MET 330

HOMEWORK 2, 3 : CHAPTER 12

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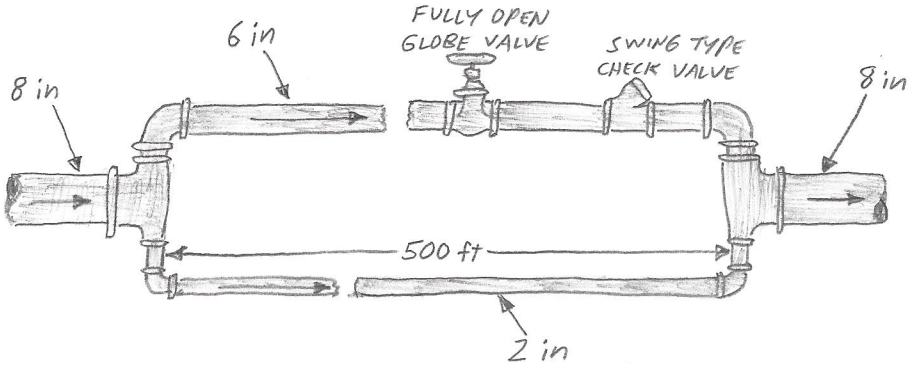
12-7) GIVEN:

BRANCHED-PIPE SYSTEM (ALL STANDARD SCHEDULE 40 STEEL PIPES)
FLUID IS BENZENE (sg = 0.87)
TEMPERATURE OF BENZENE = 140° F
FLOW RATE IN 8-in PIPE = Q = 1350 gal/min



HARDY CROSS TECHNIQUE

$Q_8 = 3.01\ ft^3/s \longrightarrow h_6 = [989 f_6 + 7.5]\frac{V_6^2}{2g}$

$h_2 = [2902 f_2 + 1.14]\frac{V_2^2}{2g}$

$h_6 = [989 f_6 + 7.5]\frac{Q_6^2}{2gA_6^2} = [989 f_6 + 7.5]\left(\frac{Q_6^2}{2(32.2\ ft/s^2)(0.2006)^2}\right)$

$h_6 = [989 f_6 + 7.5](0.3859)Q_6^2 = [381.6 f_6 + 2.894]Q_6^2$

$h_2 = [2902 f_2 + 1.14]\frac{Q_2^2}{2gA_2^2} = [2902 f_2 + 1.14]\left(\frac{Q_2^2}{2(32.2\ ft/s^2)(0.02333)^2}\right)$

$h_2 = [2902 f_2 + 1.14](28.53)Q_2^2 = [82791 f_2 + 32.52]Q_2^2$

$N_{R_6} = \frac{V_6 D_6 \rho}{\eta} = \frac{Q_6 D_6 \rho}{A_6 \mu}$

$N_{R_6} = \frac{Q_6(0.5054)(1.69)}{(0.2006)(8\times10^{-6})} = (5.322\times10^5)Q_6$

$N_{R_2} = \frac{V_2 D_2 \rho}{\eta} = \frac{Q_2 D_2 \rho}{A_2 \mu}$

$N_{R_2} = \frac{Q(0.1723)(1.69)}{(0.2333)(8\times10^{-6})} = (1.560\times10^6)Q_2$

CONTINUED

12-7) CONTINUED

$\left(\frac{D}{\varepsilon}\right)_6 = 3369 \longrightarrow \left(\frac{D}{\varepsilon}\right)_2 = 1149$

TRY $Q_6 = 2.50\ ft^3/s \longrightarrow Q_2 = 3.01 - Q_6 = 0.51\ ft^3/s$

$N_{R_6} = (5.322 \times 10^5)(2.50) = 1.33 \times 10^6 \longrightarrow f_6 = 0.0160$

$N_{R_2} = (1.560 \times 10^6)(0.51) = 7.96 \times 10^5 \longrightarrow f_2 = 0.0195$

