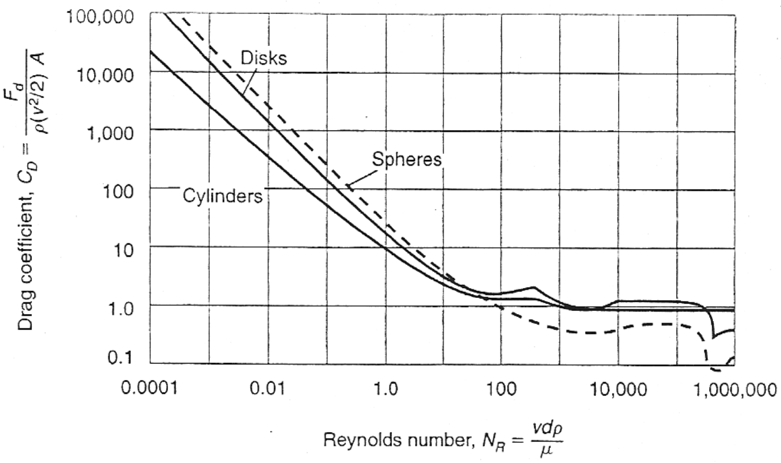
Figure 5–20

Coefficient of drag as a function of Reynolds number.



particle shape affects the value of the drag coefficient, for particles that are approximately spherical, the curve on Fig. 5–20 is approximated by the following equation (upper limit of $N_R = 10^4$):

$$C_d = \frac{24}{N_R} + \frac{3}{\sqrt{N_R}} + 0.34 \tag{5–19}$$

The Reynolds number N_R for settling particles is defined as

$$N_R = \frac{v_p d_p \rho_w}{\mu} = \frac{v_p d_p}{\nu} \tag{5–20}$$

where μ = dynamic viscosity, MTL^{-2} ($N \cdot s/m^2$)
ν = kinematic viscosity, L^2T^{-1} (m^2/s)

Other terms are as defined above.

Equation (5–18) must be modified for nonspherical particles. An application that has been proposed is to rewrite Eq. (5–18) as follows (Gregory et al., 1999):

$$v_{p(t)} = \sqrt{\frac{4g}{3C_d\phi}\left(\frac{\rho_p - \rho_w}{\rho_w}\right)d_p} \approx \sqrt{\frac{4g}{3C_d\phi}(sg_p - 1)d_p} \tag{5–21}$$

where ϕ is a shape factor and the other terms are as defined previously. The value of the shape factor is 1.0 for spheres, 2.0 for sand grains, and up to and greater than 20 for fractal floc. The shape factor is especially important in wastewater treatment where few, if any, particles are spherical. The shape factor must also be accounted for in computing N_R. The application of Eq. (5–21) will be considered in subsequent discussions of flocculent and ballasted flocculent settling.

Settling in the Laminar Region. For Reynolds numbers less than about 1.0, viscosity is the predominant force governing the settling process, and the first term in Eq. (5–19) predominates. Assuming spherical particles, substitution of the first term of the drag coefficient equation [Eq. (5–19)] into Eq. (5–18) yields Stokes' law: