QUESTION:

The terminal velocity of sphere of radius R ,falling in a viscous fluid , is proportional to

SOLUTION:

According to the Stokes' law of viscosity the frictional force exerted on spherical objects in a viscous fluid is given by

$$F_{fr} = 6\pi\mu R\upsilon$$

Here μ is the fluid viscosity, υ is the particle's velocity and R is the particle's radius

There are three forces acting on a sphere falling in a fluid:

1. F_{fr} (acting upward)
2. the gravity force mg (acting downward)
3. buoyancy force $F_b = \rho_{fluid} \cdot g \cdot V$ (acting upward)

According to the Newton's second law of motion and taking in account that the velocity of the particle remains constant (terminal velocity), we can write:

$$F_{fr} + F_b - mg = 0$$

$$m = \rho_{particle} \cdot V$$

$$V = \frac{4}{3}\pi R^3$$

$$6\pi\mu R\upsilon + \rho_{fluid} \cdot g \cdot \frac{4}{3}\pi R^3 - \rho_{particle} \cdot g \cdot \frac{4}{3}\pi R^3 = 0$$

$$\upsilon = \frac{\frac{4}{3}R^2 g(\rho_{particle} - \rho_{fluid})}{6\mu} = \frac{2}{9}R^2 \frac{\rho_{particle} - \rho_{fluid}}{\mu}$$

Hence the terminal viscosity is proportional to the particle's radius squared.

Answer

The terminal viscosity is proportional to the particle's radius squared.