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Determining the Value of the Viscosity Coefficient of Pertalite Gas Stations and Retail Filling Stations Using the Logger Pro Application

Arini Rosa Sinensis[1]*, Thoha Firdaus[2], Effendi[3], Widayanti[4], Defi Rahmawati[5]

[1] *Department of Physics Education, Universitas Nurul Huda, Indonesia, arini@stkipnurulhuda.ac.id*
[2] *Department of Physics Education, Universitas Nurul Huda, Indonesia, thohaf@stkipnurulhuda.ac.id*
[3] *Department of Physics Education, Universitas Nurul Huda, Indonesia, effendi@unha.ac.id*
[4] *Department of Physics Education, Universitas Nurul Huda, Indonesia, widayanti@stkipnurulhuda.ac.id*
[5] *Department of Physics Education, Universitas Nurul Huda, Indonesia, verawatidefi@gmail.com*

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ABSTRACT

This study aims to determine the absolute viscosity value of pertalite fuel sold at gas stations and retail. The method used is an experiment with video analysis assisted by Logger Pro software. The number of retail pertalite samples tested consisted of 5 samples taken from different places. The research step is to analyze the video recorded on the motion of a falling object, namely an iron ball (Gotri) into the fluid (pertalite fuel) with logger pro software then track the video recording and obtain terminal time and speed data. From the results of the terminal velocity then it is calculated to the absolute viscosity equation. The results of the test showed that there was no significant difference between the viscosity of pertalite sold by gas stations and those sold at retail. This is evidenced by the average viscosity coefficient value of Pertalite gas stations of 0.4074 (Ns/m^2) while the viscosity of retail pertalite is 0.4019 (Ns/m2). These results conclude that the pertalite sold retail in East Ogan Komering Ulu area is still maintains the quality of pertalite from gas stations so that it is safe for vehicle engine performance.

Keywords: Viscosity, Fuel oil, Pertalite, Logger Pro

ABSTRAK

Penelitian ini bertujuan untuk menentukan nilai viskositas mutlak pada bahan bakar pertalite yang dijual di SPBU dan Eceran. Metode yang digunakan adalah eksperimen dengan menggunakan analisis video berbantuan *software Logger Pro*. Jumlah sampel pertalite eceran yang diuji terdiri dari 5 sampel diambil dari tempat yang berbeda. Langkah penelitiannya adalah menganalisis video hasil rekaman pada gerak benda yang jatuh yaitu bola besi (Gotri) ke dalam Fluida (bahan bakar pertalite) dengan *Software logger pro* kemudian melakukan *tracking* terhadap video rekaman dan diperoleh data waktu dan kecepatan terminal. Dari hasil kecepatan terminal lalu di kalkulasikan ke persamaan viskositas mutlak. Hasil dari pengujian didapatkan bahwa tidak ada perbedaan yang signifikan antara viskositas pertalite yang dijual SPBU maupun yang dijual eceran. Hal ini dibuktikan dengan rata-rata nilai koefisien viskositas pertalite SPBU sebesar 0,4074 (N.s/m^2) sementara viskositas pertalite eceran 0,4019 (N.s/m^2). Hasil ini memberikan kesimpulan bahwa pertalite yang dijual eceran di wilayah Ogan Komering Ulu Timur tetap mempertahankan kualitas pertalite dari SPBU sehingga aman bagi kinerja performa mesin kendaraan.

Kata kunci: Viskositas, Bahan bakar minyak, Pertalite, *Logger Pro*

INTRODUCTION

One of the physical parameters in determining the quality of fuel oil is viscosity (Knothe & Steidley, 2005). Viscosity is the viscosity property of a fluid that affects the resistance of a shear force and resistance when the fluid is in contact with a solid boundary (Pérez-Sánchez et al., 2018). The temperature has a strong effect on viscosity (Hasan et al., 2010). The viscosity of the fluid decreases as the temperature increases. This is because the cohesion of the fluid decreases with increasing temperature, as well as its viscosity (Lestari, 2017). In Indonesia, the consumption of fuel oil for the transportation sector is dominated by road transportation, which is 88% (Akhmad & Amir, 2018). Therefore, good quality fuel oil is needed. In general, fuel oil in Indonesia is sold through Pertamina gas stations and also at retail. In Indonesia, the Public Fuel Filling Station functions as a place to buy fuel oil at retail or retail for motorized vehicles, both two-wheeled and four-wheeled and more. The familiar fuels used by the public are Pertamax and Pertalite.

