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# Avtur Waste Treatment to Produce Useful Fuel Products based on ASTM Standard

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**Abstract**

The many avtur samples that are tested every month has an impact on avtur waste that accumulates in the PT. Pertamina Lubricant PU Jakarta laboratory. Avtur wastes are usually just thrown away without being processed again. This study focuses on the utilization of avtur test results waste by knowing the quality of avtur waste with flash point, distillation, freezing point, density and color test parameters. The aims of this research are to solve the problem of waste from avtur testing results by reusing avtur waste to become a product so as to reduce the occurrence of losses. The first step is to prepare a sample of waste from avtur test results and then perform tests on the flash point, distillation, freezing point, density and color test parameters. After that, avtur waste was formulated: avtur ASTM standard T.107 with variations in the formulation, namely 5% LA : A, 10% LA : A, 15% LA : A and 20% LA : A. After that, the mixing process was carried out for 15 minutes using a stirrer motor with a speed of 300 rpm (rotations per minute). Then flash point, distillation, freezing point, density and color tests were carried out to get results that match the specifications of the avtur. The results showed that the formulation of the avtur test results: avtur according to American Standard Testing and Material (ASTM) standard had met the avtur specifications. Where the best formulation was found in 10% avtur waste formulation with test value of color : 25, density : 802.4 Kg/m3, flash point : 42.5 $^{o}$C, freezing point : -55.0 $^{o}$C and distillation (IBP : 156.0 oC, 10 % : 172.0 $^{o}$C, 50% : 194.0 $^{o}$C , 90% : 225.0 $^{o}$C, End Point : 257.0 $^{o}$C. Based on the results of the formulation testing that has been carried out, the avtur test results formulated with ASTM standard for avtur have met the company's quality standards.



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## INTRODUCTION

PT. Pertamina (Persero) Lubricant PU Jakarta is a company in charge of managing oil and gas mining in Indonesia. The quality products produced, such as liquid petroleum, gas avtur gasoline (avgas), petrol/ avtur mogas (motor gasoline), naphta, avtur (paraffin), Diesel, Fuel oil, Lubricating Oil, and Bitumen (**Figure 1**), of course have a very positive impact in order to maintain the domestic energy balance 9 (Vassilev, S. V., Baxter, D., Andersen, L. K., & Vassileva, C. G. 2010). Avtur (aviation turbine fuel) is aircraft fuel derived from the processing of kerosene fraction petroleum which has combustion properties and high energy whose specifications are tightened (Jena, U., Das, K. C. 2011).

This type of kerosene has been chosen as a fuel for the first generation because it has good combustion properties and is low on fire. The quality of avtur fuel is not only determined by the design and performance of the engine as well as its economic value, it is also determined by in-flight safety (Sari, D. K. 2019). This fuel is obtained from petroleum processing with a certain composition, both from the distillation process and the cracking process (Haidir, 2001; Loupatty, 2014; Sari & Ternando, 2019).

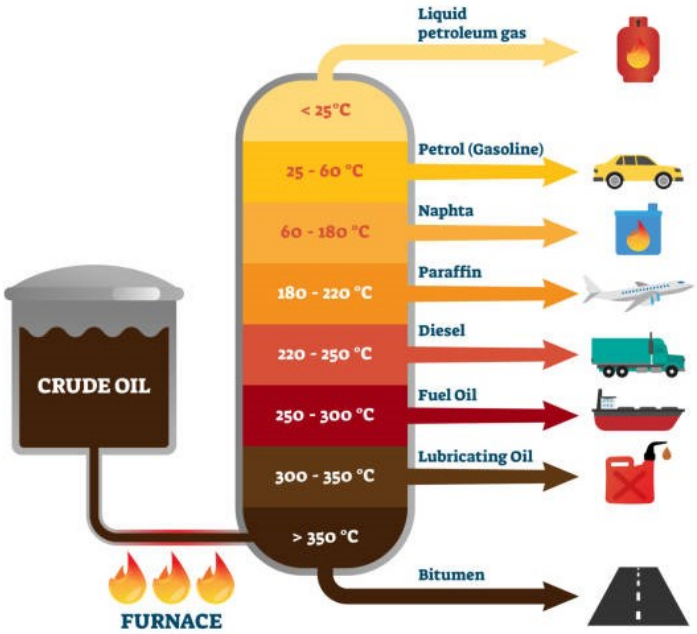


**Figure 1.** The quality products produced from oil and gas mining

Avtur produced from petroleum processing, has a boiling point between 150-300 °C, consists of hydrocarbon molecules (C11-C15) and the freezing point is limited to a maximum of -47 °C. Avtur is used as fuel for airplanes with turbine engines (jets), has strict requirements when compared to other fuels. Avtur as an aircraft fuel with high safety risk, must have a high combustion value and combustion quality and a low freezing point (Haidir, 2001). ASTM stands for American Standard Testing and Materials. Formed by a group of American engineers and scientists in 1898 which is used as a standard reference to design / engineer something in the field of civil engineering that has been standardized (Beims, R. F., Hu, Y., Shui, H., & Xu, C. 2020). For avtur, oil, and gas standards in Indonesia, standard provisions have been regulated in the Decree of the Ministry of Energy and Mineral Resources of the Republic of Indonesia in 2021.

