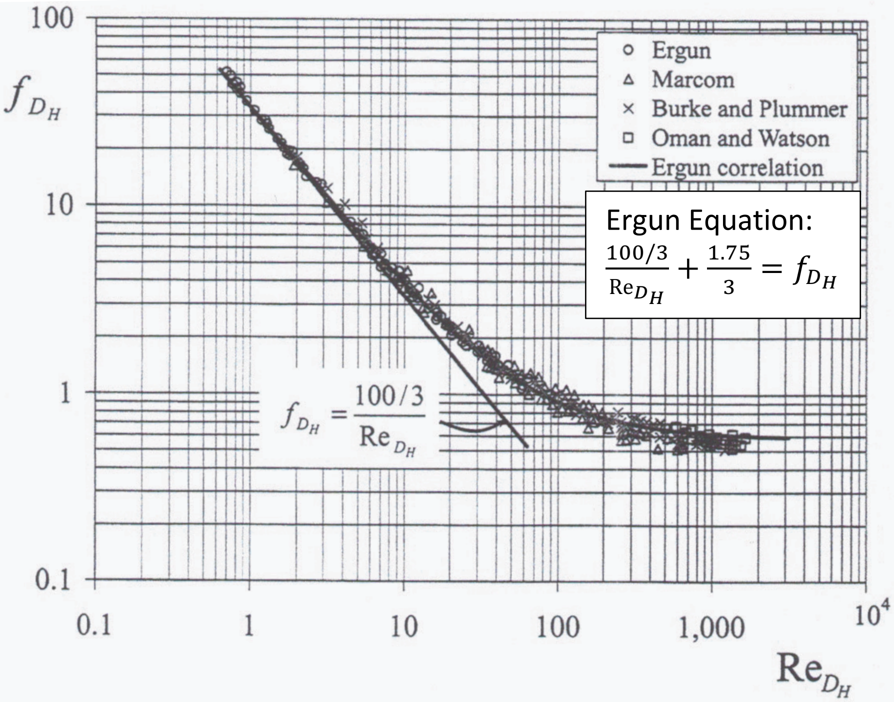
Source: F. A. Morrison, *An Introduction to Fluid Mechanics*, Cambridge, 2013



Ergun Equation:

$$\frac{100/3}{Re_{D_H}} + \frac{1.75}{3} = f_{D_H}$$

$$f_{D_H} \equiv \left(\frac{\Delta p}{L}\right)\frac{D_H \varepsilon^2}{2\rho v_0^2}$$

$$Re_{D_H} \equiv \frac{\rho(v_0/\varepsilon)D_H}{\mu}$$

Figure 7.40 Data on friction factor versus Reynolds number at low Reynolds number validate the hypothesis that $f_{D_H} Re_{D_H}$ is constant for slow flow through packed beds. The constant $f_{D_H} Re_{D_H}$ is found to be $100/3 = 33.33$. Above $Re_{D_H} = 10$, the data deviate from the hydraulic-diameter result, following instead $f_{D_H} =$ constant $= 1.75/3$, which is the result expected for flow in very rough pipe (compare to Figure 7.22 for large ε/D and large Re). Data are from reference [45].

“non-circular cross section”

“very rough pipe”

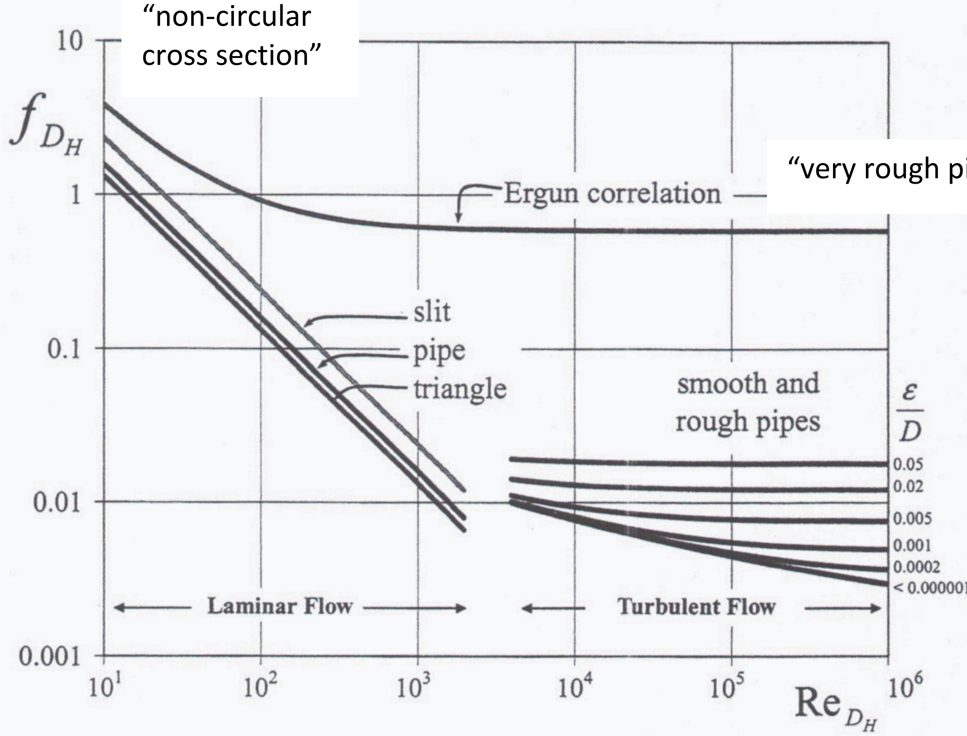


Figure 7.41 We compare the packed-bed result (i.e., Ergun correlation) with the friction-factor/Reynolds-number relationship for flows in other conduits. At low Reynolds number, the Poiseuille number, $Po = f_{D_H} Re_{D_H}$, is constant for most cross-sectional shapes and for packed beds. At high Reynolds number and high roughness in pipe flow, the friction factor becomes constant with a value that increases with increasing roughness; packed beds at high Re also have $f_{D_H} =$ constant. At intermediate Reynolds number, the observed behavior of packed beds is intermediate between these two extremes.