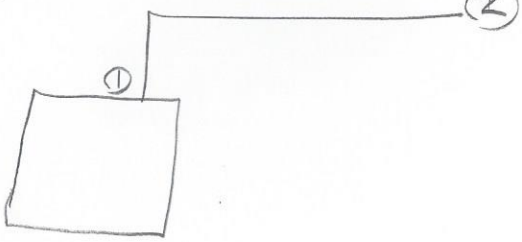
HW 5



$2116.8 \frac{lbf}{ft^2}$

$d = 4.026$ in
$L = 55$ ft
$K = 0.0012$ in
$P_2 = 14.7$ psia
$T = 100°F$
$P_1 = ?$

$\dot{m} = 95 \frac{lbm}{min} \times \frac{1 min}{60 s} = 1.583 \frac{lbm}{s}$

$\mu = .014$ cP
$C_p = 3.5 \frac{Btu}{lbm °F}$
$Z = 1.00$

$\rho = \frac{PM}{RT}$

$\rho_1 P_1 = \rho_2 P_2$

Assume subsonic

a) $\dot{m} = GA$

$1.583 \frac{lbm}{s} = G\left[\frac{\pi\left(\frac{4.026}{12} ft\right)^2}{4}\right]$

$G = 17.91 \frac{lbm}{ft^2 \cdot s}$

$Re = \frac{GD}{\mu} = \frac{17.91\left(4.026/12\right)}{.014\,(6.72\times10^{-4})}$

$Re = 6.4 \times 10^5$

$K/D = \frac{.0012}{4.026} = .0003$

$f = .0041$

$G^2 = \frac{\frac{M}{RT}\left(P_1^2 - P_2^2\right)}{4f\frac{L}{D} - \ln\left(\frac{P_2}{P_1}\right)^2}$

$\frac{(32.2 \frac{lbm \cdot ft}{lbf \cdot s^2})(2 \frac{lbm}{lbm\,mol})}{(1545.3 \frac{lbf \cdot ft}{lbm\,mol\,°R})(560°R)}\left(\left(P_1^2 - \left(2116.8 \frac{lbf}{ft^2}\right)^2\right)\right)$ $= \left(17.91 \frac{lbm}{ft^2 \cdot s}\right)^2$ (320.76)

$\frac{}{4(.0041)\left(\frac{55\times12}{4.026}\right) - \ln\left(\frac{2116.8 \frac{lbf}{ft^2}}{P_1}\right)}$

Iterating, $P_2 = 4811 \frac{lbf}{ft^2} \times \frac{ft^2}{144 in^2}$

$f = .0036$

$P_1 = 33.4$ psia

$\rho_1 = \frac{(4811 \frac{lbf}{ft^2})(2 \frac{lbm}{lbm\,mol})}{(1545.3 \frac{lbf \cdot ft}{lbm\,mol\,°R})(560°R)} = .011 \frac{lbm}{ft^3}$

b) No, it is capped at 95 lbm/min