CH.10 HW 3.1 20, 37, 39, 43, 46, 48 — JORDAN DALLS

20) PURPOSE: h_L FROM SUDDEN CONTRACTION?

GIVEN: SUDDEN CONTRACTION DN 125 → DN 50

SCH. 80 , $Q = 500$ L/MIN

DN 125 ID = 122.3 mm , AREA = $1.173E^{-2}$ m^2 = D_1, A_1

DN 50 ID = 49.3 mm , AREA = $1.905E^{-3}$ m^2 = D_2, A_2

$\Rightarrow D_1/D_2 = 122.3/49.3 = 2.48$

$\Rightarrow v_2 = Q/A = \frac{500\,L}{min} \left| \frac{min}{1.905E^{-3}\,m^2} \right| \frac{m^3}{60000\,L \cdot s} = 4.37\,m/s$

* ASSUMING 4.5 m/s & 2.5 FOR CHART *

$\Rightarrow K = 0.38$

$= h_L = K(v^2/2g) = \frac{0.38}{} \left| \frac{4.37^2\,m^2 \cdot s^2}{2(9.81)\,m} \right| = \boxed{0.37\,m}$

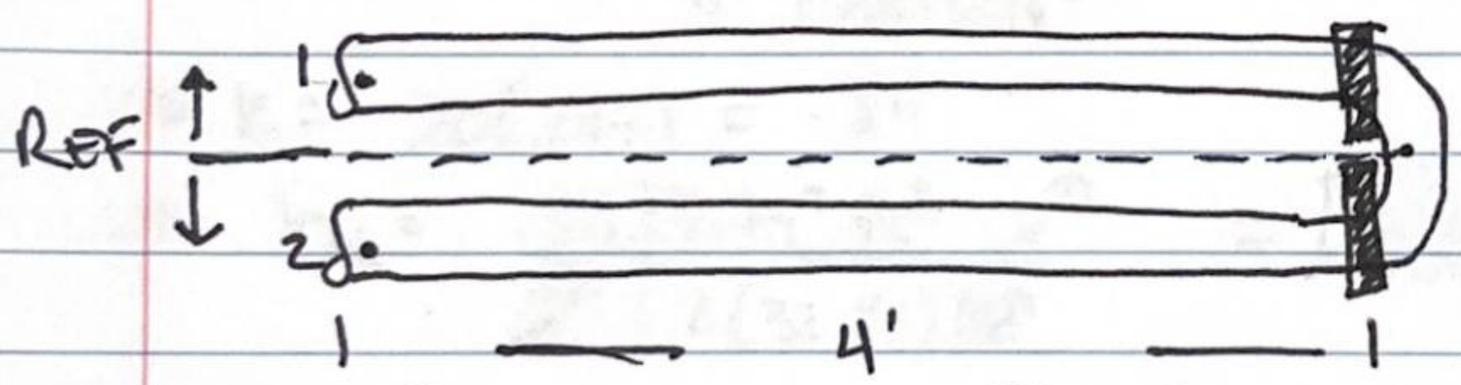
37) PURPOSE: FIND ΔP?

GIVEN: (2) 1/2" SCH. 40 PIPE, 1 CLOSE RN BEND, $Q = 12.5$ gal/min

ETHYLENE GLYCOL @ 77° F: $\gamma = 68.47$ lb/ft^3

$\nu = 1.59E^{-4}$ ft^2/s

$g = 32.17$ ft/s^2 , $L = 8$ ft



NPS 1/2" ID = .622"

$A = .00211\,ft^2$

$v = Q/A = \frac{12.5\,gal}{min} \left| \frac{min}{.00211\,ft^2} \right| \frac{ft^3}{449\,gal \cdot s} = 13.19\,ft/s$

$\Rightarrow \frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_L$ (SPLIT REF)

$\Rightarrow \frac{P_1 - P_2}{\gamma} = h_L \Rightarrow P_1 - P_2 = h_L \gamma$ ①

$h_L = f \frac{Lv^2}{D2g} + \frac{Kv^2}{2g}$ ②

37) CONT

$N_R = \frac{vD}{\nu} = \frac{13.19 \text{ ft}}{s} \Big| \frac{.622 \text{ in} \cdot \text{ft}}{12 \text{ in}} \Big| \frac{s}{1.59E^{-4} \text{ ft}^2} = 4299.9$ ☆ TURBULENT ☆

$\varepsilon = 1.5E^{-4}$ ⇒ $f = \frac{.25}{\left[\log\left(1/3.7(D/\varepsilon) + 5.74/N_R^{.9}\right)\right]^2}$

⇒ $f = .043$ (EXCEL)

⇒ $f_T = .026$, $Le/D = 50$

⇒ $K = (Le/D) f_T = 50(.026) = 1.3$

②

⇒ $h_L = \frac{.043}{} \Big| \frac{8 \text{ ft}}{.622 \text{ in}} \Big| \frac{13.19^2 \text{ ft}^2 \cdot 12 \text{ in} \cdot s^2}{s^2 \text{ ft} (2)(32.17) \text{ ft}} + \frac{1.3}{} \Big| \frac{13.19^2 \text{ ft}^2 \cdot s^2}{s^2 \, 2(32.17) \text{ ft}}$

⇒ $h_L = 17.95 \text{ ft} + 3.52 \text{ ft} = 21.47 \text{ ft}$

① ⇒ $\Delta P = \frac{21.47 \text{ ft}}{} \Big| \frac{68.47 \text{ lb}}{\text{ft}^3} \Big| \frac{\text{ft}^2}{144 \text{ in}^2} = \boxed{10.21 \text{ psig}}$

39) PURPOSE: FIND h_L?

