USED LUBRICATING OIL AS A FUEL FOR SMELTING WASTE ALUMINUM

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USED LUBRICATING OIL AS A FUEL FOR SMELTING WASTE ALUMINUM

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ABSTRACT

The increasing number of automotive applications and factories in industries has increased lubricant usage and aluminum usage. Both have caused waste that will slowly accumulate significantly. Lubricating oil will become waste lubricant, and aluminum will cause aluminum waste. Both waste types can be recycled simply. Used lubricating oil has greater viscosity value compared to new lubricating oil, so it can still be used as fuel for used aluminum smelting. For a better flow, the viscosity of fuel is lowered by means of used lubricating oil mixed with kerosene. The oil piping system can be designed simply to light the flame suitable for aluminum smelting.

Keywords: used lubricating oil, temperature flame, and waste aluminium.

1. INTRODUCTION

In everyday life, humans are faced with the needs of all sorts of things that must be fulfilled. In practice, this condition has resulted in material leftovers which can be referred to as garbage and waste.

According to the Law of the Republic of Indonesia No. 18 of 2008 in article 1 paragraph 1, waste is the material leftovers from human daily activities and/or natural processes in a solid form. In addition, the General Provisions of Law No. 32 of 2009 also provide another definition of waste: residues of a business and/or activity. Meanwhile, waste lubricating oil in daily activities results from a variety of machinery applications [1].

Garbage in this study is defined as the leftovers from activities. Some types of garbage are solid waste aluminum and plastic. Generally, aluminum classifies as light metal and is used in many industries. Among other things, aluminum is used as a component element of machinery equipment, cooking appliances, wrapping or packaging of food and beverage, and even constructions. Garbage from various sources can be recycled into useful materials.

According to the Regulation of the State Minister for the Environment No. 13/2012 [2] in article 1 paragraph 1: Any activity that reduces, reuses, and recycles or limits the amount of garbage, reuses trash, and recycles waste (hereinafter referred to as the 3R) includes any activity that can reduce consumption of material that may be a source of garbage, reuse rubbish that is suitable for a similar or different use, and processed waste to be used as a new product.

Taking that into account, waste lubricants can be reused for various purposes, such as reprocessing into engine lubricants or fuel. The utilization of waste lubricating oil as fuel can be done in a simple manner, wherein the viscosity value of the oil can be lowered if blended with kerosene, so that it is easy to atomize. Rahardjo [3] states that the process of burning used oil is very difficult because of its carbon bond length making it so difficult to break.

Naima and Liazid [4] state that used lubricating oil is very abundant waste and becomes a pollutant. Previous research has studied three types of used oils: used lubricating oil, used cooking oil, and used oil from processed plastic. All three are used as fuel substituting diesel oil for diesel motors.

Presently, according to Zhang *et al* [5], the technique for mixing oil with certain concentration has been generally accepted, but the downside is that it is costly.

Used oil is generally defined as oil derivatives of heavy oil or mixture containing synthetic oil including used oil, compressor oil, gear oil, hydraulic oil, turbine oil, industrial gear oil, heat transfer oil, and transformer oil [6]. By means of cleaning the process using clay treatment, two products, which are base oil (recycled lubricant) and clay waste made into bricks, can be produced.

Darsopuspito and Brata [7] state that the mixing of kerosene and used lubricating oil as fuel for diesel motor will leave soot residue. Soot content increases with a greater concentration of lubricant in kerosene. The calorific value decreases as the lubricant concentration increases.

Pratomo [8] examined the viscosity of used lubricating oil that has a relatively high viscosity making it difficult to atomize. Pratomo has designed a burner for dealing with high viscosity, so that when lubricating oil transforms into mist, it becomes easier to atomize. The ratio of used lubricating oil mix to air is set at 1: 3, which is a very good ratio to achieve a maximum temperature of 1012 ^{0}C.

Other researchers state that used lubricating oil can be used and exploited for applications like direct combustion and motor fuel combustion.

Used engine oil lubrication (UELBO) is said to be a renewable energy source when tested in a furnace.

The study concludes that UELBO is a very significant energy source, and it represents an energy management opportunity with great potential [9].

Durani *et al* [10] state that the utilization of solvent extraction to process used lubricating oil into lubricating oil is worth considering. By way of this process, a number of impurities contained in the used oil can be reduced significantly.

