

## 3.3 - Viscosity and Turbulent Flow

PJ Gibson - Peace Corps Tanzania

May 2020

- (1998) Two equal drops of water are falling through air with a steady velocity of  $0.15 \text{ ms}^{-1}$  , If the drops coalesce, find their new terminal velocity.
- (1999) With the help of a well labelled diagram briefly explain how you will determine the coefficient of viscosity of a liquid by a constant pressure head apparatus in the laboratory.
- (2010) In the form of Millikans experiment, an oil drop was observe fall with a constant velocity of  $2.5 \times 10^{-4} \text{ m/s}$  in the absence of an electric field. When a p.d of 1000 V was applied between the plates 10 mm apart, the drop remained stationary between them. i the density of oil is  $9 \times 10^2 \text{ kg/m}^3$  , density of air is  $1.2 \text{ kg/m}^3$  and viscosity of air is  $1.8 \times 10^{-5} \text{ Ns/m}^2$  , Calculate the radius of the oil drop and the number of electric charges it carries.
- (2013) Write down the Poiscuilles equation for a viscous fluid flowing through a tube defining all the symbols.
  - What assumptions are used to develop the equation above.
- (2015) A sphere is dropped under gravity through a fluid of viscosity,  $\eta$  . Taking average acceleration as half of the initial acceleration, show that the time taken to attain terminal velocity is independent of fluid density.
- (2015) The flow rate of water from a tap of diameter 1.25 cm is 3 litres per minute. The coefficient of viscosity of water is  $10^{-3} \text{ Ns/m}^2$  . Determine the Reynolds number and then state the type of flow of water.
- (2016) State Newtons law of viscosity and hence deduce the dimensions of the coefficient of viscosity.
- (2016) In an experiment to determine the coefficient of viscosity of motor oil, the following measurements are made:
  - Mass of glass sphere =  $1.2 \times 10^{-4} \text{ kg}$ .
  - Diameter of sphere =  $4.0 \times 10^{-3} \text{ m}$ .
  - Terminal velocity of sphere =  $5.4 \times 10^{-5} \text{ m/s}$ .
  - Density of oil =  $860 \text{ kg/m}^3$
  - Calculate the coefficient of viscosity of the oil.
- (2016) Give reasons for the following observations as applied in fluid dynamics.
  - A flag flutter when strong winds are blowing on a certain day.

- A parachute is used while jumping from an airplane.
- Hotter liquids flow faster than cold ones.
- (2017) Derive an expression for the terminal velocity of a spherical body falling from rest through a viscous fluid.
- (2019) Give the meaning of the terms velocity gradient, tangential stress and coefficient of viscosity as used in fluid dynamics.
- (2019) Write Stokes equation defining clearly the meaning of all symbols used.
  - State two assumptions used to develop the equation above
- (2019) Calculate the terminal velocity of the rain drops falling in air assuming that the flow is laminar, the rain drops are spheres of diameter 1 mm and the coefficient of viscosity,  $\eta = 1.8 \times 10^{-5} \text{ Ns/m}^2$ .
- (2019) Water flows past a horizontal plate of area  $1.2 \text{ m}^2$ . If its velocity gradient and coefficient of viscosity adjacent to the plate are  $10 \text{ s}^{-1}$  and  $1.3 \times 10^{-5} \text{ Ns/m}^2$  respectively, calculate the force acting on the plate.