GIVEN: 3" SCH. 40 PIPE → ID = .2557 ft A = .05132 ft²

1 TEE (FLOW THROUGH) : $K = 20 f_T$, $f_T = .017$

$Q = .4 \text{ ft}^3/s$, WATER @ 50° F

⇒ $v = Q/A = \frac{.4 \text{ ft}^3}{s} \Big| \frac{}{.05132 \text{ ft}^2} = 7.79 \text{ ft/s}$

⇒ $K = 20(.017) = .34$

⇒ $h_L = \frac{.34}{} \Big| \frac{7.79^2 \text{ ft}^2 \cdot s^2}{s^2 \, 2(32.17) \text{ ft}} = \boxed{0.32 \text{ ft}}$

43) ~~[illegible]~~ PURPOSE: FIND h_L FOR BOTH SCHEMES?

GIVEN: 50 mm OD x 2 mm wall COPPER TUBE → ID = 46 mm

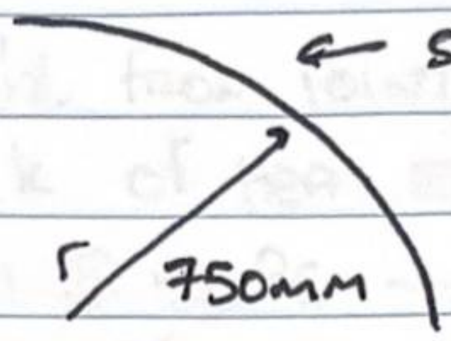
$Q = 750 \text{ L/min} \rightarrow .0125 \text{ m}^3/s$ $A = 1.662E^{-3} \text{ m}^2$

PROPYL Alcohol @ 25°C → $\gamma = 7.87 \text{ kN/m}^3$

$\varepsilon = 1.5E^{-6} \text{ m}$ $\nu = 2.39E^{-6} \text{ m}^2/s$

$v = Q/A = \frac{.0125 \text{ m}^3}{s} \Big| \frac{}{1.662E^{-3} \text{ m}^2} = 7.52 \text{ m/s}$

43 CONT) PROPOSAL 1:



← SAME COPPER TUBING

$r/D = 750mm/46mm$

$= 16.3$

$\Rightarrow L_e/D = 42$

$D/\varepsilon = \frac{46mm}{1000mm} \Big| \frac{m}{1.5E^{-6}\,m} = 30666.7$

$N_R = \frac{VD}{\nu} = \frac{7.52\,m}{s} \Big| \frac{.046m - s}{2.39E^{-6}\,m^2} = 144736$

$\Rightarrow f_T = \frac{.25}{[\log(\frac{1}{3.7(D/\varepsilon)})]^2} = .0098$

$\Rightarrow K = .0098(42) = .4116$

$\Rightarrow h_L = \frac{.4116(7.52)^2}{2(9.81)} = \boxed{1.19\,m}$

PROPOSAL 2: $h_L = \frac{fLv^2}{D2g} + \frac{Kv^2}{2g}$, $L = 1.2m$

$\Rightarrow f = .0168$ (EXCEL)

$\Rightarrow D/\varepsilon = 30666.7$ $\quad r/D = 150mm/46mm = 3.26$ $\quad \Rightarrow L_e/D = 12$

$\Rightarrow f_T = .0098$ $\quad \Rightarrow K = .0098(12) = .1176$

$\Rightarrow h_L = \frac{.0168}{s^2} \Big| \frac{1.2m}{.046m} \Big| \frac{7.52^2\,m^2 \cdot s^2}{(2)(9.81)\,m} + \frac{.1176}{s^2} \Big| \frac{7.52^2\,m^2 \cdot s^2}{2(9.81)\,m}$

$\Rightarrow h_L = 1.26m + .34m$

$\Rightarrow \boxed{h_L = 1.6m}$

46) PURPOSE: FIND h_L FROM POINT 1 TO 2 ?
FIND k of HEAT EXCHANGER?

