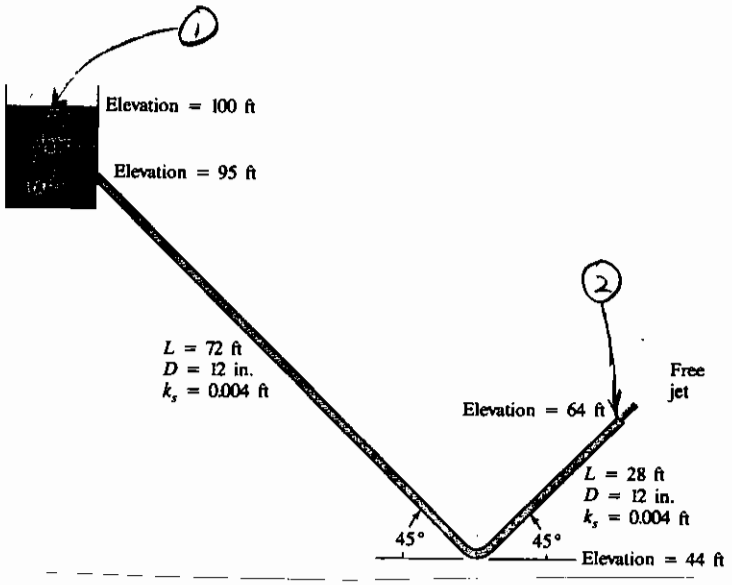
10.78 (1)



GIVEN; TANK DISCHARGING THROUGH PIPE AS SHOWN.

FIND: (1) FLOW RATE Q

(2) DRAW HGL & EGL

(3) LOCATION OF MIN. & MAX. PRESSURES.

(4) VALUE OF MIN. & MAX. PRESSURES.

SOLUTION: (1) APPLY PIPE FLOW ENERGY EQUATION FROM (1) TO (2).

$$\cancel{\frac{p_1}{\gamma}}^{\,0\text{ GAGE}} + z_1 + \alpha\cancel{\frac{V_1^2}{2g}}^{\,0} = \cancel{\frac{p_2}{\gamma}}^{\,0\text{ GAGE}} + z_2 + \alpha\frac{V_2^2}{2g} + h_L$$

$$h_L = f\left(\frac{L}{D}\right)\frac{V^2}{2g} + 0.5\frac{V^2}{2g} + 0.2\frac{V^2}{2g}$$

0.5 ↑ ENTRANCE; 0.2 ↑ BEND

$$\frac{V^2}{2g}\left(1 + f\left(\frac{L}{D}\right) + 0.7\right) = z_1 - z_2 = 36\text{ FT}$$

L = 100 FT D = 1 FT

10.78 (2)

$$V = \sqrt{\frac{2(32.2)36}{(1.7 + 100f)}} = \sqrt{\frac{2318.4}{(1.7+100f)}}$$

1ST GUESS: $f = 0.020 \Rightarrow V = 25.0$ FT/S

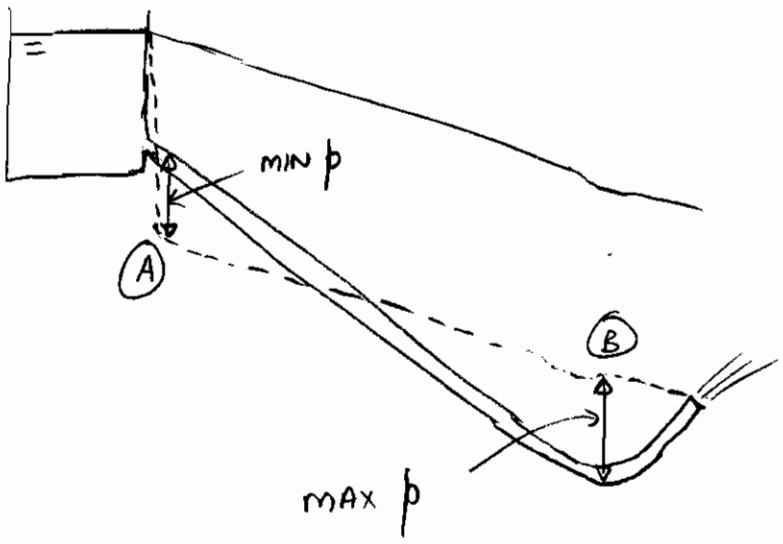
$$Re = \frac{(1)(25.0)}{1.22 \times 10^{-5}} = 2.05 \times 10^6$$

$$\frac{k_s}{D} = 0.004 \Rightarrow f = 0.028$$

USE $f = 0.028$

$V = 22.7 \frac{FT}{S}$ $\quad Q = \left(\frac{\pi}{4}\right) 1^2$ $\quad \boxed{Q = 17.8 \text{ CFS}}$

(2)



(3) LOCATION OF MIN. p AND MAX. p ARE SHOWN ABOVE.