Based on previous research, regarding the determination of the quality of avtur fuel at PT. Pertamina (Persero) Refinery Unit II Dumai obtained avtur quality for the first, second and third weeks in a row as follows: total acidity 0.002; 0.002 ; and 0.002 mgKOH/g ; aromatic 10.03 ; 9.9 ; and 10.2% (v/v); sulfur mercaptan 0.0005; and 0.0007 % (w/w); naphthalene 0.0031 ; 0.0155 ; and 0.0109 % (v/v), where the total value of acidity, aromatics, mercaptan sulfur, and naphthalene has met the quality standard according to Defense of Standard 91-91 ISSUE 7 fresh but from waste and it is necessary to add test parameters (ASTM.D5972-16., 2008; ASTM.D86-17., 2008; ASTM.D40052-15., 2013; ASTM.D6045-12., 2018; Rofiansyah, 2015).

PT. Pertamina Lubricant PU Jakarta (PUJ), in addition to producing lubricants and grease, also acts as a test lab for external products, one of which is avtur products that exist throughout Indonesia. The number of avtur samples that are tested every month has an impact on avtur waste that accumulates in the PUJ laboratory. Avtur wastes are usually just thrown away without being processed again. Where in a day sample test requests received as many as 3-4 samples. Each avtur sample consists of two parts, namely top and lower, each containing 1 liter/bottle. So the total of one avtur sample is 2 liters. If averaged in a day there are 6 liters/bottle of aviation fuel samples and in a month there are approximately 180 liters of aviation fuel.

This study focuses on the utilization of avtur test results waste by knowing the quality of avtur waste with flash point, distillation (Fatimura, M. 2014), freezing point, density and color test

parameters. It is hoped that this research can solve the problem of waste from avtur testing results by reusing avtur waste to become a product so as to reduce the occurrence of losses.

## METHOD

The tools used in this research are a set of trial blend tools, density meter, automatic color, a series of distillation tools, flash point capable and analytical balance. The materials used in this test are avtur test results, avtur according to ASTM standard T.017, SBPX solution (as a rinse and cleaner for testing equipment), and aluminum foil.

### Sample Preparation Process

Avtur waste that was obtained in September (obtained for a month) 2021 from the results of testing the used avtur waste in PT. Pertamina Lubricant PU Jakarta, Indonesia. The avtur waste that was not used in the testing process was then mixed and weighed into a beaker as much as 1000 g then store the beaker on the blend tool and close. Furthermore, the glass beaker using aluminum foil was stirred using a blend tool at a trial speed +/-300 rpm and wait for the blending process for 15 minutes. After the process is complete and the results of the mixture of avtur waste are obtained, then the density, color, flash point, distillation and freezing point tests are carried out to determine the value of the waste before formulation.

### Avtur Waste Formulation

Avtur waste that has been blanded and tested is then formulated. Avtur waste is mixed in avtur according to KP with respective formulations, LA (5%) :A, LA (10%) :A, LA (15%) :A, and LA (20%) :A using a set of bland tools for 15 minutes. minutes at a speed of +/-300 rpm. Then the resulting LA:A formulation will be tested for density, color, flash point, distillation and freezing point.

**Table 1.** Avtur Waste Formulation (LA): Avtur Release (A)

| **Product** | **Formulation LA : A (b/b) gram** | | | | |
|---|---|---|---|---|---|
| | **0%** | **5%** | **10%** | **15%** | **20%** |
| Avtur Waste (LA) | 1000 | 50 | 100 | 150 | 200 |
| Avtur (A) according to KP | 0 | 950 | 900 | 850 | 800 |
| Total | 1000 | 1000 | 1000 | 1000 | 1000 |

(**Source :** Data of this study)

### Digital Density Meter

Aspirate the SBPX solution and rinse the tool using a syringe 3 times. Aspirate avtur sample and inject syringe into the tool. Press the start button, then the tool will work automatically. Wait for the test results. After the instrument displays the results of the density test, for the four significant figures, record the test results on the monitor layer as density (ASTM.D5972-16., 2008; ASTM.D86-17., 2008; ASTM.D40052-15., 2013; ASTM.D6045-12., 2018).