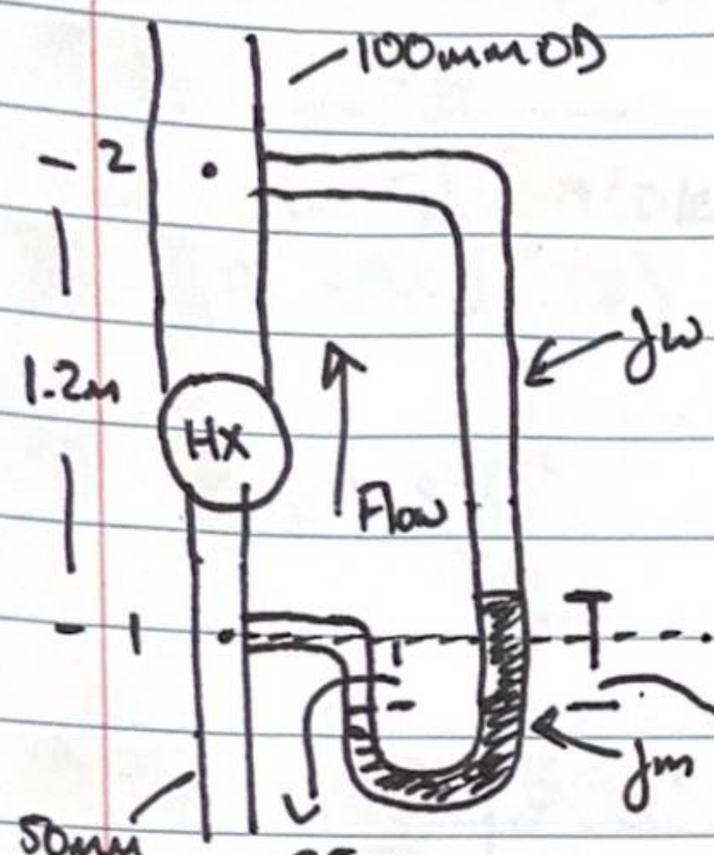
GIVEN: WATER @ 50°C → $\gamma = 9.69\ kN/m^3$, $\nu = 5.48E^{-7}\ m^2/s$

$Q = .006 m^3/s$

MANOMETER, Mercury → $\gamma = 132.8\ kN/m^3$, $\nu = 1.23E^{-7}\ m^2/s$

STEEL, Hyd. TUBES: 50mm OD (2x) → ID = 46mm, $A_1 = 1.662E^{-3}\ m^2$

100mm OD (3.5x) → ID = 93mm, $A_2 = 6.793E^{-3}\ m^2$



$$v_1 = Q/A_1 = \frac{.006 m^3}{s} \Big| \frac{}{1.662E^{-3} m^2} = 3.61\ m/s$$

$$v_2 = Q/A_2 = \frac{.006 m^3}{s} \Big| \frac{}{6.793E^{-3} m^2} = 0.883\ m/s$$

$$\Rightarrow \frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2 + h_L$$

$$\Rightarrow h_L = \frac{P_1 - P_2}{\gamma_w} + \frac{v_1^2 - v_2^2}{2g} + (z_1 - z_2)$$

MANOMETER: $P_1 + \gamma_w(.25m) - \gamma_m(.35m) - \gamma_w(1.2m) = P_2$

$$\Rightarrow \frac{P_1 - P_2}{\gamma_w} = \frac{\gamma_m(.35m)}{\gamma_w} + \frac{\gamma_{H_2O}(0.85m)}{\gamma_{H_2O}}$$

$$\Rightarrow \frac{P_1 - P_2}{\gamma_w} = \frac{132.8 kN/m^3 (.35m)}{9.69 kN/m^3} + .85m = 5.65m$$

$$\Rightarrow h_L = 5.65m - 1.2m + \frac{(3.61)^2 - (.883)^2}{2(9.81)} = \boxed{5.07\ m}$$

$$\Rightarrow K = \frac{h_L 2g}{v_1^2} = \frac{5.07 m}{s^2} \Big| \frac{2(9.81) m}{3.61^2 m^2} \Big| s^2 = \boxed{7.63}$$

48) PURPOSE: FIND h_L IN 90° BEND

GIVEN: STEEL TUBE, 1.5" OD $\longrightarrow$ ID = .1142 ft , $A = 1.024E^{-2}\ ft^2$

$Q = 27.5 gal/min \rightarrow .061 ft^3/s$

@ 104°F hydraulic oil $\rightarrow 4.3E^{-4}\ ft^2/s = \nu$

$\varepsilon = 5E^{-6}$ ft , $r = .271$ ft

$\Rightarrow r/D = .271ft / .1142ft = 2.37 \Rightarrow$ Approx $Le/D = \underline{12}$

$\Rightarrow D/\varepsilon = .1142ft / 5E^{-6} ft = \underline{22840}$

$\Rightarrow f_T = \dfrac{.25}{[\log(1/3.7(D/\varepsilon))]^2} = \underline{.0103}$

$\Rightarrow K = .0103(12) = \underline{.1236}$

$\Rightarrow h_L = \dfrac{KV^2}{2g}$, $V = Q/A = \dfrac{.061 ft^3/s}{1.024E^{-2} ft^2}$

$V = \underline{5.96\ ft/s}$

$\Rightarrow h_L = \dfrac{.1236}{} \dfrac{5.96^2\ ft^2 \cdot s^2}{2(32.17)\ ft} = \boxed{\underline{.068 ft \text{ OR } .82 \text{ INCHES}}}$