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Viscosity

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ABSTRACT

Viscosity measures the thickness or resistance of a liquid to flow. It originates from the word "viscous," describing a material that softens and flows slowly when heated. Viscosity reflects the internal movement of fluid layers, influenced by intermolecular attraction forces. Liquids with strong intermolecular forces exhibit high viscosity, causing slow flow, like glycerin, castor oil, and honey. In contrast, low-viscosity liquids such as water, alcohol, and gasoline flow quickly. Viscosity depends on temperature, molecular attraction, and the size and number of dissolved molecules. As temperature rises, viscosity decreases because molecules move more freely. Fluids, both liquids and gases, have molecules spaced variably, not fixed in lattices, allowing free movement. The viscosity coefficient varies with fluid type, molecular interactions, and temperature. Observations showed water's viscosity as 3.0×10^{-2} Ns/m², cooking oil 7.2×10^{-3} Ns/m², sunlight 7.6×10^{-2} Ns/m², and alcohol 3.1×10^{-4} Ns/m². Sunlight exhibited the highest viscosity compared to oil, alcohol, and water, indicating its greater resistance to flow.

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1. Introduction

Viscosity is a measurement that states the thickness of a liquid or liquid. Viscosity (thickness) comes from the word "viscous." If a material is heated before it becomes liquid, it first becomes viscous; that is, it becomes soft and can flow slowly. Viscosity can be thought of as the movement in the interior (internal) of a fluid.

The large intermolecular attraction forces in liquids result in high viscosity. Viscosity is a property of a fluid that is closely related to resistance to flow. Some fluids can flow quickly, while others flow slowly. Fast-flowing fluids such as water, alcohol, and gasoline have a small viscosity. Meanwhile, slow-flowing fluids such as glycerin, castor oil, and honey have a large viscosity [2].

The internal friction force that occurs between fluid layers is known as viscosity. The higher a fluid's viscosity, the more difficult it is to flow.

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There are various methods of measuring viscosity, one of which is the capillary viscosity method. In this method, fluid is allowed to flow through a capillary of a specific diameter. Then, the time required for the fluid to flow through the capillary is used to calculate the viscosity value.

Viscosity determines how easily a molecule forms due to friction between layers of material. Therefore, viscosity shows a liquid's level of resistance to flow. Several factors influence the amount of viscosity, including temperature, intermolecular attractive forces, and the size and number of dissolved molecules. Different types of fluids, including liquids and gases, have different levels of viscosity. Viscosity can be considered the movement of parts within a fluid [10].

Fluids are groups of molecules with large and small separation distances for liquids. The distance between molecules is large compared to their center lines. The molecules are not bound to a lattice but rather move freely toward each other. Therefore, fluid velocity, or mass volume velocity, does not have a precise meaning because the number of molecules occupying a certain volume is constantly changing [9].

The level of fluid viscosity depends on temperature. The higher the temperature, the less viscous the liquid. Apart from temperature, the viscosity of a fluid—more precisely, the viscosity coefficient—also depends on the type of fluid, the attraction force between molecules, and the size and number of molecules [1]. In general, measuring the viscosity coefficient of fluids depends on the resistance to the movement of objects in the fluid. For example, one might measure the rotation speed of a cylinder in a fluid to determine the fluid's viscosity [5].

A moving fluid experiences internal friction, usually referred to as viscosity. This occurs in both gases and liquids because fluid layers maintain constant flow. The fluid flow rate depends on viscosity, pressure difference, and tube dimensions [4].

2. Materials and Method

a. Tools and materials

In this practicum, we carried out a viscosity experiment or practicum. The tools used are a set of Hoppler viscometers, a pycnometer, a stopwatch, a 25 mL measuring pipette, and a funnel. The materials used are 2 marbles. There are 4 liquids we use, namely water, cooking oil, alcohol, and sunlight.

b. Making process

The initial step taken was to measure the diameter of the ball, and the mass of the ball was also weighed. The length of the viscometer tube is measured (from the upper limit to the lower limit) at 10 cm and 15 cm using a ruler. Next, determine the density of

each liquid. Fill the measuring tube with distilled water and put marbles in it. When the ball is at the upper limit, we turn on the stopwatch, and when the ball is at the lower limit, the stopwatch is turned off. The time required for the ball to fall from the top boundary to the straight boundary is recorded. These steps must be repeated three times with different-sized marbles. With the same procedure, it is also carried out with different types of fluid, namely oil and dishwashing soap.

c. Result

Eksperiment Result

Table 1. Table Eksperiment Result

Materials Used	ϱ (Kg/m³)	v (m/s)	η (Ns/m³)
Aquadest	120,616	5,325	-0,0030
Alcohol	9,828	4,18	-0,0031
Sunlight	432	0,2275	-0,076
Minyak Goreng	14,625	2,675	-0,00072

Table 2. Marble Data

Sample	Diameter	Fingers	Mass
Marble 1	0,01441	0,007205	0,004714
Marble 2	0,01473	0,007365	0,0048137
Average	0,01457	0,007285	0,00476

d. Discussion

In this practicum, we conducted a viscosity experiment. We used two cans with different diameters as our materials. One marble has a diameter of 0.01441 m, and the other has a diameter of 0.1473 m in our fluid. The substances used were alcohol, sunlight, distilled water, and cooking oil.

