Sample problem -2 NLE

Wednesday, 3 March 2021 10:4? PM

Terminal Velocity

at constant terminal velocity

$F_D = \frac{1}{2}\rho_g A_p C_D v_t^2$

$F_g - F_b = (\rho_p - \rho_g) V_p g$

$$F_D = F_g - F_b$$

$$\frac{1}{2}\rho_g A_p C_D v_t^2 = (\rho_p - \rho_g) V_p g \qquad V_p = \frac{\pi}{6} d_p^3 \quad A_p = \frac{\pi d_p^2}{4}$$

$$v_t = \sqrt{\frac{4(\rho_p - \rho_g) g\, d_p}{3 C_D \rho_g}}$$

$$C_D = \begin{cases} 24/Re & \text{if } Re < 1 \\ \frac{24}{Re}(1 + 0.15 Re^{0.687}) & \text{if } 1 < Re < 800 \\ 0.44 & Re > 1000 \text{ to } 2\times10^5 \end{cases}$$

$$Re = \frac{\rho v_t d_p}{\mu}$$

so $v_t \rightarrow Re \rightarrow$ Regimen $\rightarrow C_D \rightarrow v_t$

Problem Oil droplets of diameter 2 mm are to be settled from air with $\rho_g = 1.184 \text{ kg/m}^3$. The density of oil is 900 kg/m3. Calculate the terminal settling velocity of the particles. For air at these conditions $\mu = 1.85\times10^{-5}$ kg/m.s

C_D is given by
$$C_D = \frac{24}{Re}(1 + 0.15 Re^{0.687})$$

Sol^n try with successive substitution using **MS. Excel**

$$v_t^{k+1} = f(v_t^k)$$

Start from $v_t^k\ (k=0) \rightarrow Re^k \rightarrow C_D^k \rightarrow \underline{v_t^{k+1}}$

$v^{k+1} \longrightarrow Re^{k+1} \quad C_D^{k+1} \rightarrow v_t^{k+2}$

⋮

till $\left|\frac{v_t^{k+1} - v_t^k}{v_t^{k+1}}\right| < tol$

$tol = 10^{-3}$