Advanced Transport Phenomena 1

ChE 862 — February 15, 2019 — Spring 2019

Due: February 22, 2019

Application of the explicit method: Transient flow in an annular passageway with sliding inner surface, application of a coating to a wire or rod.

A viscous fluid is at rest in the annular passageway between two concentric cylinders. At t=0 the solid surface at $r=R_1$ begins to slide in the +z-direction with fixed velocity, V. At the same instant, a *positive dp/dz* is applied to the fluid, opposing the sliding motion. Our starting point is eq. 1.57c:

$$\rho \frac{\partial v_z}{\partial t} = -\frac{\partial p}{\partial z} + \mu \left[\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial v_z}{\partial r} \right) \right].$$

We want to determine how the velocity distribution develops, and we want to know how large *dp/dz* must be to produce *zero net flow* in the annulus at steady-state. The initial parameters we will employ are:

R_1 =2 cm	R_2 =3 cm	V=20 cm/s
ρ=1.2 g/cm^3	ν=0.02 cm^2 /s	dp/dz=2 dyne/cm^2 per cm

Prepare a graph that illustrates clearly how the velocity distribution develops using these parameters. Then, adjust *dp/dz* until zero net flow is achieved for steady-state.