Prasaji *et al* [11] state that coal fly ash can be used in the processing of used lubricating oil because it physically adsorbs and removes contaminants or impurities from the used lubricating oil. Thus, it is possible to obtain lubricating oil that is free of dirt and other contaminants.

Manasomboonphan and Junyapoon [12] studied the production of fuel oil from processed lubricating oil through pyrolysis. The pyrolysis process method is an environmentally friendly technique and the resulting oil or gas product from this process has high calorific value. Pyrolitic distillation process is used to process waste lubricating oil into diesel oil that can be used as fuel. Some percentage of additives is then added to obtain the desired physical properties [13].

In the case of mixing two or more fuels, it has been observed that there is an increase of calorific value in the fuel mix, which in overall would result in a greater calorific value [14]. Sarjovaara and Larmi [15] reveal that a mixture of ethanol and gasoline can also change the properties of the fuel. Similarly, Lahane and Subramanian [16] state that the mixing of biodiesel and diesel would have an effect on the physical properties of the fuel.

When the processing technology used to recycle used lubricating oil becomes complicated, it would lead to increasing cost, time, workload, and other economic challenges. Thus, this study concentrates on the processing of used oil by means of simple and inexpensive filtration. The resulting product of the recycled used oil will be used as a fuel by mixing it with kerosene. It is relatively easy to transform used lubricating oil into its mist form without resistance at the tip of the burner nozzles.

The existence of dirt due to material friction between the elements of the engine and the occurring carbon insertion from combustion of gasoline or diesel fuel makes it is necessary to perform a screening process.

Due to evaporation of water in lubricating oil and evaporation in the combustion system, the used lubricating oil would contain a certain amount of water content. The presence of water would inhibit the ignition of used lubricating oil. To that end, the water content should be reduced as much as possible by depositing the used lubricating oil for some time. Precipitation gives two physical benefits: separation of water due to a difference in density and precipitation of impurities or contamination at the bottom part of the used lubricating oil liquid. Precipitation can be performed in a simple tank made of a drum.

A crucible for waste aluminum has been carefully designed, with a capacity that can hold 10 kg of molten aluminum [17]. The crucible can operate on liquid fuel.

The utilization of used lubricating oil as fuel in aluminum recycling in the foundry industry requires a low cost and a simple process. The use of complex processing technology requires a high cost and time, which will lead to increasing workload and other economic challenges. This research aims for cleaner used lubricant oil processing by means of simple and economical filtration. In addition, it is more desireable to achieve a burner that is able to transform used lubricating oil into a mist of steam without experiencing a deadlock at the tip of the burner nozzles. The presence of dirt due to material friction between the elements of the engine and the occurring carbon insertion from combustion of gasoline or diesel fuel makes filtration a necessity.

2. MATERIALS AND METHODS

Used lubricating oil was collected from several motorcycle repair shops in Palembang, Indonesia. The purchased used lubricating oil contained varied dirt depending on the habitual use and care of the motor vehicles, which determines the schedule of lubricant oil replacement, the age of the vehicles and the type or brand of lubricant. Hence, it was anticipated that there was going to be unequaled mixture of motor vehicle types from one repair shop to another. To minimize dirt and excess water content contained in the collected used lubricating oil, it was first stored for up to two weeks.

After the precipitation process, the used lubricating oil was filtered with five tiers of filters: 80, 100, 150, 170, and 200 Mesh in measure (equivalent to ASTM specification E-11-70). A stratified filtration device with stainless steel screen was added in the application. At the end of the precipitation process, the used lubricating oil was mixed manually with kerosene obtained from an official dealer in the market.

A test to see the physical properties of new lubricating oil, kerosene, and the mixture of the used lubricating oil and kerosene (mixed fuel) was performed, which measures:

a. Viscosity by ASTM D2501 - 11
b. Flash point by ASTM D93 IP 34
c. Density by ASTM D1298
d. Calorie value based on ASTM D4809
e. Cetane Number by ASTM D976

This study follows the research flowchart shown in Figure-1. Temperature measurements in the casting process were performed on the flame and on the liquid metal. The measuring instrument used was infrared thermogun. The raw materials for smelting used aluminum were taken from Coca-Cola, Fanta, and Sprite soft drink cans. With air and fuel piping systems from blowers, a mixture of used spent lubricating oil fuel with air from the blower supply is used to melt spent aluminum in a crucible.