The condition of a very diverse society with different economic levels, and the unequal availability of public fuel filling stations in each region has resulted in some people buying relatively cheap fuel, one of which is Pertalite. This fuel oil is not only sold at Pertamina's General Refueling Station but is also sold at retail. This is because the location of people's residences is diverse and not all of Pertamina's Public Refueling Stations are available, resulting in people buying retail Pertalite. Whereas fuel oil sold at retail can affect the quality of the fuel oil itself because most of it is packaged in plastic bottles used for drinking water. Exposure to direct sunlight (heat) and air (oxygen) can change the physical/chemical specifications of the fuel (Lumbantoruan & Yulianti, 2016). Based on the above, the researchers were interested in researching the viscosity of Pertalite type fuel oil. This study aims to determine the viscosity value of Pertalite fuel which is sold at Pertamina's General Fuel Filling Station and which is sold at retail. The research data was analyzed using the Logger Pro application. Thus the results of this study are expected to provide scientific information to the public on using quality Pertalite fuel so that it is safe for the performance of their vehicle engine performance.

Logger Pro application is software that is used to analyze the shape of curves, videos or images. The use of the Pro logger has been widely used to analyze physical phenomena including the Pro logger to determine Co2 content analysis with sensors (Astuti & Firdaus, 2017), analysis of physics experiments on momentum (Rahmawati et al., 2020), analysis of water quality with PH parameters (Anggeraeni et al., 2020), water viscosity value (Rada & Panuluh, 2021), for the measurement of steel shear modulus using spring-mass oscillation analysis (Hia & Panuluh, 2021) and magnetic damping (Panuluh & Bulu, 2021). From this description, it shows that technological developments play a very important role in science and physics learning. Its role is very helpful in the process of analyzing, collecting research data efficiently. Thus in this study a logger is used to track the results of the video analysis of the motion of the iron ball which will be applied in pertalite.

METHODOLOGY

The method used in this research is experimental. The stage in this research was to analyze the video recording of the motion of objects dropped in a tube filled with pertalite fuel using *Logger Pro software*. After that, tracking was carried out on the video recording of the motion of the iron ball (gotri) that fell in the pertalite so that it got time and speed data. Based on these data, the viscosity of the fluid (Pertalite) can be calculated. The sample of this research was Pertalite from

gas stations and 5 samples of retail Pertalite in East Ogan Komering Ulu (OKU). Tools and materials for viscosity testing are shown in the figure 1.

Figure 1.a. Tube measuring 50.5 cm

Figure 1.b. Gotri Iron Ball (R = 0.0005 m)

Figure 1.c. Retail Pertalite Sample

Figure 1. Tools and materials used in research

After the tools and materials were prepared, the next step was to assemble the tools. The series of test equipment can be shown in Figure 2.

Figure 2. The circuit is a tube that will be filled by pertalite

The results of the viscosity test on pertalite fuel are then analyzed using the logger pro application to determine the terminal speed. After that, the determination of the viscosity coefficient is calculated using equation 1. As for the acceleration due to gravity (g), the standard value of the average acceleration due to gravity is 9.8 m/s^2.

$$\eta = \frac{2gR^2(\rho_{bola}-\rho_{fluida})}{9}\frac{1}{v} \quad (1)$$

RESULTS AND DISCUSSION

Determination of the value of the viscosity coefficient was used using a fairly simple viscosity experimental tool, namely using a tube filled with fluid and a small iron ball as shown in Figure 2. The iron ball is then dropped into the tube and then recorded with a camera with good resolution. The fluid used in this experiment is pertalite fuel. Data collection begins by recording the motion of the ball that is dropped into the rope. Pertalite samples used in this test are 1 Pertalite gas station and 5 retail Pertalite taken randomly from several villages and different sub-districts. The experiment was repeated 2 times for each sample.

There are two kinds of viscosity, namely dynamic viscosity, in which fluid properties relate shear stress to fluid motion. The kinematic viscosity is the ratio between dynamic viscosity and fluid density (Maroto et al., 2010). Kinematic viscosity decreases exponentially with increasing temperature in the fuel (Dafsari et al., 2019). In testing the viscosity of this pertalite fuel, namely testing the absolute viscosity. This test is carried out by analyzing the video, namely entering the recorded video results into the Logger pro application or software, starting with calibration, determining the initial position from the state before it reaches the exact position of the iron ball (gotrit) falling to touch the fluid (pertalite). The results of the video recording the trajectory of the ball's motion is shown in Figure 3.

