

**Georgia Tech**  
**ChE 4400, Spring 2003**  
**Lee**

**Quiz #1**  
**Closed Book, Closed Notes**  
**Allowed Time: 15 minutes**

1. Consider the orifice / DP cell device for measuring flow rates. The DP Cell's viable range of measurement is 0-5psi. (Assume that the full DP range is to be used.) The pressure drop across the orifice follows the relationship of

$$Q = \frac{C_d A_2}{\sqrt{1 - (A_2 / A_1)^2}} \sqrt{\frac{2 g_c \Delta P}{\rho}} \quad \text{where } C_d = 0.6. \quad \text{The (differential) pressure}$$

in the DP cell is converted to an electrical signal of 4-20 mA, which is transmitted to the controller. (Again, assume that the full transmitter range is used.)

- a. The maximum flow rate that should be measured is 100 gal/min. Calculate the appropriate size of the orifice ( $A_2$  value). Include the unit.
- b. Is the design acceptable? Assume that the total line pressure is *psi*.
- c. With the size above, calculate the electrical signal output that corresponds to 80 gal/min when the *square root extraction* is used (and therefore the transmitter output is proportional to the square root of  $\Delta P$ ).
- d. Calculate the same when *square root extraction* is NOT used.
- e. Suppose that the orifice is under-sized by 20% (i.e.,  $A_2$  chosen is only 80% of the right size). What's the flow rate range that can be measured?

Data Needed:

- $A_1 = 7.393 \text{ in}^2$
- $g_c = 32.2 \text{ lb}_m \cdot \text{ft} / (\text{lb}_f \cdot \text{sec}^2)$
- $\rho = 62.4 \text{ lb}_m / \text{ft}^3$
- $1 \text{ ft}^3 = 7.481 \text{ gal}$
- $1 \text{ ft} = 12 \text{ inches}$
- Total line pressure = 150 psi
- For acceptable design, the pressure drop must be less than 4% of the total line pressure and  $0.2 < \beta < 0.7$