### Automatic Color

Place the sample cup that has been filled with the sample on the tool and take measurements according to the TKPA (Work Procedures for Using Tools) or the manufacturer's instructions. Click the start button, the tool will work automatically. Report color values or Saybolt color values as per reporting (ASTM.D5972-16., 2008; ASTM.D86-17., 2008; ASTM.D40052-15., 2013; ASTM.D6045-12., 2018).

### Distillation Equipment Circuit

Put the sample in a 100 mL measuring cup. The sample that has been measured is poured into a distillation tube. Insert the distillation tube into the series of tools and attach the thermometer.

Install the measuring cup at the end of the condenser and turn on the heater and observe the test results (ASTM.D5972-16., 2008; ASTM.D86-17., 2008; ASTM.D40052-15., 2013; ASTM.D6045-12., 2018).

**Freezing Point**

Aspirate the SBPX solution and rinse the tool using a syringe 3 times. Then suck avtur sample and inject it into the tool. Click the run button then the tool will work automatically. The tool will display the results of the freezing point test (ASTM.D5972-16., 2008; ASTM.D86-17., 2008; ASTM.D40052-15., 2013; ASTM.D6045-12., 2018).

**Flash Point Abel (IP 170)**

Put the avtur sample into a brass cup as much as 75 ml. Insert the brass cup containing the sample into the Abel flash point tool. Setting the expected temperature on the tool then turn on the condenser. Click the apply button to check the fire and close the automatic valve then click start and wait for the test results to automatically read the test results.

## RESULTS AND DISCUSSION

**Quality of Avtur Waste After Homogenization Process**

Based on the quality test of avtur waste obtained during September, the results are shown in **Table 2**. The quality of avtur waste that has been tested by the lab does not meet the speculative standards of avtur products. This is because one of the flash point test parameters is still below the standard, while the other test parameters such as color, density, freezing point and distillation are still according to speculation, although the test values tend to be low.

**Table 2.** Avtur Waste Test Results

| Test | Spec Avtur | Avtur Waste Results | Unit |
|---|---|---|---|
| Colour | Reported | 12 | - |
| Density | Reported | 799.2 | Kg/m$^3$ |
| Flash Point | Min 38.0 | 27.0 | $^o$C |
| Freezing Points | Max -47.0 | -52.7 | $^o$C |
| Distillation | - | - | - |
| -IBP | Reported | 151.0 | $^o$C |
| -10% | 205.0 | 167.0 | $^o$C |
| -50% | Reported | 193.0 | $^o$C |
| -90% | Reported | 222.0 | $^o$C |
| End Point | 300.0 | 251.0 | $^o$C |
| Residue | 1.5 | 1.4 | % Vol |
| loss | 1.5 | 0.5 | % Vol |

(**Source :** Data of this study)

The decrease in flash point value in avtur waste was caused by damage and loss of hydrocarbon components during the flash point testing process and sample distillation in fresh conditions (Carli, M. F., Susanto, B. H., & Habibie, T. K. 2018). Where the loss of the hydrocarbon component is due to the repeated testing (heating) process because this waste sample is a combination of several test results of avtur samples that have been accommodated in a month.

The repeated combustion process when the previous sample was tested resulted in the hydrocarbene component undergoing an overhaul, so that many of the hydrocarbon components evaporated. According to Rofienda (2013), volatile hydrocarbons are widely used as fuel and industrial solvents, paint industries and other chemical industries (Milne, T. A., Brennan. A. H., & Glenn, B. H. 1990; Sánchez, N. M., Link, F., Chauhan, G., Halmenschlager, C., El- Sayed, H. E., Sehdev, R., Lehoux, R., & Klerk, A. 2021). So that the avtur waste can be valuable, a formulation process is carried out with the released avtur product (De Jong, S., Hoefnagels, R., Wetterlund, E., Pettersson, K., Faaij,

A., & Junginger M. 2017). the formulation process is carried out by a blending process. The specifications for the avtur release sample are in **Table 3**.

**Table 3.** Results of Avtur Release T.107 No Batch SKH/T.107/326

| Test | Spec Avtur | Avtur Waste Results | Unit |
|---|---|---|---|
| Colour | Reported | 28 | - |
| Density | Reported | 805.7 | Kg/m$^3$ |
| Flash Point | Min 38.0 | 45.5 | $^o$C |
| Freezing Points | Max -47.0 | -55.2 | $^o$C |
| Distillation | - | - | - |
| -IBP | Reported | 160.0 | $^o$C |
| -10% | 205.0 | 174.0 | $^o$C |
| -50% | Reported | 196.0 | $^o$C |
| -90% | Reported | 228.0 | $^o$C |
| End Point | 300.0 | 258.0 | $^o$C |
| Residue | 1.5 | 1.1 | % Vol |
| loss | 1.5 | 0.5 | % Vol |

(**Source :** Data of this study)

In **Table 3** the parameter values for avtur Tank 107 meet the specifications, so it is used as a formulation material for avtur waste. The formulations used are 5%, 10%, 15% and 20%. It is hoped that the formulation process can increase the value of avtur waste, so that avtur can be resold.