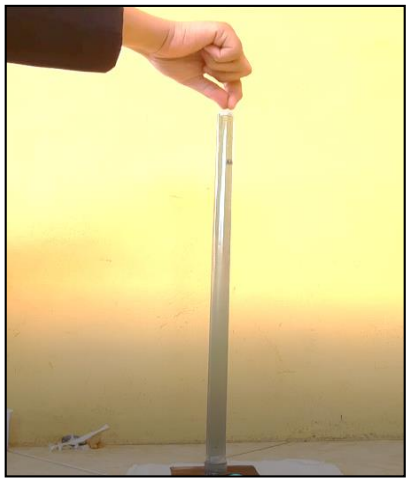

Figure 3. Video recording of the trajectory of the ball being dropped

The motion of the ball that has been analyzed will be illustrated as a graph as shown in Figure 4. The graph chosen is the graph of x against t to get the terminal velocity value, namely through the slope of the graph. The x-coordinate was chosen because the analyzed video is horizontal. This also makes it easier and more accurate in the tracking process.

Based on the graphic equation, it is obtained that the linear equation x=mt+b, with the parameter m indicating the velocity and b being the initial position. Thus to determine the terminal velocity can be represented from the value of m graph equation. The value of the viscosity coefficient in the pertalite fuel test is calculated by equation 2.3 with the R value of iron ball (gotri) = 0.0055m, (gotri) = 8000 (kg/m^3), (pertalite) = 770 (kg/m^3), gravity = 9.8 (m/s^2). Video analysis using *logger pro software* was carried out on 5 retail samples and 1 pertalite from the Public Refueling Station for 2 trials each. So that the results are shown in Table 1.

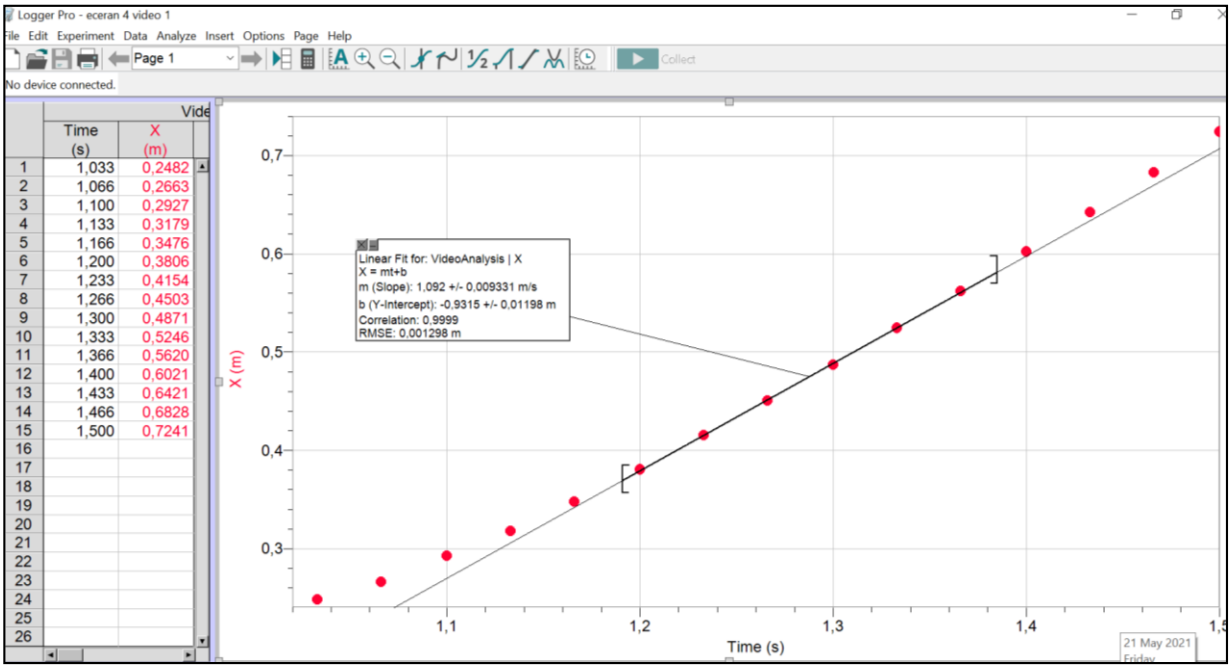

Figure 4. The graph of the video analysis of the motion of the buckshot ball that was dropped in the pertalite

