to stand for 24 hours to produce three layers, namely the lowest layer in the form of acid chloride, the second layer of sediment due to contaminants of hydrochloric acid and carbon so that it can be forming a salt compound, and the third layer is the lubricant it self. In figure 3 is used lubricating oil as a result of adding acid before separating the layers (saline solution with lubricating oil).

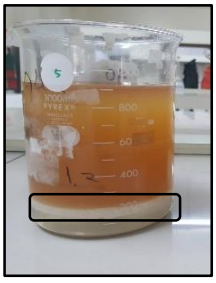
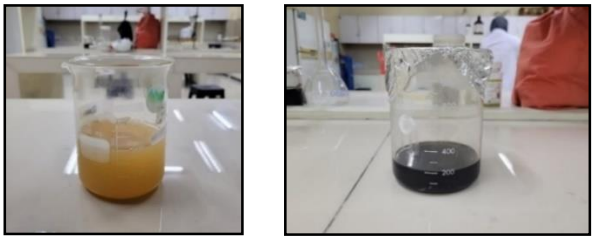


Fig. 3. Saline Solution

Bentonite claya ctivated is able to purify the lubricating oil so that the color will changes, this is caused by an ion exchange where bentonite clay on negatively charged surface. According to [18], if opposite charges can lead to attraction and if

the charges the same will refuse. The increase in adsorption capacity is influenced by the composition and The activation conditions are the type of acid, concentration, time, temperature, contact time, speed mixing, particle size, and acid ratio [19].

The adsorption process is said to be successful if the weight bentonite clay weight gain occurs. This is due to the increasing amount of adsorbent weight so that it makes the surface area of the adsorbent is wider. This event occurs on the surface of the bioadsorbent which absorbs more ions [20]. Adsorption of bentonite clay aims to absorb metallic and non-metallic impurities and eliminate odors used lubricant. Adsorption process bentonite clay. This is due to the cation exchange process. Figure 4 is a used lubricating oil that is purified.



(a) (b)

Fig. 4. Refined Lubricating Oil: (a) After Adding Acid, (b) After Adding Acid and Bentonite

3.4 Lubricating Oil Quality

The addition of hydrochloric acid and adsorbent in the form of bentonite clay activation in refining lubricating oil obtained 9 variations based on temperature 85℃,95℃, and 105℃, and the mass of bentonite clay activated, namely 10 gr, 15 gr, and 20 gr. Dari9 variations are obtained results purification based on figure 5 and figure 6.

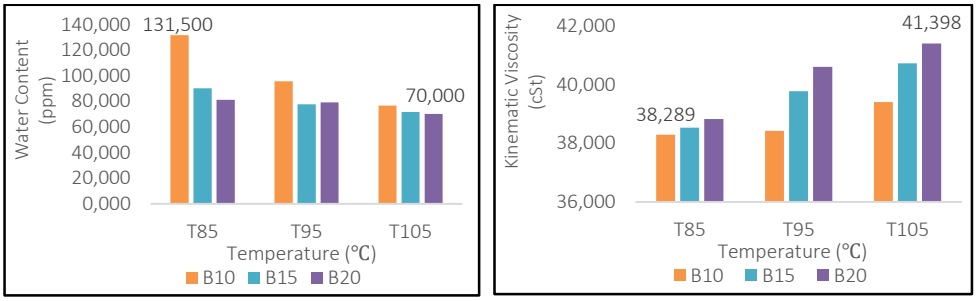


Fig. 5. Graphs of Water Content and Kinematic Viscosity

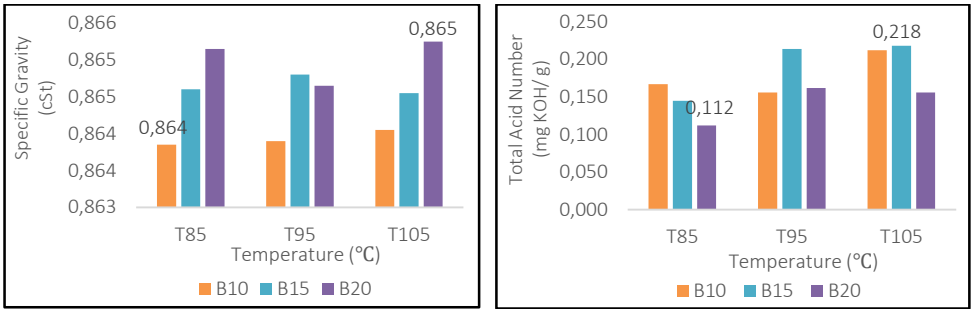


Fig. 6. Graphs of Specific Gravity and Total Acid Number

On the water content parameter, the variation of B20T105 which means 20 gr and heated with a temperature of 105°C has the lowest water content value which is the most optimal variation because it still meets the criteria based on standards for utilization. Heavier bentonite and the higher the temperature during the adsorption process, the higher the water content will be small, this is because the high temperature can evaporate the water content in the oil lubricants [21].

The most optimal variation of the kinematic viscosity parameter is B20T105, but the value of it still does not meet the criteria based on SNI 7069.9:2016. Not fulfilling the value of kinematic viscosity based on research [21] is due to The heavier the bentonite, the higher the kinematic viscosity value. Meanwhile, according to [22] the viscosity value is influenced by the adsorption temperature and the weight of bentonite that the more bentonite used and the higher the adsorption temperature, the greater the value of the increase in viscosity is obtained.

Score specific gravity the lowest is in the variation of B10T85 or 10 gr and a temperature of 85°C is the most optimal variation for this parameter. This is because the value obtained when it gets closer to the value of specific gravity on the standard used, the contaminants lost in lubricating oil is higher [22]. Meanwhile, according to [23], the more contaminants are trapped in the bentonite clay then returns the values specific gravity getting smaller.

The variation of B20T85 on the TAN parameter is the most optimal variation because the heavier the adsorbent used, the smaller the value of total acid number (TAN) [24]. However, of all variations of lubricating oil, it still meets the standard for utilization of used lubricating oil in the power generation industry.

4 Conclusions

The conclusion obtained based on the results of the purification analysis, the water content parameters were 70.000 ppm, 0.865 cSt for specific gravity, and 0.156 mg KOH/gr, for the total acid number. So from this value it still meets the standards for the use of lubricating oil. While the kinematic viscosity still does not meet the standards for the use of lubricating oil because the value obtained is 41.398 cSt and this value is still below the minimum limit. So it is necessary to increase the weight of the adsorbent in the form of bentonite clay to increase the kinematic viscosity value.

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