**Advanced Transport Phenomena 1**

**ChE 862** **March 8, 2019** **Spring 2019**

**Due: March 20, 2019 at 11:00 AM**

*Mid-term problem: Laboratory evaluation of the transport of a viscous slurry through a half-filled cylindrical tube. Please note that independent effort is expected and no late submissions will be accepted.*

This is a variation of problem 3C from the text. A bench-top experiment is to be conducted to assess the effectiveness of a moving belt (at the bottom of a cylindrical tube) to convey a viscous slurry. The plastic tube will be half-filled with the slurry and a sliding fabric belt will cover the bottom of the tube for positions between 150° and 210°. Thus, the moving surface covers exactly one-third of the wetted surface. The governing equation is 1.57c:

$$\rho \frac{\partial v_z}{\partial t} = \mu \left[ \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial v_z}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 v_z}{\partial \theta^2} \right].$$

Since the tube is only half-filled, no pressure differences can be imposed and the apparatus is perfectly horizontal. The viscous slurry is initially at rest, but at $t$=0 the fabric belt begins to move with constant velocity, $V$. We want to find the velocity distribution in the slurry for $t$=24 s. And we want to produce a graph that shows how the volumetric flow increases with time; in particular, when will the volumetric flow rate reach 95% of its ultimate value? The parameters we will employ are provided here:

$R$=1.5 cm $V$=10 cm/s $\nu$=0.02 $cm^2$/s

*Please note: You must provide sufficient detail so I can follow your work—I cannot evaluate what does not appear in your submission.*