7.7 Closure

The chapter began with the exploration of various dimensionless numbers that describe the significance of the terms within the Reynolds equation. The Reynolds number compares the inertia and viscous terms; the Froude number compares the inertia and gravity terms. The ratio of the Reynolds number to the Froude number compares the gravity and viscous terms.

The Reynolds equation was derived by coupling the Navier-Stokes equations with the continuity equation and by using laws of viscous flow and the principle of mass conservation. The Reynolds equation contains Poiseuille, physical wedge, stretch, local compression, and normal and transverse squeeze terms. Each of these terms describes a specific type of physical motion, and the physical significance of each term was brought out. Standard forms of the Reynolds equations that are used throughout the text were also discussed. The chapter closed with a description of 13 different sliding and/or normal squeeze motions with the corresponding Reynolds equation.

7.8 Problems

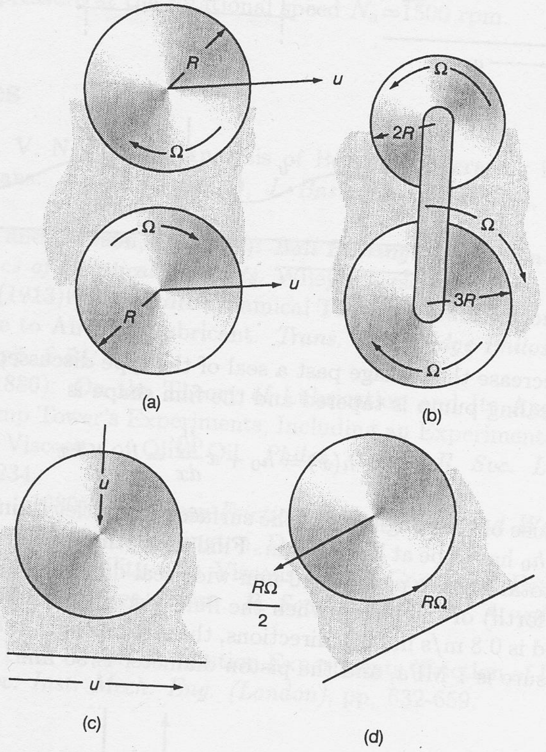
7.1 Starting from the Navier-Stokes equations expressed in cylindrical polar coordinates [Eqs. (6.31) to (6.33)] derive the Reynolds equation given in Eq. (7.56). Assume you are applying the cylindrical polar coordinates (r, θ, z) to a thrust bearing where z is in the direction of the lubricating film (h) and $h \ll r$.

7.2 From relationships between Cartesian and cylindrical polar coordinates prove that Eq. (7.47) when the viscosity and density are constant ($\eta = \eta_0$ and $\rho = \rho_0$) is equivalent to Eq. (7.57).

7.3 Compare the Reynolds equation for laminar flow conditions with that appropriate for turbulent flow conditions. Also list operating conditions and applications where turbulence in fluid film distribution is most likely to occur.

7.4 A water-lubricated journal bearing in a boiler feed pump has a shaft of radius 0.10 m which rotates at 10 rev/s. The kinematic viscosity in the full fluid film region may be taken as directly proportional to the film thickness and has a value of 4×10^{-7} m^2/s at a film thickness equal to the radial clearance of 0.10 mm. Determine if the bearing is operating in the laminar or turbulent flow regime. If laminar flow is predicted, what change in these operating conditions would produce the onset of vortex flow.

7.5 Write the Reynolds equation for the situations shown below. The circles represent infinitely long cylinders, and all velocities are in relation to a fixed coordinate system. The lubricant can be assumed to be Newtonian, incompressible, and isoviscous.



7.6 For the situation described in each diagram given below, express the appropriate Reynolds equation and sketch the expected pressure distributions. It can be assumed that the bearings are of infinite width and that the lubricant is Newtonian, isoviscous, and incompressible and does not experience cavitation. The shaded members shown in the diagrams are at rest.