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Analysis characteristics of viscosity coefficient using viscometer stromer

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Analysis characteristics of viscosity coefficient using viscometer stromer

A Malik*, M A Hakiki, N Imiyati, P Kurnia, R Zakwandi, W Setya and M M Chusni

Prodi Pendidikan Fisika, UIN Sunan Gunung Djati, Jl. A.H. Nasution No. 105. Bandung 40154, Indonesia

*adammalik@uinsgd.ac.id

Abstract. This research aims to develop methods of measuring the coefficient of viscosity using viscometer stromer are analyzed using Newtons law of 1. The viscometer stormer came from the simple equipment modifications in the form of a hollow cylinder, laver, a pulley, a ruler, a stopwatch, burdens, taps, boards, iron rods, and rope. The trial results do indicate fairly accurate results with the reference. Furthermore, the equipment used, reaching a level of precision that is good at the moment in the trial to the school community. According to the trial results obtained the relationship between viscosity coefficients against time is inversely proportional. The resulting coefficient of viscosity is greater when the mass of the given object is getting bigger. Thus, the viscometer stomer can describe the relationship between the value of the viscosity coefficient, the time and mass of several types of liquid.

1. Introduction

The viscosity coefficient is one of the properties owned by the fluid material that shows a level of viscosity of a substance. Viscosity in fluid dynamic gives the obstacles during the process of the liquid stream. Liquid viscosity coefficient value is small, tend to flow more quickly than with a liquid that has a large viscosity coefficient [1]. The viscosity can be considered as friction going on inside (internal) fluid [2]. The viscosity of fluid properties aims to describe fluid resistance when flowing [3].

The concept of viscosity is widely used in everyday life. Lubricants (oil) are a clear example of the use of the viscosity concept used in automotive vehicles. Based on the results of research from Scott and Erika shows that the value of the engine oil viscosity coefficient and the addition of oil (special motor) are different. This is because of the difference in the functions of both the oil [4]. The concept of viscosity has also been applied in determining the value of the viscosity coefficient of cooking oil, especially made from palm oil. The viscosity value of palm oil is different before and after repeated heating [5]. The viscosity of a gas increases with increasing temperature because a greater temperature increase occurs when molecular activity increases. Conversely, the distance between liquid molecules is much smaller than gas, so the molecular cohesion there is very strong. Increased temperature will reduce the impact on molecular cohesion, this is indicated by the decreasing value of fluid viscosity [6].

Other research also indicates that that difference value of viscosity can also affect the boiling point of a solution because of the relationship between the coefficient of viscosity with a temperature of the solution is inversely proportional [7]. The application of this concept can be used as a simple method in

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choosing portable chargers based on alternating current. high viscosity coefficient values will inhibit temperature rise.

One of the instruments used to determine the viscosity coefficient is viscometer stromer. This instrument is able to identify the value of the viscosity of a solution that incorporated into the tube of measurement and then the data obtained were analysed and interpreted in such a way. Research that has been done previously has yielded viscometer stromer with quite complex forms. In addition to this, development has ever done to simplify the equipment viscometer stromer gives the limitations and constraints in the form of a level of efficiency and ease of use of the tools. At this time that the system is said to be a balance between force gravity load and friction on the cylinder [8]. Novelties in this study, stromer developed comes from simple equipment and materials. Such equipment is found in everyday life, for example, cylindrical hollow, vessel, pulley, ruler, stopwatch, load, tap, board, iron rod, and rope.

2. Method

The method used in the experiment of making viscometer stromer was research and development. The development method begins by designing a prototype stromer viscometer with the steps as shown in Figure 1.

