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Laminar flow rate analysis on plate with stokes theorem

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Abstract. This experiment as conducted to analyze velocity of the laminar flow on a plate by using Stokes theorem. The sample used was honey and oil which has a density of $643,4 \text{ gr} / \text{cm}^3$ and $762,2 \text{ gr} / \text{cm}^3$. When the density of the two samples have known, it will be easier to obtain viscosity with compared both sample and test samples each having results as $0,00594 \text{ Ns/m}^2$ for honey and $0,00503$ for the oil. The results of these calculations will be obtained pressure for each samples treated with different speeds the flow of each sample was different. The plate which flowing honey has a velocity $0,046 \text{ m} / \text{s}^2$ and velocity $0,002$ for oil with spiral plate, while for honey and oil in zigzag plate have both of velocity $0,02 \text{ m} / \text{s}^2$ and $0,0058 \text{ m} / \text{s}^2$.

1. Introduction

In the middle of the development of science and technology, the study of the modification boundary layer very beneficial for development. Research modification of plate boundary layer directed to reduce the negative effects to fluid flow [1]. Usually, areas of the boundary layer flow near to the surface of the plate which influenced by force of viscous, therefore this layer often scrutinized for analyzing the variety of fluid flow, one of them is Laminar flow.

Laminar flow is turbulent fluid flow without current, moving relatively slowly and parallel [3]. This flow rare happening in the water and in the air, but a kind of this flow often occurs in the fluid which has a high relative degree of viscosity, such as oil, glycerin, and oil. The high viscosity of a substance can give many effects with a flow rate of the plate.

This experiment ever investigation [6], with using hot plat plate for analyzing influence turbulent flow of characteristic concerning boundary layer. The experiment only describes an effect of turbulence on the speed of the water, while research on laminar flow has not been known. Therefore it is important to make research about it. So that, this experiment created for to analyze the speed of laminar flow on the plate with using Stokes theorem.

2. Experimental Method

The experiment was carried out on 30 March 2015 until 30 June 2015 at the physics laboratory of UHAMKA. This experiment using many samples such as oswtald viscometer, pycnometer, digital balance, measuring cup, hollow pipe, oil X brand, honey X brand, and plate to type (zigzag and spiral). Pottery contain oil in measuring cup until 30 ml, weigh blank pycnometer using digital balance, and then poured the oil in pycnometer and weigh using digital balance, poured the oil into viscometer Ostwald with using tunnel, wait flow of oil until balance, after that suction the sample using a vacuum until through pipe B and up until through line M, then let the sample down to line N. Record this time when the sample through line M to N. The same treatment to honey [2].



The last treatment is putting the plate (zigzag plate) in the hollow pipe, pour the oil in this plate, observe the movement and view the time it takes for the flow get the bottom of the pipe using a stopwatch. the same treatment for honey with the different plate (spiral plate).

3. Results and Discussion

Table 1. Calculation of density and viscosity of materials

Description	Honey	Oil
ρ (g / cm ³)	643,4	762,2
η (Ns/m ²)	0,00594	0,00503

Table 2. Pressure and flow velocity (zigzag plate)

Material	P (Pa)	v (m/s ²)
Honey	1,46	0,02
Oil	0,34	0,0058

Table 3. The pressure and flow velocity (spiral plate)

Material	P (Pa)	v (m/s ²)
Honey	2,46	0,0046
Oil	0,18	0,0023

From the table in J Waspakrik [5], both these fluids have the same volume with different mass, where the mass of honey is 38.110 gr and the mass of the oil is 32.700 gr. From table 1, the density of oil is bigger than honey, it can happen because density strongly influenced by the volume and mass, the greater mass of the fluid the greater density. From table 1, viscosity honey is greater than oil. It can happen because the viscosity affected by density. Determination viscosity of the fluid can be using comparison both this viscosity, between the viscosity of aquadest and viscosity which looking for.

From table 3, the pressure to honey greater than the pressure to oil, it can happen because pressure on the object very influenced by mass on the object, can look mass of honey greater than the mass of the oil, so that pressure too honey greater than the pressure to the oil. But the different case for table 2 with the zigzag plate, it can happen maybe oil common using machine with the spiral plate, so the movement oil greater than honey. From table 2, oil has the greater velocity than honey, it can happen because of the pressure of honey greater than oil. A velocity of flow very influenced by pressure.

The last part of the discussion is looking for the flow velocity using Stokes theorem. It using Stokes theorem who uses the surface integral to define a small area of a flow, the theorem Stokes in question is a blend of divergent functions with integral full on a formula of velocity, so that the calculation results can be seen, that's both types of fluid flowed to the plate (zigzag plate) is faster than the fluid flowing through the plate (spiral plate).

4. Conclusion

The conclusion from the experiment is that velocity of laminar flow can be analyzed using Stokes theorem, with different velocity for both of fluids.

References

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