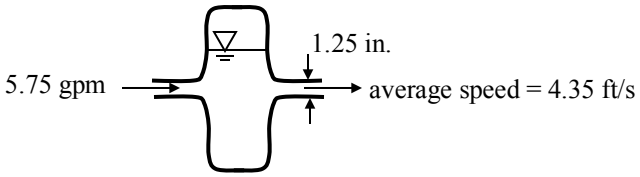
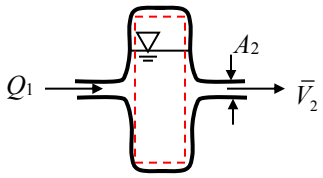
An hydraulic accumulator is designed to reduce pressure pulsations in a machine tool hydraulic system. For the instant shown, determine the rate at which the accumulator gains or loses hydraulic oil (with a specific gravity of 0.88).



SOLUTION:

Apply conservation of mass to the control volume shown below.



$$\frac{d}{dt}\int_{CV}\rho dV + \int_{CS}\rho \mathbf{u}_{rel}\cdot d\mathbf{A} = 0 \tag{1}$$

where

$$\frac{d}{dt}\int_{CV}\rho dV = \frac{dM_{CV}}{dt} \tag{2}$$

$$\int_{CS}\rho \mathbf{u}_{rel}\cdot d\mathbf{A} = -\rho Q_1 + \rho \bar{V}_2 A_2 \tag{3}$$

Substitute and simplify.

$$\frac{dM_{CV}}{dt} - \rho Q_1 + \rho \bar{V}_2 A_2 = 0 \tag{4}$$

$$\boxed{\frac{dM_{CV}}{dt} = \rho\left(Q_1 - \bar{V}_2 A_2\right)} \tag{5}$$

Using the given data,

ρ = (0.88)(1.94 slug/ft^3) = 1.71 slug/ft^3

Q_1 = 5.75 gpm = 1.28*10^{-2} ft^3/s

$\bar{V}_2$ = 4.35 ft/s

A_2 = π(1.25 in.)^2/4 = 8.52*10^{-3} ft^2

$\Rightarrow$ $\boxed{dM_{CV}/dt = -4.15*10^{-2}\ \text{slug/s}}$ The accumulator is losing oil.