Table 1. Analysis of pertalite fuel viscosity test data

No.	Gas Station Pertalite Sample	v (m/s)	η (Pa.s)
1	Gas Station Pertalite (Video 1)	1,1650	0,4088
	Gas Station Pertalite (Video 2)	1,173	0,4060
		Pertalite Average	0,4074
No.	**Retail Pertalite Sample**	**v (m/s)**	**η (Pa.s)**
1	Retail 1 (Video 1)	1,176	0,4050
	Retail 1 (Video 2)	1,201	0,3965
2	Retail 2 (Video 1)	1,11	0,4290
	Retail 2 (Video 2)	1,134	0,4200
3	Retail 3 (Video 1)	1,204	0,3955
	Retail 3 (Video 2)	1,12	0,4252
4	Retail 4 (Video 1)	1,092	0,4361
	Retail 4 (Video 2)	1,149	0,4145
5	Retail 5 (Video 1)	1,203	0,3959
	Retail 5 (Video 2)	1,274	0,3738
		Retail Average	0,4019

Based on the data in Table 1 shows that the value of the viscosity coefficient is relatively constant and the difference in the resulting viscosity value is not significant. The average result shows that the absolute viscosity coefficient value for gas stations is 0.4074 (Pa.s)(N.s/m²) while retail pertalite is 0.4019 (Pa.s)(N.s/m2). Thus, it can be concluded that there is no difference in the value of the viscosity coefficient in 5 samples of pertalite sold at retail in the East OKU when compared to pertalite sold at gas stations.

Based on the data in Table 1, data analysis was carried out using *IBM SPSS Statistic 20* to test whether there was a difference between the viscosity values and the following hypothesis:

1. H_0 = The result of the retail pertalite viscosity coefficient value is the same as the gas station pertalite viscosity value
2. H_a = The result of the retail pertalite viscosity coefficient value is not the same as the gas station pertalite viscosity value

The results of the test using the t-test are shown in table 2.

Table 2. Significance test results one-sample test

One-Sample Test						
	Test Value = 0.407					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Retail	.354	9	.731	.0021500	-.011575	.015875

The results of the analysis showed that H_0 was accepted and H_a was rejected with a significance value ($p = 0.731 > 0.05$). These results conclude that the viscosity coefficient of retail pertalite is the same as the viscosity value of pertalite at gas stations. The packaging used by retail pertalite sellers has used Aqua bottles, this temperature exposure factor affects the viscosity value, if exposed to sunlight the longer the viscosity value decreases. In this study, there was no significant difference in the viscosity value, which was also influenced by the storage/packaging of retail fuel which was not stored for too long because it sold quickly. Oil requires a maximum storage time of 8 months in plastic bottles, so the quality of the oil will decrease (Suparmi, 2013).

Several factors that are predicted to cause differences in the value of the viscosity coefficient show different results, including the quality of the recorded video. Other factors that may affect the experimental results, namely the motion of the iron ball (gotrit) in the fluid that is not straight (slightly tilted) because it touches the tube wall, the rotational motion of the ball. These factors were also found by (Marliani et al., 2015) in their research in determining the viscosity coefficient of lubricating oil with a software tracker. The pertalite fuel viscosity test was carried out at room temperature and the temperature factor was not analyzed. One of the factors that affect viscosity is temperature, solution concentration, dissolved molecular weight, and pressure. So viscosity is inversely proportional to temperature. If the temperature increases, the viscosity will decrease, and vice versa (Lumbantoruan & Yulianti, 2016). When the temperature rises in a liquid, the molecules will shift to each other more easily making the liquid less viscous (Esteban et al., 2012). Viscosity is also influenced by pressure (Ding et al., 2018), the viscosity will increase with increasing pressure. This can happen because the higher the pressure, the more difficult it is for the liquid to flow due to the load imposed by the liquid. Therefore, viscosity is an important factor affecting the process of fuel atomization in engines (Yuan et al., 2009).

CONCLUSION

Based on the test results about the value of the viscosity coefficient on pertalite fuel at gas stations, an average value of 0.4074 N.s/m² was obtained. Meanwhile, when compared to pertalite which is sold at retail, the average value is 0.4019 N.s/m². These results indicate that there is no significant difference between the value of the viscosity coefficient of pertalite sold by public refueling stations and Pertalite sold at retail.

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