AGH University of Science and Technology in Cracow

Department of Electronics

Laboratory Manual
Physics_1

Title:

Viscosity coefficient

Experiment No.

2

2009 r.

1. Goal

To investigate the nature of viscosity in liquid, determining of viscosity coefficient using Stokes law.

2. What to learn?

Viscosity, temperature dependence of fluid viscosity, motion of a ball in fluid, Stokes equation and its range of application, viscosity coefficient unit, laminar and turbulent motion, Reynolds number, forces that act on a ball falling in oil, changes of ball velocity during the movement in oil.

3. Equipment

Glass cylinder with paraffin oil placed on a stand, a glass burette with a volumetric graduation, a stopwatch.

4. Measurements

1. Fill in a burette with water.
2. Slowly open the valve under the burette and observe water drops at different water flow then close the valve. End of the burette must be submerged in oil.
3. Slowly open the valve and pour 20 cm^3 water into a glass cylinder. At the same time count number of water drops. Note that position of the valve must be fixed during drops counting.
4. Measure with a stopwatch the time of water drop fall between marks on the cylinder. Repeat for 10 drops. Distance between the marks should be 25 cm (check it!).

   Note that (3) and (4) must be carried out at the same time (fixed and the same position of the valve).
5. Measurements (3, 4) perform twice for significantly different water flow (drop sizes).

5. Data handling

1. Calculations perform for each measurement (different water drop sizes) separately.
2. Using data from (3) and (4) calculate average radius, average mass and velocity of drops.
3. Calculate viscosity coefficient using formula:

$$\eta = \frac{(m - \rho V)g}{6\pi r v(1 + 2.4\frac{r}{R})}$$

where: m – average drop mass, ρ – density of oil equals 0,80 g/cm3, V – average drop volume, g – gravitational acceleration, r – average drop radius, v – average velocity of water drops; diameter of cylinder equal to 2R = 4.5 cm.

4. Calculate uncertainty of viscosity coefficient using the logarithmic derivative method. Assume the correction 2.4 r/R equals to 0.

Literature:

1. Halliday, Resnick "Fundamentals of Physics - 8th edition", John Wiley 2007,
2. Zięba "Pracownia Fizyczna Wydziału Fizyki I Techniki Jądrowej AGH", Uczelniane Wydawnictwo Naukowo-Dydaktyczne 1999.

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