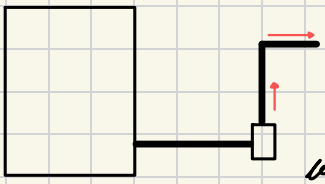
Homework #5

Problem 8-33

$Q = 1500 \frac{gal}{min}$ $\quad T_s = 60°F$

↳ $\times \frac{1}{449} \Rightarrow 3.34 \frac{ft^3}{s}$



a)

$A_A = \frac{\pi}{4} 10^2 \cdot \frac{1}{12} \Rightarrow .54\ ft^2$

$v_A = 3.34 / .54 \Rightarrow 6.12\ ft/s$

$\rightarrow 6.12 / 64.4 \Rightarrow .58\ ft$

$N_R = \frac{6.12 (10/12)}{1.21E-5} \Rightarrow 4.2E5$

↳ value from look

for h: $\frac{10/12}{1.5E-4} \Rightarrow 5555.55$ apply Bernoulli $\rightarrow h_L = \frac{f L v_A^2}{D 2g}$?

$\rightarrow \frac{.0155(45)(.58)}{10/12} \Rightarrow .49\ ft$ again $h = \frac{P_A}{\rho w} + \frac{v_A^2}{2g} + h_L$ so $\frac{5}{62.4} + 144 \frac{in^2}{ft^2} + .58 + .49$

$\Rightarrow 12.6\ ft = h$

b) $v_B = Q / A_B \rightarrow \frac{3.34}{\frac{\pi}{4} \cdot 8/12^2} \Rightarrow 9.6\ ft/s$

$N_R = \frac{v_B D}{\nu} \rightarrow \frac{9.6 \cdot 8/12}{1.21E-5} \Rightarrow 5.3E5$ look ≈ 0.016

$\frac{D}{\varepsilon} \rightarrow \frac{8/12}{1.5E-4} \Rightarrow 444.44$

again Bernoulli $h_L = \frac{f L v_B^2}{D 2g} \rightarrow \frac{.016(2600)(9.6)^2}{8/12 (64.4)} \Rightarrow 88.7\ ft$

use $h_A = \frac{P_B - P_A}{\rho w} + z_B - z_A + \frac{v_B^2 - v_A^2}{2g} + h_L$

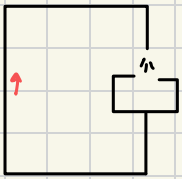
$\rightarrow \frac{80(144)}{62.4} + 25 + \frac{9.6^2 + 6.12^2}{64.4} + 88.7 \Rightarrow 299.2\ ft$

and $P = h_A \rho w Q \rightarrow 299.2 (62.4)(3.3) \frac{1}{550} \Rightarrow$ **113 hp**

Problem 8-49 given liq + valve

25°C glycerin $Q = 180\ L/min$

80 mm Ø × 7.8 mm wall



Bernoulli: $\frac{P_1 - P_2}{\gamma} = (z_2 - z_1) + h_L$ (am)

$V = \frac{180/6000}{4.36E-3} \Rightarrow .69\ m/s$ (dominant tab)

$N_R = \frac{\rho V D}{\mu} = \frac{1.26(.69)(.074)}{.96} \Rightarrow 67.3$ (dominant tab; variable viscos. w/ temp)

$f = 64/67.3 \Rightarrow .95$

$h_L = \frac{.95(25.6)(.69)}{2(.074 \times g)} \Rightarrow 8m$

so.. $P_1 - P_2 = 12.34(.68 + 8) \Rightarrow$ **107 kN/m²**

Problem 8-37 given liq + valve

$T = 77°F$ $Q = 12.5\ gal/min$

$Q \times \frac{1}{60} = .028\ ft^3/s$

in

out

close return line

same pipe so $z_1 = z_2$, $v_1 = v_2$

$P_1 - P_2 = \gamma(h_L - h_f)$

from diam: steel pipe $D = .0518\ ft$ $A = .00211\ ft^2$

$v = .028/.00211 \Rightarrow V = 13.18$

rel. rough $\Rightarrow \frac{\varepsilon}{D} = f_t(\varepsilon/D)$

rel. in valve, fitting: $\varepsilon/D = 50$

drawn tub: $\varepsilon = 1.5E-4$ $\Rightarrow D/\varepsilon = \frac{.0515}{1.5E-4} \Rightarrow 345.3$

$K = .026(50) \Rightarrow 1.3$

from table $\Rightarrow \nu = 1.59E-4\ ft^2/s$

$\gamma = 68.5\ lb/ft^3$

$h_L = K\frac{v^2}{2g} \Rightarrow 1.3\left(\frac{13.18^2}{64.4}\right) \Rightarrow 3.5$

$N_R = \frac{13.18(.052)}{1.59E-4} \Rightarrow 4292.2$

moody diag: $f = .042$ so $h_f = .042\left(\frac{8}{.052}\right)\left(\frac{13.18}{64.4}\right) \Rightarrow 17.3$

then $P_1 - P_2 = \gamma(h_L - h_f) \Rightarrow 68.5(3.5 + 17.3) = 1422.8\ lb/ft^2$

or **$P_1 - P_2 = 9.8\ psi$**