**Quality of Avtur Waste After Formulation Process**

Based on the quality test of avtur waste that has been formulated with avtur Tank 107, the following results were obtained (**Table 4**).

**Table 4.** Formulation of Avtur Waste Testing: Tank Avtur 107

| Test | Spec Avtur | Results | | | | Unit |
|---|---|---|---|---|---|---|
| | | 5% | 10% | 15% | 20% | |
| Colour | Reported | 27 | 26 | 24 | 20 | - |
| Density | Reported | 804.0 | 802.4 | 800.9 | 800.4 | Kg/m$^3$ |
| Flash Point | Min 38.0 | 44.0 | 42.5 | 38.5 | 33.5 | $^o$C |
| Freezing | Max | -54.5 | -55.0 | -54.5 | -54.6 | $^o$C |
| Point | 47.0 | - | - | - | - | - |
| Distillation | - | - | - | - | - | - |
| -IBP | Reported | 158.0 | 156.0 | 154.0 | 154.0 | $^o$C |
| 10% | 205.0 | 172.0 | 172.0 | 170.0 | 169.0 | $^o$C |
| -50% | Reported | 196.0 | 194.0 | 194.0 | 193.0 | $^o$C |
| -90% | Reported | 226.0 | 225.0 | 225.0 | 223.0 | $^o$C |
| End Point | 300.0 | 257.0 | 257.0 | 255.0 | 251.0 | $^o$C |
| Residue | 1.5 | 1.0 | 1.1 | 1.1 | 1.3 | % Vol |
| loss | 1.5 | 0.5 | 0.5 | 0.6 | 0.5 | % Vol |

(**Source :** Data of this study)

In **Table 4** that the color test parameters have decreased, this is due to the avtur waste tends to have a yellowish color due to the formation of residues due to the combustion process during the distillation test (Djandja, O. S., Wang, Z. C., Wang, F., Xu, Y. P., & Duan, P. G. 2020). However, even though the color value decreases, the formulation results are still released because the avtur product specifications do not have a minimum limit, namely reported.

Furthermore, for the density test parameter, the addition of the formulation resulted in an increase in the density value of avtur waste, this is because avtur tank 107 has a higher density value

than avtur waste, so the higher the percentage of avtur tank 107, it can increase the density value of avtur waste (Usman, K. (2013; Hendrawati, T. Y., Siswahyu, A. & Ramadhan, A. I. 2018).

Then for flash point testing for the 20% formulation, the test results do not enter the aviation fuel specification, which is 33.5 $^{o}$C (repead), this is because avtur waste has a lower flash point value of 27 $^{o}$C (repead), thus affecting the flash point value when formulated in large number (Shi, H., Mahinpey, N., Aqsha, A., & Silbermann, R. 2016). Meanwhile, the addition of 15% flash point value increased by 38.5 $^{o}$C (release) where the formulation met the minimum avtur product specifications 38 $^{o}$C, although according to the 15% formulation specifications, it is feared that there will be a decrease when the sample will be stored in a storage tank and the average value of avtur products sold has a flash point value above 40 $^{o}$C and above. As for the 10% formulation, it is fairly good because the flash point value is 42.5 $^{o}$C, so it doesn't really affect the decrease in the flash value when stored in the storage tank.

For testing the freezing point parameter, the addition of the formulation did not really affect the test value even though the freezin point value tends to fluctuate. This is because the freezing point value of the avtur test results is not too far off when compared to the avtur release freezing point value of T.107 so that the value tends to fluctuate. Furthermore, for the distillation parameter, the addition of the formulation experienced a downward trend even though it had met the specifications for the IBP, 10%, 50%, 90% and End Point values. This is because the avtur waste value is lower than tank avtur. So that the variation of the formulation is able to increase the value of the avtur waste itself.

## CONCLUSION

The quality of avtur waste does not meet the speculative standards that have been set from avtur products. This is because one of the test parameters, namely the flash point is still below the standard, which is 27 $^{o}$C, while the test parameters for color, density, freezing point are according to speculation. On the other hand, the best quality of avtur waste formulation is 10% formulation with color test value: 26, density : 802.4 Kg/m$^3$, flash point : 42.5 $^{o}$C, freezing point : -55.0 $^{o}$C and distillation (IBP : 156.0 $^{o}$C, 10% : 172.0 $^{o}$C, 50% : 194.0 $^{o}$C, 90% : 225.0 $^{o}$C, End Point : 257.0 $^{o}$C Based on the results of the formulation testing that has been carried out, the avtur formulated with avtur waste has met the company's quality standards.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest concerning the publication of this article. The authors also confirm that the data and the article are free of plagiarism.

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