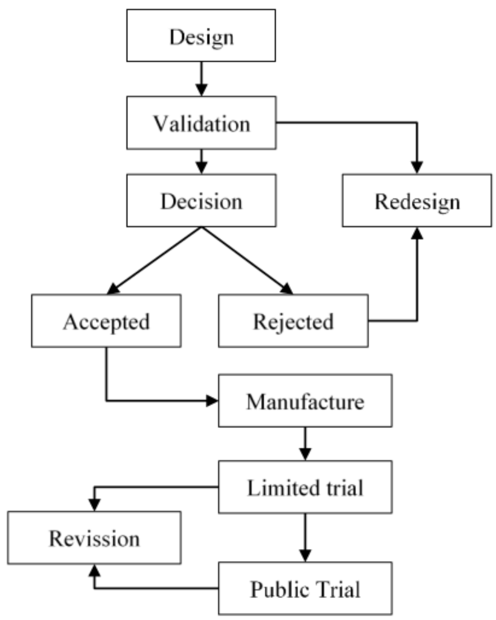

Figure 1. Step of research.

The making of the stromer viscometer is started by first determining the tools and materials used which consist of a hollow cylinder, vessel, fixed pulley, mounting rod, stopwatch, cargo, single tap, foam, wooden board, liquid (water, oil, soap dish), iron rods and ropes. The stromer viscometer tool that has been made is shown in Figure 2

Figure 2. The shape of the stromer viscometer tool.

The stromer viscometer works based on Newton's law which states that each object will maintain a state of silence or move straight regularly unless there is a force acting to change it. This law states that if the resultant force (the number of vectors of all forces acting on an object) is zero, then the velocity of the object is constant [9]. The forces acting on viscometer include force gravity caused by load and friction that appears when moving or rotating the cylinder [8]. At the time the tool was given a load of ballast, the cylinder will spin, the first load will move with the acceleration due to the Earth's gravitational acceleration influences. However, due to friction on the cylinder then the motion of the load change of the motion accelerated motion be straight with constant speed. At this time that the system is said to be a balance between style gravity load and friction on the cylinder [10].

Processing and analysis of experimental data using stromer viscometer ware done using mathematical equation modelling. Understanding of mathematical equation modelling is done based on the balance of forces broken down into three parts, namely the part of friction caused by the cylinder blanket, the friction part by the part of the base and the cylinder cover and gravity load. In detail, the mathematical equations of decline are explained as follows.

2.1. Friction by blanket cylinder

The magnitude of the friction in the liquid is expressed as:

$$f_{viscosity} = k\eta v \tag{1}$$

Linear motion speed and size of the blanket cylinders depending on the radius of the cylinder. The components of the fluid thickness value are the difference of the radius of the tube with a rotating cylindrical vessel:

$$l = \Delta r;$$

for the entire surface of the cylinder, the value becomes:

$$l = r_l - r_d \tag{2}$$

Thus equation (1) can be written

$$f_{vis} = \frac{\eta\,(2\pi r_d h) v (\frac{r_d}{r_k})}{r_l - r_d} \tag{3}$$

$$f_{vis} = \frac{\eta\, 2\pi h v (r_d^2)}{(r_l - r_d) r_k} \tag{4}$$

Friction arose due to the granting of a load that produces gravity that is connected by a rope to the cylinders through a pulley so cylinder rotates. The friction component serves as a counterbalance to the style weight *W* when the load is released and the cylinder starts rotating. So at this time, the condition of the tool meets the inform I Newton then components of gravity load friction and viscosity can be written to:

$$f_{vis} = \frac{\eta\, 2\pi h v (r_d^2)}{(r_l - r_d) r_k} \tag{5}$$

$$mg = \frac{\eta\, 2\pi h v (r_d^2)}{(r_l - r_d) r_k} \tag{6}$$

$$\eta = \frac{mg (r_l - r_d) r_k}{2\pi h v (r_d^2)} \tag{7}$$

If v can be determined by calculating the distance traveled divided travel time (after reaching a motion with no acceleration), where x/t, then the above equation can be written:

$$\eta = \frac{mg(r_l - r_d)r_k}{2\pi h(r_d^2)}\left(\frac{t}{x}\right) \tag{8}$$

2.2. Friction by part of the base and the lid of the cylinder

From the previous equation to viscosity style

$$f_{viscosity} = k\eta v \tag{9}$$

or

$$f_{viscocity} = \frac{A}{l}\eta v \tag{10}$$

and replace A is part of the base and the lid of the cylinder:

$$A = 2(\pi r^2) \tag{11}$$

and v is a rotational velocity of the cylinder.

