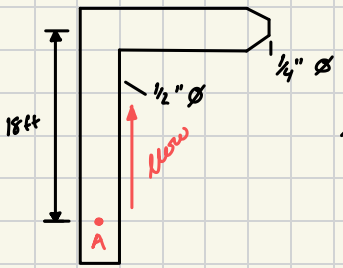
Homework #6

Problem 11-13

* closed system *



a) 20 psig gage pressure $\frac{P}{\gamma} \rightarrow \frac{20(144)}{62.4}$ (conv. units) $\Rightarrow$ 46.15 ft

$v^2 = 2g(46.15) \Rightarrow v = 54.52$

for $N_R = \frac{vD}{\nu} \rightarrow \frac{54.5(3/12)}{.738E-5} \Rightarrow 307,814$ so turb flow

from table 2 of H_2O @ 100°F is .738 E-5

Moody diagram $\rightarrow f = .024$

$Q = Av$ so set v @ both equal $\rightarrow$ get $A_{in} v_{in} = A_{out} v_{out}$

$\rightarrow \frac{\pi(1/2)^2}{4} v_{in} = \frac{\pi(1/4)^2}{4} v_{out} \quad \therefore v_{out} = 1/4\, v_{in}$

$h_f = \frac{f_i L v^2}{2gD} \rightarrow \frac{.024 \cdot 20 (1/4 v)^2}{2 \cdot 32.2 (3/12)} \Rightarrow h_f = .0112 v^2$

loss coefficient is .2 for tank + rounded given

loss in tank $= .2\left(\frac{v_{out}}{2g}\right) \rightarrow .2\left(\frac{.25 v^2}{64.4}\right) \Rightarrow 1.9E-4\, v^2$

loss in nozzle $= .15\left(\frac{v^2}{2g}\right) \rightarrow .15\left(\frac{v^2}{64.4}\right) \Rightarrow 2.3E-3\, v^2$

so... $46.15 = .0112 v^2 - 1.9E-4\, v^2 - 2.3E-3\, v^2 = \frac{v^2}{2g} \Rightarrow v = 39.7 \frac{ft}{s}$

b) $\frac{80(144)}{62.4} = 186.6$ ft $\quad v^2 = 64.4(186.6) \Rightarrow 109.63 \frac{ft}{s}$

then $N_R = \frac{109.6(5/12)}{.738E-5} \Rightarrow 618959$ also turb flow

moody diagram gives $f = .022$

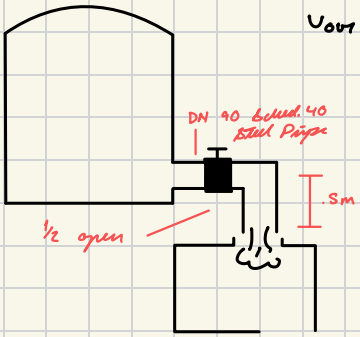
$h_f = \frac{.022 \cdot 20 (1/4 v)^2}{64.4(5/12)} \Rightarrow .0103\, v^2$ ft

loss in tank $= .2\left(\frac{1/4 v^2}{64.4}\right) \Rightarrow 1.94E-4\, v^2$ ft (same as 1)

loss in nozzle $= .15 \frac{v^2}{64.4} \Rightarrow 2.3E-3\, v^2$ ft

$v^2(.0155 + 2.3E-3 + 1.9E-4 + .0103) = 186.62 \quad \Rightarrow v = 81.2 \frac{ft}{s}$

Problem 11-23



$A = \frac{\pi}{4}(.09)^2 \Rightarrow 6.4E-3\ m^2$

$V_{out} = Q/A \rightarrow 1800/6.4E-3(60,000) \Rightarrow 3.9\ m/s$

$h_L = \left(\frac{P_A - P_B}{\gamma}\right) + \left(\frac{V_A^2}{2g} - \frac{V_B^2}{2g}\right) + z_A - z_B$

then $h_L + \frac{V_B^2}{2g} = z_A - z_B$

loss @ inlet: $h = k\frac{V_B^2}{2g} \rightarrow .8\left(\frac{3.92^2}{19.62}\right) \Rightarrow .392\ m$

loss @ valve: $h = 160\left(\frac{f V_B^2}{2g}\right) \rightarrow 160\left(\frac{.018 \cdot 3.92^2}{19.62}\right) \Rightarrow 2.25\ m$

loss @ elbow: $h = 30f\left(\frac{V_B^2}{2g}\right) + 30(.018)\left(\frac{3.92^2}{2g}\right) \Rightarrow$

$.422$

$\Sigma h = 3.07$

$z_A - z_B = 3.07 + \frac{3.92^2}{19.62} \Rightarrow 3.85$ + $z_A - z_B = h + .5$

so $h = 3.85 - .5 \Rightarrow h = 3.4$