Viscosity is the friction caused by moving fluids or solid objects in a fluid. This friction is also commonly referred to as the degree of viscosity of a liquid substance. Therefore, the greater the viscosity of a liquid, the more difficult it is for solid objects to move through it. Viscosity plays a role in liquids by creating a cohesive force between liquid particles [7].

In the first experiment, we can see that the size of the ball affects its speed. The greater an object's mass, the slower it will move. Conversely, if the object/ball has a small diameter, then its journey time is faster.

Different types of fluids, both liquids and gases, have different levels of viscosity. Viscosity, aka viscosity, is actually the friction force between the molecules that make up a fluid. So the molecules that form a fluid rub against each other when the fluid flows. In liquids, viscosity is caused by the presence of cohesive forces (attractive forces between similar molecules). Meanwhile, in gaseous substances, viscosity is caused by collisions between molecules [3].

When the marble was placed in a more liquid fluid with a test tube distance of 1.65 m, it took 0.32 s for the marble to reach the bottom of the tube. Meanwhile, the second marble travels to the bottom of the tube for 0.30 s. It is known that the density of water is 1 g/m^3. This proves that the fluid usually flows easily and has a low viscosity so that the marble can quickly reach the bottom of the test tube.

Furthermore, when the marble was put into alcohol with a distance of 1.65 m, the same results were obtained as with AR fluid. Can 1 only took 0.41 s to reach the bottom of the test tube. Meanwhile, canister 2 takes 0.38 s to reach the bottom of the test tube. This also proves that alcohol has a low viscosity.

When marbles are placed in oil, it also takes time to reach the bottom of the tube. This is also the same as when you put it in water and alcohol. This means that the oil also has a small viscosity; marble 1 takes 0.55 s and marble 2 takes 0.70 s to reach the bottom of the test tube.

When a marble is placed in a test tube containing sunlight, it passes through the fluid slowly. The marble reaches the bottom of the test tube in 7.62 seconds for marble 1 and 6.85 seconds for marble 2. This proves that sunlight has a higher viscosity than the other samples due to its low water content. Collisions between molecules and the material being tested also affect a fluid's viscosity.

The greater a liquid's viscosity, the more difficult it is for an object to move through it. In liquids, viscosity is produced by the cohesive forces between molecules. A greater force is required for very viscous fluids, and a smaller force is required for less viscous fluids. A liquid's level of viscosity also depends on temperature. The higher the temperature of a liquid, the lower its viscosity [6].

Pressure influences viscosity: liquid viscosity increases with increasing pressure, while gas viscosity is not influenced by pressure. Temperature and viscosity decrease with increasing temperature, while gas viscosity increases. Heating a liquid causes its molecules to gain energy. The molecules of the liquid move, weakening the interaction forces between them. Thus, the viscosity of the liquid decreases with increasing temperature [8]. Viscosity increases with increasing molecular weight. For example, viscosity is high with a fast alcohol flow rate and a slow oil flow rate.

The viscosity of a gas increases at a constant temperature, while the viscosity of a liquid decreases as the temperature increases. This difference can be explained by examining the causes of viscosity. A fluid's resistance to shear stress depends on its cohesion and the rate at which molecular momentum is transferred. Liquids have much greater cohesive forces than gases because their molecules are denser. Cohesion appears to be the main cause of viscosity in fluids. Because cohesion decreases with increasing temperature, viscosity also decreases [11].

The viscosity value obtained is less than or equal to one (≤1). This occurs because the viscosity of the object (marble) is too small, resulting in a very high percent error. Marbles passing through a fluid are also influenced by frictional forces. In liquid fluids, minimal friction forces occur, which are influenced by cohesive forces. In liquid fluids, the attractive forces between fluids are small, resulting in low viscosity.

Greater viscosity is also due to greater friction between molecules and the greater pressure needed to make marbles flow to the bottom of the measuring cup.

e. Conclusions

The paragraph discusses an experiment on viscosity using marbles of different sizes and various fluids like alcohol, water, and oil. It explores how viscosity affects the movement of objects in fluids, with larger objects moving slower in comparison to smaller ones. Different fluids exhibit varying viscosity levels, with liquids having cohesive forces between molecules contributing to viscosity. The results indicate that fluids with lower viscosity, such as water and alcohol, allow marbles to move faster, while fluids with higher viscosity, like oil and sunlight, slow down the movement. Factors affecting viscosity include pressure, temperature, and molecular weight. The paragraph also notes that the viscosity values obtained were less than one, possibly due to small marble viscosity and frictional forces. Overall, viscosity affects the ease of movement of objects in fluids, with higher viscosity requiring more force to move objects.

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