10.78 (3)

(4) MINIMUM PRESSURE

$$\cancel{\frac{p_1}{\gamma}}^{\to 0} + z_1 + \alpha \cancel{\frac{V_1^2}{2g}}^{\to 0} = \frac{p_A}{\gamma} + z_A + \alpha \frac{V_A^2}{2g} + h_L$$

$$\frac{p_A}{\gamma} = 100\,FT - 95\,FT - \frac{V^2}{2g}(1 + 0.5)$$

$$\frac{p_A}{\gamma} = 5 - 12.0\,FT = -7\,FT$$

$$p_A = -437\,PSFG = -3.03\,PSIG$$

MAXIMUM PRESSURE

CANCEL

$$\frac{p_B}{\gamma} + z_B + \alpha \cancel{\frac{V_B^2}{2g}} = \cancel{\frac{p_2}{\gamma}} + z_2 + \alpha \cancel{\frac{V_2^2}{2g}} + h_L$$

0 GAGE

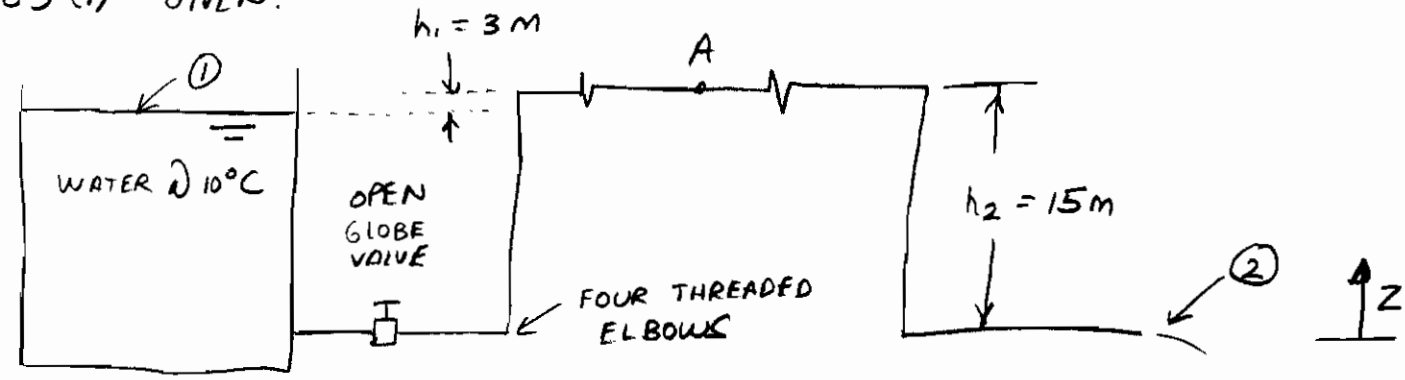
$$\frac{p_B}{\gamma} = 64\,FT - 44\,FT + f\left(\frac{L}{D}\right)\frac{V^2}{2g} + K_B\frac{V^2}{2g}$$

$L = 28\,FT \qquad f = 0.028 \qquad K_B = 0.2$

$$\frac{p_B}{\gamma} = 20\,FT + 7.9\,FT. \qquad p_B = 1739\,PSFG$$

$$\boxed{p_B = 12.1\,PSIG}$$

10.83 (1) GIVEN:



$D = 10$ CM $\quad L = 1000$ m GALVINIZED STEEL PIPE

FIND: DISCHARGE AND PRESSURE AT A.

SOLUTION: WRITE EXTENDED BERNOULLI EQUATION FROM ① TO ②.

$$\cancel{\frac{p_1}{\gamma}}^{0} + Z_1 + \cancel{\alpha_1 \frac{V_1^2}{2g}}^{\to 0} = \cancel{\frac{p_2}{\gamma}}^{0} + Z_2 + \cancel{\alpha_2}^{1} \frac{V_2^2}{2g} + h_L$$

$$Z_1 - Z_2 = \frac{V_2^2}{2g} + \frac{V_2^2}{2g}\left(f\frac{L}{D} + 4K_b + K_v + K_e\right)$$

$$\uparrow \quad \uparrow \quad \uparrow$$
$$.9 \quad 10 \quad .5$$

$$12 = \frac{V_2^2}{2g}\left(f\frac{1000}{.1} + 3.6 + 10 + .5 + 1\right)$$

$$V_2 = \sqrt{\frac{2(9.8)12}{(10{,}000 f + 15.1)}}$$

$k_s = .15$ mm $\qquad \frac{k_s}{D} = \frac{.15}{100} = .0015$

FIRST ITERATION

GUESS $f = 0.020$

$V_2 = 1.05$ m/s $\qquad Re = \frac{(.1)(1.05)}{1.31 \times 10^{-6}} = 79{,}800$

10.83 (2)

ENTER MOODY DIAGRAM WITH $\frac{k_s}{D}$ AND Re.

FIND $f = 0.024$

SECOND ITERATION $f = 0.024$

$V_2 = 0.960 \frac{m}{s}$ $Re = 73,300$

MOODY DIAGRAM $\Rightarrow$ $f = 0.025$

FINAL ITERATION $f = 0.025$

$V_2 = 0.942 \frac{m}{s}$

$Q = VA = (0.942)\frac{\pi}{4}(.1)^2$

$Q = 0.00740 \frac{m^3}{s}$

PRESSURE AT A.

$$z_1 = \frac{p_A}{\gamma} + z_A + \frac{V^2}{2g} + \frac{V^2}{2g}\left(f\frac{L}{D} + 0.5 + 10 + 1.8\right)$$

$$p_A = \gamma(z_1 - z_A) - \frac{V^2}{2g}\left(.024\frac{500}{.1} + 12.3\right)\gamma$$

$$p_A = 9810(-3m) - \frac{0.942^2}{2 \cdot 9.8}(132.3)\ 9810$$

$$p_A = -29,430 - 58,760$$

$p_A = -88,200$ Pa WHICH IS GETTING CLOSE TO THE POINT OF CAVITATION.