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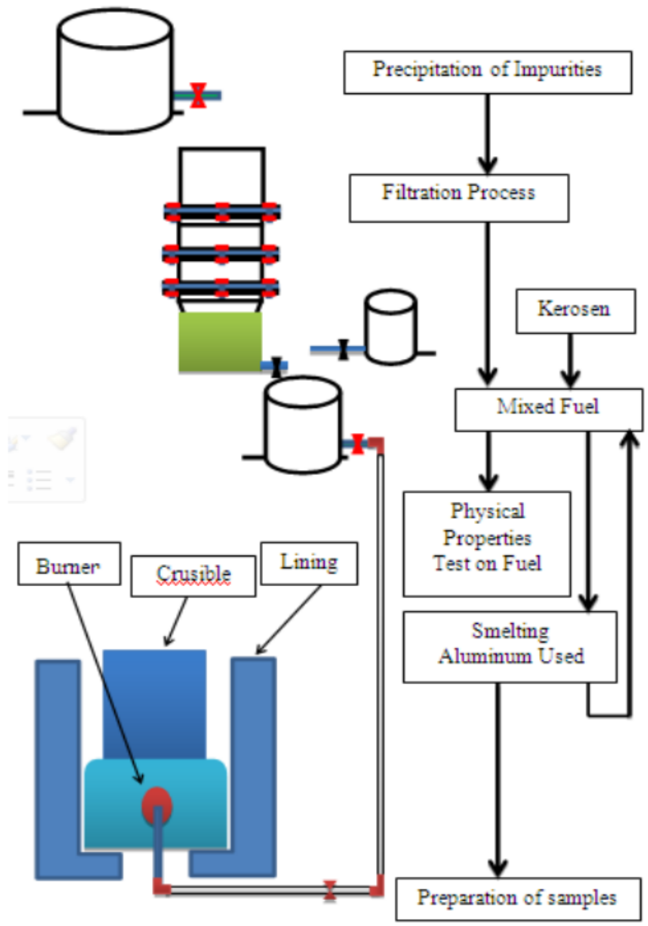

Figure-1. The flowchart of the research.

3. RESULTS AND DISCUSSIONS

The complete measurement data are presented in Table-1. It can be seen from the table that the new lubricating oil has greater measured values than those of the waste lubricating oil, except for density values that appear to be roughly equal for both the mixed or unmixed ones. N90 is the new lubricating oil (lubricating oil sold in the market in drums and is declared as recycled lubricating oil) with 10% kerosene content, while X90 is the filtered used lubricating oil with 10% kerosene content.

Seeing that kerosene functions as a diluent for the lubricant oil, it can be utilized to reduce the viscosity of new, recycled, or used lubricating oil. The viscosity reduction is intended so that lubricating oil can easily be transformed into mist or be atomized. It can be said that such dilution has been a success and lubricating oil can be continuously used as fuel.

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Table-1. Physical properties of new and waste lubricating oil mixed with kerosene.

	Viscosity (mm²/s)	Density (g/cm³)	Cetane number	Flash point (°C)	Calorific value (kcal/kg)
New Lubricating Oil (N)	131.73	0.84	59.8	305	10,788
N90	68.57	0.84	59.2	238	10,782
N80	41.14	0.84	58.2	191	10,771
N70	24.22	0.84	55.5	102	10,739
N60	15.02	0.85	53.2	85	10,726
Waste Lubricating Oil (X)	60.06	0.82	57.8	191	10,787
X90	33.33	0.82	57.5	146	10,784
X80	21.32	0.83	55.5	128	10,784
X70	15.52	0.85	53.4	94	10,763
X60	10.81	0.85	52.2	86	10,709
Kerosene	1.86	0.84	39.1	42	10,706

3.1 The results of the design

The piping system for fuel flow and air supply blower was made. The piping system consists of two pipes: the main air pipe and the fuel supply pipe is shown in Figure-2. Mixing these two fluids takes place on the outside of both ends of the pipes. The 3-inch outer diameter main pipe, which is inside and located at the core of the main pipe, is a fuel pipe. The complete installation of a simple furnace system is shown in Figure-3.

