FLUID MECHANICS D209 Q1 1996

1 a) Describe with the aid of diagrams the variation of drag coefficient with Reynolds Number for the flow of a liquid past a completely immersed sphere.

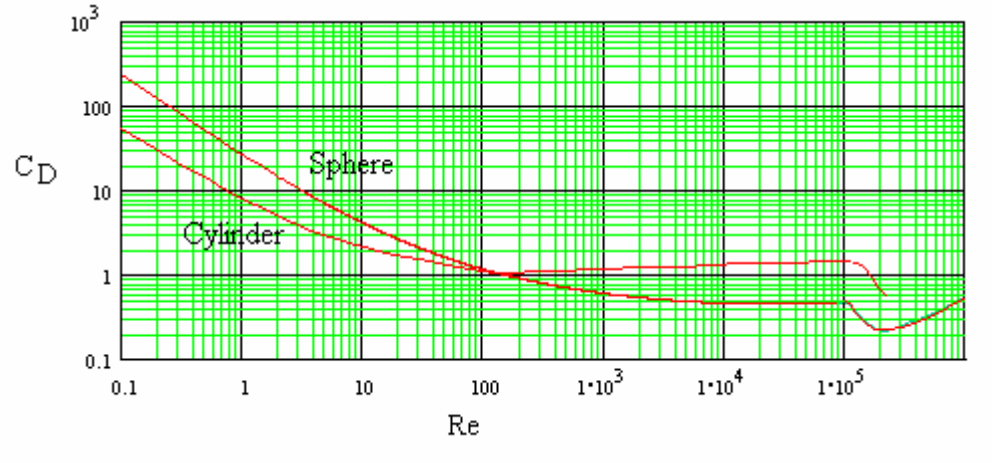
b) Spherical particles of density 2900 kg/m^3 moving horizontally enter water which is flowing upwards at a velocity of 0.27 m/s. It may be assumed that for each particle the relationship between drag coefficient C_D and Reynolds Number Re is

$$C_D = \frac{24}{R_e}\left[1 + 0.15R_e^{0.687}\right]$$

Determine the diameter of the smallest particle that would move downwards.

c) Describe briefly the factors which affect the sedimentation in liquids of solid particles of different sizes.

a) Refer to tutorial 3 for notes on this subject.



b)

$$R = \frac{\pi d^3 g(\rho_s - \rho_f)}{6} \qquad C_D = \frac{\pi d^3 g(\rho_s - \rho_f)}{(\pi\ d^2/4)(\rho\, u^2/2)}$$

$$C_D = \frac{4dg(\rho_s - \rho_f)}{3\rho_f\ u^2} = \frac{4d \text{ x } 9.81(2900 - 1000)}{3 \text{ x } 1000 \text{ x } 0.27^2} = 340.9d$$

$$C_D = \frac{24}{R_e}\left[1 + 0.15R_e^{0.687}\right] = 340.9d$$

$$\frac{\mu}{\rho ud}\left[1 + 0.15\left(\frac{\rho ud}{\mu}\right)^{0.687}\right] = 14.2d = \frac{0.89 \text{ x } 10^{-3}}{1000 \text{ x } 0.27d}\left[1 + 0.15\left(\frac{1000 \text{ x } 0.27 \text{ x } d}{0.89 \text{ x } 10^{-3}}\right)^{0.687}\right]$$

$$4309197d^2 = \left[1 + 0.15(875.4d)^{0.687}\right]$$

$d^2 - 203.1 \text{ x } 10^{-6}d^{0.687} - 232 \text{ x } 10^{-9} = 0$

By plotting or any other means d = 0.0016 m or 1.6 mm

c) A moving stream can be used to separate small particles from large particles. Small particles take longer to settle out in a static pond and particles that are very tiny (colloidal) may never settle and simply colour the water.