FRICTION FACTORS FOUND FROM MOODY'S DIAGRAM

$h_6 = [381.6(0.016) + 2.894]\,Q_6^2 = 9.000\,Q_6^2 = k_6 Q_6^2$

$h_2 = [82791(0.0195) + 32.52]\,Q_2^2 = 1647\,Q_2^2 = k_2 Q_2^2$

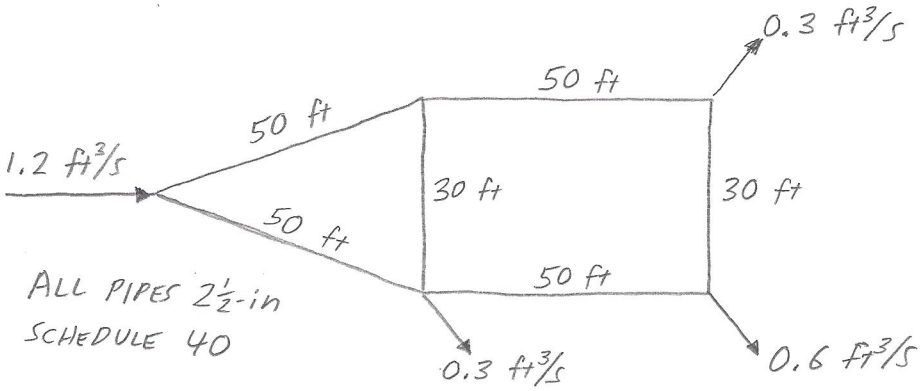
TRIAL	PIPE	Q	N_R	f	k	(I) $h = kQ^2$	(II) ΣkQ	$\Delta Q = \frac{(I)}{(II)}$
1	6	2.50	1.33×10^6	0.0160	9.000	56.25	45.00	-0.21575
	2	-0.51	7.96×10^5	0.0195	1647	-428.4	1679.94	
						-372.15	1724.94	
2	6	2.716	1.45×10^6	0.016	9.000	66.39	48.89	-0.07635
	2	-0.294	4.59×10^5	0.020	1688	-145.9	992.5	
						-79.51	1041.4	
3	6	2.792	1.49×10^6	0.016	9.000	70.16	50.26	-0.01253
	2	-0.2177	3.40×10^5	0.020	1688	-80.00	734.95	
						-9.84	785.21	
4	6	2.805	1.49×10^6	0.016	9.000	70.81	50.49	-0.00037
	2	-0.205	3.20×10^5	0.020	1688	71.05	692.65	(NEGLIGIBLE)
						-0.24	642.16	

$Q_6 = 2.805\ ft^3/s$

$Q_2 = 0.205\ ft^3/s$

12-9) GIVEN:

TEMPERATURE OF WATER = 60°F

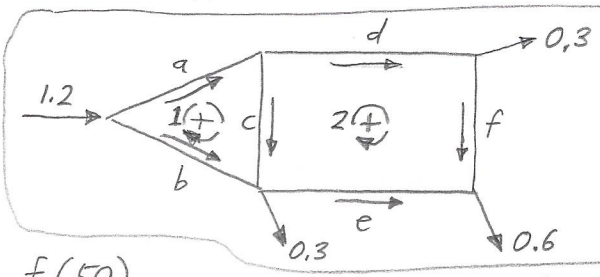


$2\frac{1}{2}$ in SCHEDULE 40 PIPES: $D = 0.2058$ ft $\rightarrow A = 0.03326$ ft²

GENERAL FORM FOR k

$$h = kQ^2 = \frac{fL}{D}\frac{v^2}{2g} = \frac{fLQ^2}{D2gA^2}$$

$$\therefore k = \frac{fL}{D2gA^2}$$



$a + b = 1.2$

$c + d = a$

$e + f = 0.6$

$d - f = 0.3$

$b + c = e + 0.3$

$$k_a = k_b = k_d = k_e = \frac{f(50)}{(0.2058)(64.4)(0.03326)^2} = 3410f$$

$$k_c = k_f = \frac{f(30)}{(0.2058)(64.4)(0.03326)^2} = 2046f$$

VALUES OF f TO BE COMPUTED.

FOR ALL PIPES $D/\varepsilon = 0.2058/1.5 \times 10^{-4} = 1372$

USE WATER AT 60°F: $\nu = 1.21 \times 10^{-5}$ ft²/s

$$N_R = \frac{VD}{\nu} = \frac{QD}{A\nu} = \frac{Q(0.2058)}{(0.03326)(1.21 \times 10^{-5})} = (5.114 \times 10^5)Q$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(1372)} + \frac{5.74}{(N_R)^{0.9}}\right)\right]^2} \longrightarrow f = \frac{0.25}{\left[\log\left(\frac{1}{1.970 \times 10^{-4}} + \frac{5.74}{(N_R)^{0.9}}\right)\right]^2}$$

FOR TRIAL 1: FLOW EQUATIONS AT NODES:

$Q_a + Q_b = 1.2$ ft³/s

TRY $Q_a = 0.50 \rightarrow Q_b = 0.70$

$Q_c + Q_d = Q_a = 0.50$

TRY $Q_c = 0.10 \rightarrow Q_d = 0.40$