$$dv = \omega\, dr$$

$$v = (\omega. \int_0^{rd} dr)$$

$$v = \omega . r_d \tag{12}$$

While the value of ω deriver from the motion of the object after reaching the balance position where:

$$\omega = \frac{v}{r_k};$$

so the value of v into:

$$v = \left(\frac{v}{r_k}\right) r_d \tag{13}$$

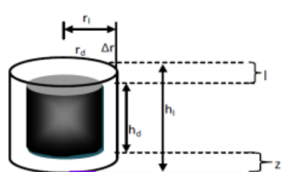

Figure 3. The thickness of the fluid.

Component thickness of fluid (for this section) value is the distance between vast fields of the base or cover with the bottom or surface fluid as described in Figure 3.

If the equations (11) and (13) are combined it will be retrieved:

$$f_{vis} = \frac{\eta\, 2\left(\pi r_d^2\right) v \left(\frac{r_d}{r_k}\right)}{l}$$

$$f_{vis} = \frac{\eta\, 2\left(\pi v (r_d^3\right)}{l(r_k)} \tag{14}$$

Next. If the equation (14) above entered into law I Newton with gravity, when the balance of force $\sum F = f_{vis}$. With $\sum F = W$ and liquid friction in the equation (14) will be retrieved:

$$mg = \frac{\eta\, 2\left(\pi r_d^2\right) v \left(\frac{r_d}{r_k}\right)}{l}$$

$$\eta = \frac{mg(l)r_k}{2\pi v(r_d^3)} \tag{15}$$

If the components of the velocity obtained by calculating the distance travelled divided load time (after reaching a motion with no acceleration), where $v = x/t$, then the above equation can be written:

$$\eta = \frac{mg(l)r_k}{2\pi(r_d^3)}\left(\frac{t}{x}\right) \tag{16}$$

The final equation that can be used to determine the viscosity coefficient is an equation that can cover an entire surface of a rotating cylinder and rub together with fluid. These equations can be obtained from summation equation of gravity with blanket friction tubes (equation 4) and the gravity equation with friction piece pedestal tube and lid (equation 9), the rope is as follows [11]:

$$\eta = \frac{mg(r_l - r_d)r_k}{2\pi h(r_d^2)}\left(\frac{t}{x}\right) + \frac{mg(l)r_k}{2\pi(r_d^3)}\left(\frac{t}{x}\right)$$

$$\eta = \left(\frac{r_l - r_d}{h} + \frac{l}{r_d}\right)\left(\frac{r_k mgt}{2\pi r_d^2 x}\right) \quad (17)$$

with: m = mass (kg), g = acceleration of Earth's gravitation ($m.s^{-2}$), rad = radius of cylinder (m), r_l = outer cylinder radius (m), h = height of the cylinder (m), r_k = pulley radius (m), l = distance between the surface of the bottom with/field of cylinder cover/trays (m), x = distance (m), t = travel time (s).

3. Result and discussion

After the tool stromer viscometer has been made, then it is tested repeatedly to ensure that the stromer viscometer can be used. Based on the experiments carried out, the viscometer practical correction level was obtained from 0.63 with the range of giving a weight mass of 30-50 grams. The right measurement results are obtained by first determining the viscosity coefficient when the tool is empty or not filled with liquid. The measured fluid viscosity coefficient is obtained from the measurement of the fluid coefficient minus the coefficient when the tool is empty [12]. Observations of various types of liquids that have different masses obtained different coefficient and time values. The results of the observations are shown in Table 1.

Table 1. Data observations.

