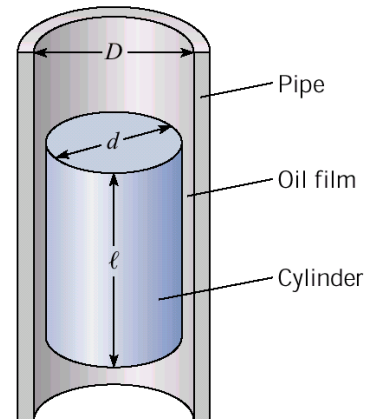


CHEN.3030 Fluid Mechanics

Short Quiz: Viscosity and Shear Stress Relationship for Newtonian Fluids

A solid circular cylinder of diameter d and length ℓ slides inside a vertical smooth pipe that has an inside diameter D as shown in the sketch. The small space between the cylinder and the pipe is lubricated with an oil film that has viscosity μ . Assume that the cylinder has a weight W and is concentric with the pipe as it falls. Also assume that the velocity profile within the small gap is linear.



- Under the above conditions, derive a formula for the steady state velocity of the cylinder in the vertical pipe. Explain your logic.
- Using your development from Part a, find the terminal velocity of the cylinder using the following data:

$$d = 10 \text{ cm} \quad D = 10.05 \text{ cm} \quad \ell = 20 \text{ cm} \quad W = 20 \text{ N}$$

lubricant: SAE 20W oil at 10°C with $\mu = 0.3 \text{ N}\cdot\text{s}/\text{m}^2$