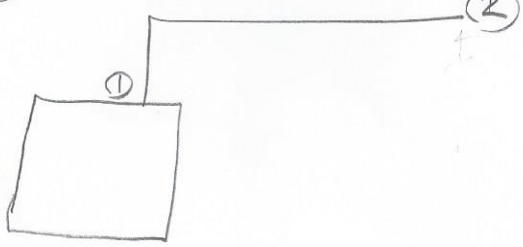
HW 5



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

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

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

$\mu = .014$ cP
$Z = 1.00$
$C_p = 3.5$ Btu/lbm °F

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

$\rho_1 P_1 = \rho_2 P_2$

Assume subsonic

a) $\dot{m} = GA$

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

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

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

$Re = 6.4 \times 10^5$

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

$f = .0041$

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

$\frac{(32.2 \frac{lbm \cdot ft}{lbf \cdot s^2})\, 2 \frac{lbm}{lbm\,mol}}{(1545.3 \frac{lbf \cdot ft}{lbm\,mol \cdot °R})(560 °R)}\left(\left(P_1^2 - (2116.8 \frac{lbf}{ft^2})^2\right)\right)$ $= \left(17.91 \frac{lbm}{ft^2 \cdot s}\right)^2$ (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, $P_2 = 4811 \frac{lbf}{ft^2} \times \frac{ft^2}{144 in^2}$

$P_1 = 33.4$ psia

b) $1.667 \frac{lbm}{s} = G\left[\frac{\pi\left(\frac{4.026}{12}\right)^2}{4}\right]$

$G = 18.85$

$\frac{18.85 \text{ lbm/ft·s}}{.00489 \frac{lbm}{ft^3}} = \frac{G}{\rho_2}$

$= 3854.35$ ft/s $\quad G = \rho u$

$u = 3660.9$ ft/s

$u = \frac{17.91 \frac{lbm}{ft \cdot s}}{.00489 \frac{lbm}{ft^3}}$

$u = 3669.9$ ft/s

$\rho_2 = \frac{(2116.8 \frac{lbm}{ft^2})(2 \frac{lbm}{lbm\,mol})}{1545.3 \frac{lbm \cdot ft}{lbm\,mol \cdot °R}(560 °R)}$

$= .00489 \frac{lbm}{ft^3}$

$V_{sonic} = \sqrt{\frac{ZRT}{M}}$

$\rightarrow V_{sonic} = 3732.6$ ft/s

$u < u_{sonic}$, Valid assumption

$u > u_{sonic}$, so it's Not possible