

UnitsOfViscosity

Starting from the definition of viscosity as the ratio of shear stress to shear rate, derive the cgs units of viscosity. This is called a poise, P. For reference, the viscosity of water is about 0.01 P or 1 cP. Another popular unit of viscosity is the Pa·s. What is the conversion factor between these two?

$$\begin{aligned}\eta &= \frac{\tau}{\dot{\gamma}} \\ &= \frac{\text{force/area}}{s^{-1}} = \frac{\text{force} \cdot s}{\text{area}} \\ &= \frac{gm \frac{cm}{s^2} \cdot s}{cm^2} = \boxed{\frac{gm}{cm \cdot s} \text{ (Poise) }}\end{aligned}$$

$$1 \text{ Pa} \cdot s = 1 \frac{kg \frac{m}{s^2}}{m^2} \cdot s = 1 \frac{kg}{m \cdot s} \times \frac{1000 gm}{kg} \times \frac{1 m}{100 cm} = 10 \frac{gm}{cm \cdot s}$$

$$1 \text{ Pa} \cdot s = 10 \text{ Poise} = 1000 \text{ cP}$$

$$\text{Water viscosity: } 1 \text{ cP} \approx 0.001 \text{ Pa} \cdot s$$