

Problem 3B.1

Flow between coaxial cylinders and concentric spheres.

- (a) The space between two coaxial cylinders is filled with an incompressible fluid at constant temperature. The radii of the inner and outer wetted surfaces are κR and R , respectively. The angular velocities of rotation of the inner and outer cylinders are Ω_i and Ω_o . Determine the velocity distribution in the fluid and the torques exerted by the fluid on the two cylinders needed to maintain the motion.
- (b) Repeat part (a) for two concentric spheres.

Answers:

$$\begin{aligned} \text{(a)} \quad v_\theta &= \frac{\kappa R}{1 - \kappa^2} \left[(\Omega_o - \Omega_i \kappa^2) \left(\frac{r}{\kappa R} \right) + (\Omega_i - \Omega_o) \left(\frac{\kappa R}{r} \right) \right] \\ \text{(b)} \quad v_\phi &= \frac{\kappa R}{1 - \kappa^3} \left[(\Omega_o - \Omega_i \kappa^3) \left(\frac{r}{\kappa R} \right) + (\Omega_i - \Omega_o) \left(\frac{\kappa R}{r} \right)^2 \right] \sin \theta \end{aligned}$$