Data Correlation for Drag Coefficient for Sphere

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The correlation for drag coefficient in uniform flow around a sphere (Schlichting, 1955; Bird et. al, 2002; Denn, 1980; Geankoplis, 2003; White, 2006) is a staple of fluid flow calculations and fluid mechanics education. Engineers use the drag coefficients from this chart to calculate pressure drops and flow rates for flows around spheres, including settling and ballistics flows. A correlation is presented (Morrison, 2013) that captures drag coefficient versus Reynolds number for all values of Reynolds number (creeping flow, recirculating, and turbulent).

It is occasionally desirable to have a data correlation that spans the entire range of Reynolds number, from creeping flow, through flows with vorticies, and reaching the highest values of Reynolds number in turbulent flows. For this purpose, we have developed a new data correlation for uniform flow around a sphere, one that is explicit in drag coefficient and which is relatively simple in form. The equation is given below (Morrison, 2013):

Sphere drag:
$$C_D = \frac{24}{\mathrm{Re}} + \frac{2.6\left(\frac{\mathrm{Re}}{5.0}\right)}{1+\left(\frac{\mathrm{Re}}{5.0}\right)^{1.52}} + \frac{0.411\left(\frac{\mathrm{Re}}{263{,}000}\right)^{-7.94}}{1+\left(\frac{\mathrm{Re}}{263{,}000}\right)^{-8.00}} + \left(\frac{\mathrm{Re}^{0.80}}{461{,}000}\right) \qquad (1)$$

where C_D is the drag coefficient, and Re is the Reynolds number.

A plot of equation 1 is shown in Figure 1 along with data for spheres from Schlichting (1955). At low Reynolds number, equation 1 becomes $C_D=24/\mathrm{Re}$. At the highest Reynolds numbers, equation 1 becomes a line with slope of 0.80 on a log-log graph. We do not recommend using equation 1 for Reynolds numbers larger than 10^6. Equation 1 captures the shape of the data for uniform flow around a sphere through the highly variable transition region near Re=$2x10^6$ (Figure 1).

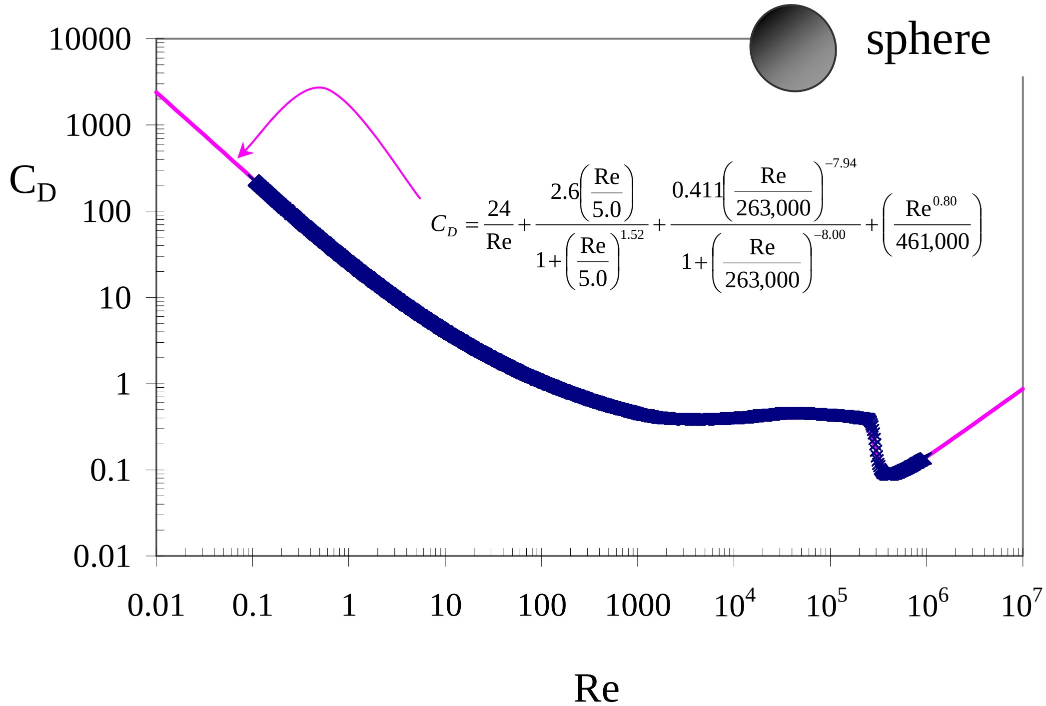

Figure 1: Equation 1 (Morrison, 2013) captures drag coefficient as a function of Reynolds number over the entire Reynolds-number range of the available experimental data. Also shown are data for uniform flow around a sphere (Schlichting, 1955). Use beyond Re=10^6 is not recommended; for Re<*2* equation 1 follows the creeping-flow result (C_D=*24/*Re).

References:

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