Experiment No. 2 Date: …. /…. /20…..

TO DETERMINE THE COEFFICIENT OF VISCOSITY OF A LIQUID BY STOKES METHOD.

APPARATUS REQUIRED:

1. Experimental liquid (Glycerin)
2. A tall transparent jar (About 1 m tall)
3. Steel ball bearings (of different sizes)
4. A stop watch
5. A micro meter screw gauge
6. A meter scale
7. A thermometer
8. Rubber bands

THEORY:

The property of liquid by virtue of which it opposes the relative motion between its different layers is known as viscosity.

The force which tends to oppose the motion of layer over another is called as viscous force.

The Newton's formula for the viscous force (F) between two layers is:

$$F = \eta\, A\, \frac{dv}{dx} \dots\dots\dots\dots (1) \quad \text{[In magnitude]}$$

Where, $\eta = coefficient\ of\ viscosity.$

$A = area\ of\ contact\ between\ two\ layers\ .$

$\frac{dv}{dx} = velocity\ gradient\ between\ two\ layers.$

For $A = 1m^2$

$\frac{dv}{dx} = 1\ s^{-1},$

$$\boldsymbol{\eta = F}$$

Thus, coefficient of viscosity (η) is defined as the tangential backward force per unit area of layer required to maintain unit velocity gradient between the layers.

Stoke's law:

According to stoke, if a sphere of radius r moves through a liquid or a fluid of viscosity η with a velocity $\boldsymbol{v}$ then the viscous force on the sphere is given by:

$$\boldsymbol{F_v = 6\pi\eta r v}$$: Stoke's formula for viscous force.

✓ The viscous force is velocity dependent force. $\boldsymbol{F_v \propto v}$.

When a solid body moves through a fluid, the fluid layer in contact with the solid moves with the velocity of solid. The layers away from solid move with decreasing velocity. Thus, a relative motion is created between different layers of fluid so that a viscous force acts on the body.

When a solid body falls through a viscous fluid, three forces come into play:

1. Weight of body (acting downward)
2. Upthrust (buoyancy0 due to fluid (acting upward)
3. Viscous force on body (acting upward- opposite of motion)

Initially, the body accelerates downward due to gravity (velocity increases and hence the viscous force also increases). After some time, a situation is reached at which the upward force (sum of viscous force and buoyancy) is equal to the downward force (weight of body). The body now falls downward with a constant velocity-called as terminal velocity $\boldsymbol{v_t}$. This means the falling object has reached its maximum velocity and acceleration is now zero

The viscous force at this condition is written as:

$$\boldsymbol{F_v = 6\pi\eta r v_t}$$