No	Liquid	Mass of Object (kg)	Distance (m)	Coefficient of Viscosity	Time (s)
1	Water	35 x 10^{-3}		0.23 x 10^{-1}	(1.3±0.1)
		35 x 10^{-3}		0.86 x 10^{-1}	(1.6 ±0.1)
		40 x 10^{-3}	$(105\ \pm 0.05)x\ 10^{-2}$	0.25 x 10^{-1}	(0.98±0.1)
		40 x 10^{-3}		0.3 x 10^{-1}	(1.028 ±0.1)
		45 x 10^{-3}		0.29 x 10^{-1}	(0.83±0.1)
		45 x 10^{-3}		0.12 x 10^{-1}	(0.77 ±0.1)
2	Oil	35 x 10^{-3}		0.02 x 10^{-1}	(1.2±0.1)
		35 x 10^{-3}		0.1 x 10^{-1}	(1.26 ±0.1)
		40 x 10^{-3}		0.105 x 10^{-1}	(0.91±0.1)
		40 x 10^{-3}	$(105\ \pm 0.05)x\ 10^{-2}$	0.3 x 10^{-1}	(1.04 ±0.1)
		45 x 10^{-3}		0.23x 10^{-1}	(0.81±0.1)
		45 x 10^{-3}		0.48x 10^{-1}	(0.902 ± 0.1)
3	Dish soap	35 x 10^{-3}		4.01 x 10^{-1}	(3.1±0.1)
		35 x 10^{-3}	$(105\ \pm 0.05)x\ 10^{-2}$	5.12 x 10^{-1}	3.63
		40x 10^{-3}		4.15x 10^{-1}	(2.73±0.)
		40x 10^{-3}		4.18 x 10^{-1}	2.62
		45 x 10^{-3}		3.72x 10^{-1}	2.1
		45 x 10^{-3}		3.72x 10^{-1}	2.1

Based on the above Table 1 each type of liquid viscosity coefficient values has a bit different, depending on the type of viscosity of a substance, the mass and the travel time required. On the mass 35 × 10^{-3}, 40 × 10^{-3} and 45 × 10^{-3} with a mileage of (105 ± 0.05) × 10^{-2}) When the liquid mass is enlarged, the value of the viscosity coefficient obtained will be greater and less time will be needed [13]. Based on this data we can conclude that the relationship between the coefficient of viscosity and the time required is inversely proportional. The greater the viscosity coefficient of a substance, the less time it takes will be less and as well as otherwise.

The third coefficient value of the liquid consisting of the largest water, oil and dish soap is found in dishwashing soap. However, from the data obtained the value of the viscosity coefficient on water and dishwashing soap does not match the theory described. Where when the value of the viscosity coefficient on water and dish soap is small, the time needed is also short. Supposedly if the viscosity coefficient is large then the time needed is short, because the relationship between coefficient values and time is inversely proportional. This happens because the factors that occur when the data retrieval process lack of thoroughness or there is an error in the component tools [14].

From these observations, if we compare it with the existing observations with regard to viscosity as practical tools ever undertaken by Budianto is indeed still there is little difference. The results of the observations made by Budianto can be seen in the Table 2 [15].

Table 2. Viscosity data.

No	Liquid	Temperature (°C)	Viscosity Coefficient	Uncertainty
1	Water	27	0.3 ± 0.01	3.86 %
		90	0.2 ± 0.01	5.55 %
2	Cooking Oil	27	2.3 ± 0.02	1.05 %
		90	1.4 ± 0.05	3.55 %
3	Oil	27	8.5 ± 0.2	1.77 %
		90	1.5 ± 0.04	2.88 %

From Table 2, we can see some differences in observing the value of the viscosity coefficient. For example, the use of liquid used, Budianto uses oil and oil other than water. Observations made in this study used water, oil and dishwashing soap. Besides, there is a temperature difference. Budianto's observations measured the temperature of the fluid, while in this study did not take temperature measurements. The value of the viscosity coefficient of the liquid produced between observations in this study with Budianto's observation was only slightly different and even close to the same [15].

4. Conclusion

We have succeeded in conducting research on the analysis of viscosity coefficient characteristics using viscometer stromer. The viscometer stomer made in this study comes from simple materials and equipment found in many daily lives. Based on the results of research, the relationship between the viscosity coefficient is inversely proportional to time. If the value of the type of substance viscosity coefficient is greater, the time needed will be less, and vice versa. The viscosity coefficient of water and dish soap decreases when the mass is given bigger. Only the value of the oil viscosity coefficient is greater if the mass given is getting bigger. Thus, the viscometer stromer made can prove the difference in the viscosity coefficient of some liquid.

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