Chapter 10 Solutions

10.17

$h_L = Kv_2^2/2g$

$v_2 = v_1(A_1/A_2) = v_1(D_1/D_2)^2 = 4.00$ ft/s $(4.0/2.0)^2 = 16.00$ ft/s

For $(D_2/D_1)^2 = 2.0$, K=0.34 (Table 10.3)

$h_L = (0.34)(16.0\text{ ft/s})^2/2(32.2\text{ ft/s}^2) =$ **1.35 ft**

10.28

$h_L = K(v_{avg}^2/2g) = 5.842$ ft/s (based on v_{avg} = volumetric flow rate/cross sectional area)

K = 0.5 per text

$h_L = 0.5(5.842\text{ ft/s})^2/2(32.2\text{ ft/s}^2) =$ **0.26 ft**

$h_L = K(v_{avg}^2/2g) = f_T(L_e/D)(v_{avg}^2/2g)$ or $K = 0.5 = f_T(L_e/D)$

and f_T for fully turbulent flow = about 0.019 and won't change much for small changes in diameter

where D = inner dia of 2" steel tubing with .065 wall

So, $L_e = K\ D\ /\ f_T = (0.5)(0.1558\text{ ft})/0.019 =$ **4.1 ft of 2" steel tubing**

10.38

$Le = ((2)(L_e/D)f_T)\ (v_{avg}^2/2g)$ where $L_e = 20$ and where f_T = about 0.025

So, $(2Le/D)(f_T) = (2)(20)(0.025) = 1$

h_P = losses for 8.5 ft tubing = $(f\ (L/D))\ (v_{avg}^2/2g)$ where L = 8.5 ft and D = 0.05167 ft

and $v_{avg} = 13.28$ ft/s

Need to find $N_R = (68.47\text{ lb/ft}^3)(13.28\text{ ft/s})(0.05167\text{ ft})/(10.88 \times 10^{-2}\text{ lb/ft-s}) = 4320$

$D/e = (0.05167\text{ ft})/(1.5\text{x}10^{-4}\text{ ft}) = 344$

From Moody Diagram, f = about 0.043

Therefore, h_P = losses of 8.5 ft tubing = $(f\ (L/D))\ (v_{avg}^2/2g)$

So, h_P = (0.043)(8.5 ft)/(0.05167 ft) X (2.738 ft velocity head)

Therefore, total loses = h_P (i.e. tubing) + Le (i.e. elbows)

= (7.074 + 1) 2.738 veloctiy head) = **22 ft head of ethylene glycol**

To get pressure drop, write Bernoulli from inlet to outlet of tubing

Where $v_{avg1} = v_{avg2}$ since pipe diameter is constant and assume horizontal pipe (no elevation change)

So, $(P_1-P_2)/\gamma$ = losses or P_1-P_2 = losses * γ = 22 ft * 68.47 lb/ft^3

P_1-P_2 = 1506 lb/ft^2 or 10.5 psig