Determining terminal setting velocity when diameter is known, and vice versa

The following equations are an addition to the equations in your textbook. They were prepared by Professor Reist. The equations can be used to avoid using tables or figures when calculating terminal settling velocities for particles out of the Stokes region.

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If d is known and is desired to find v_T, then use

$$C_D \operatorname{Re}^2 = \frac{4}{3} \frac{d^3 r_m (r_p - r_m) g}{m^2}$$

and solve for $C_D \mathrm{Re}^2$. This rearrangement eliminates the v term in Eq. (19). The result from Eq. (20) can be used to enter Fig. 5, a plot of $C_D \mathrm{Re}^2$ vs. Re, and find Re, which can then be solved to give v_T.

An approximation of the curve in Fig. 5 is given by

$$\operatorname{Re} = \log^{-1}\left(-5 + \sqrt{12.09 + 9.09 \log(C_D \operatorname{Re}^2)}\right) \tag{1}$$

A plot of the relationship between $C_D \mathrm{Re}^2$ and Re is given on the next page. Also plotted is the relationship from Eq. (1). The equation matches the data quite well, for values of Re < 10^5. The logs in this figure are to the base 10.

If v_T is known and it is desired to find d, then use

$$\frac{C_D}{\operatorname{Re}} = \frac{4 m g (r_p - r_m)}{3 v_T^{\,3} r_m^{\,2}}$$

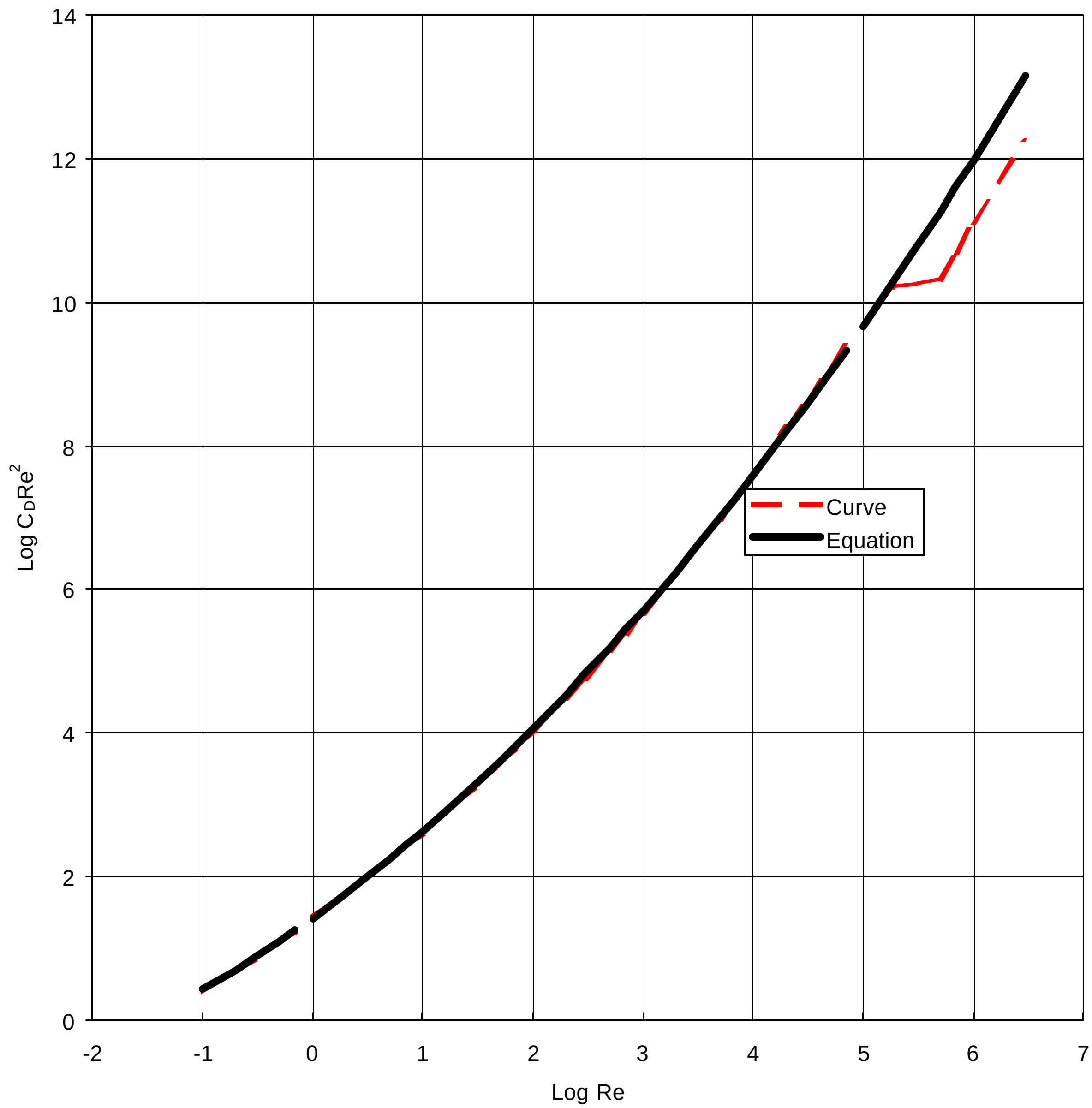
and solve for C_D/Re. This rearrangement eliminates the d term in Eq. 19. The result from Eq. 21 can be used to enter Fig. 6, a plot of C_D/Re vs. Re, and find Re, which can then be solved to give d.

An approximation for Re when C_D/Re is known is given by

$$\operatorname{Re} = \log^{-1}\left(8.26 - \sqrt{56 + 8.7 \log(C_D / \operatorname{Re})}\right) \tag{2}$$

A plot of the relationship between C_D/Re and Re and results given by Eq. (2) are on the second page after this one. Again, the equation works well for Re < 10^5. Again, the logs in this figure are to the base 10.

Relationship between C_DRe^2 and Re



Relationship between C_D/Re and Re