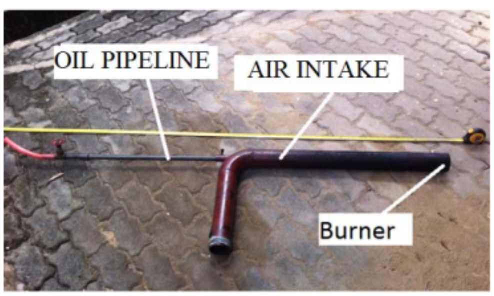

Figure-2. Piping system.

Figure-3. The complete installation of a simple furnace system.

3.2 Ignition of fuel blend, used aluminum smelter, and test for measuring temperatures

The fuel used at this stage uses a mixture of used oil with a mixture of 90% kerosene with used oil and 10% kerosene. This was done by taking into account the viscosity of the mixture whose percentage is lower than that of pure used lubricating oil.

In practice, the maximum measured ignition temperature that could be achieved is 922 °C. This temperature was achieved by opening 100% of the air supply regulator in the blower, hence the abundant supply of burning oil. Taking into account the aluminum melting temperature at only 740 °C, the aperture was adjusted to only 50%, while the opening valve (stop valve) of fuel oil was opened completely. The ignition was done by feeding wooden branches into the flame, which lit up gradually, as the air and oil were supplied slowly until it was fully burning, and then the arrangement was set according to the research plan. The measurement with the thermogun is shown in Figure-4.

Figure-4. Measurement by means of infrared Thermogun.

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The mixed temperature values between used lubricating oil and kerosene are shown in Table-2.

Table-2. Measured temperatures Mixture of 90% Used Lubricating Oil and 10% Kerosene.

No	Air Aperture (%)	Temperature (°C)
1	0	445
2	25	670
3	50	834
4	75	895
5	100	922

The remelting and casting produced the resulting used aluminum as shown in Figure-5. Figure-6 shows some of the tensile test samples made from the casting with the simple piping system. It appears that the low-capacity crucible for the casting is capable of producing good results.

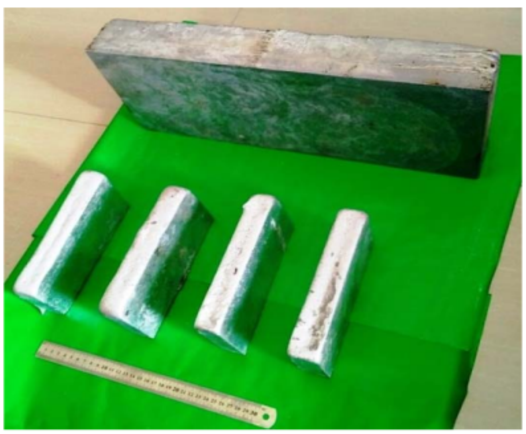

Figure-5. Casted aluminum block made of waste aluminium.

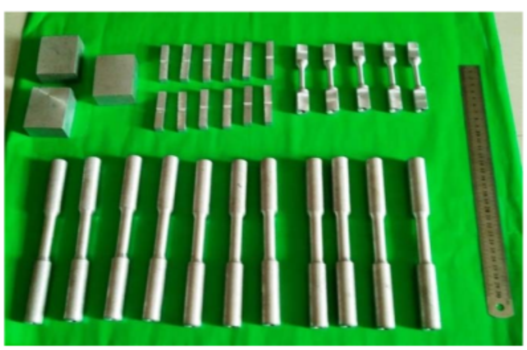

Figure-6. Test samples.

4. CONCLUSIONS

The results show that this filtration system is the easiest way to get fuel for used aluminum liquefaction. Decreasing values of physical properties happen after lubricating oil filtration results are mixed with kerosene. However, this decrease does not have a major effect, so this research has actually achieved its purpose: to get fuel that will be in accordance with the design of fuel burner, by facilitating purification of used lubricants from dirt drained through the supply pipes and nozzles from the burner.

This study has gained success in making a simple piping system for mixing used lubricating oil mixed with kerosene. There is no viscosity barrier because of the mixing of both types of oil. A suitable temperature has been obtained for aluminum smelting and the temperature can be kept stable by controlling air intake in the blower.

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