10.39

GIVEN: LONG UNIFORM PIPE WITH $k_s = 10^{-4}$ FT.

$V = 1 \frac{FT}{S}$, $D = 0.10$ FT, AND $\nu = 10^{-4} \frac{FT^2}{S}$.

FIND: THE RESISTANCE COEFFICIENT, f.

SOLUTION: CHECK REYNOLDS NUMBER.

$$Re = \frac{DV}{\nu} = \frac{(0.1)(1)}{10^{-4}} = 1000$$

THE FLOW IS LAMINAR SO

THE PIPE WALL ROUGHNESS DOES

NO INFLUENCE f.

$$f = \frac{64}{Re}$$

$$\boxed{f = 0.064 \qquad (a)}$$

10.46

(a) TRUE

(b) FALSE THIS IS ONLY TRUE FOR TURBULENT PIPE FLOW, LAMINAR PIPE FLOW IS NOT INFLUENCED BY WALL ROUGHNESS.

(c) $Re_1 = \frac{1 \cdot 1}{10^{-6}} = 10^6$ $f_1 = .0118$

$Re_2 = 2 \times 10^6$ $f_2 = .0104$

$h_f = f \frac{L}{D} \frac{V^2}{2g}$

f IS ABOUT CONSTANT

h_f VARIES BY A FACTOR OF 4, (BECAUSE OF V^2)

FALSE

(d) $Re_1 = \frac{1 \cdot 1}{10^{-2}} = 100$ LAMINAR FLOW

$Re_2 = 200$

$h_f \propto V$ TRUE

(e) FALSE SEE PART (c)

h_f VARIES BY A FACTOR OF 4,

10.53 (1)

GIVEN:

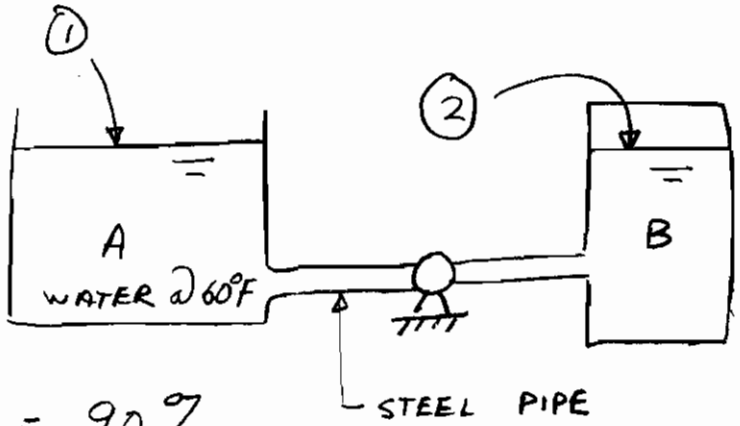
$D = 4$ IN.

$L = 300$ FT

$Q = 1.00$ CFS

$p_B = 10$ PSIG

$\eta_{PUMP} = 90\%$



FIND: POWER NECESSARY TO OPERATE THE PUMP
DRAW HGL & EGL.

SOLUTION: APPLY EXTENDED BERNOULLI FROM (1) TO (2)

$$\frac{p_1}{\gamma}\ (0 \text{ GAGE}) + z_1 + \alpha_1 \frac{V_1^2}{2g}\ (0) + h_p = \frac{p_2}{\gamma} + z_2 + \alpha_2 \frac{V_2^2}{2g}\ (0) + h_L$$

$$h_p = \frac{p_2}{\gamma} + h_L \qquad h_L = f \frac{L}{D} \frac{V^2}{2g} + \frac{V^2}{2g}$$

PIPE — ABRUPT EXPANSION

STEEL PIPE: $k_s = 1.5 \times 10^{-4}$ FT, $\frac{k_s}{D} = .00045$

$$Re = \frac{DV}{\nu}, \quad V = \frac{Q}{A} = \frac{1}{\frac{\pi}{4}\left(\frac{4}{12}\right)^2} = 11.46 \frac{FT}{S}$$

$$Re = \frac{\left(\frac{4}{12}\right)(11.46)}{1.22 \times 10^{-5}} = 3.13 \times 10^5$$

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

$$f = 0.019$$

10.53 (2)

$$h_p = \frac{10.144}{62.37} + \left[0.019\left(\frac{300}{4/12}\right) + 1\right]\frac{11.46^2}{2 \cdot 32.2}$$

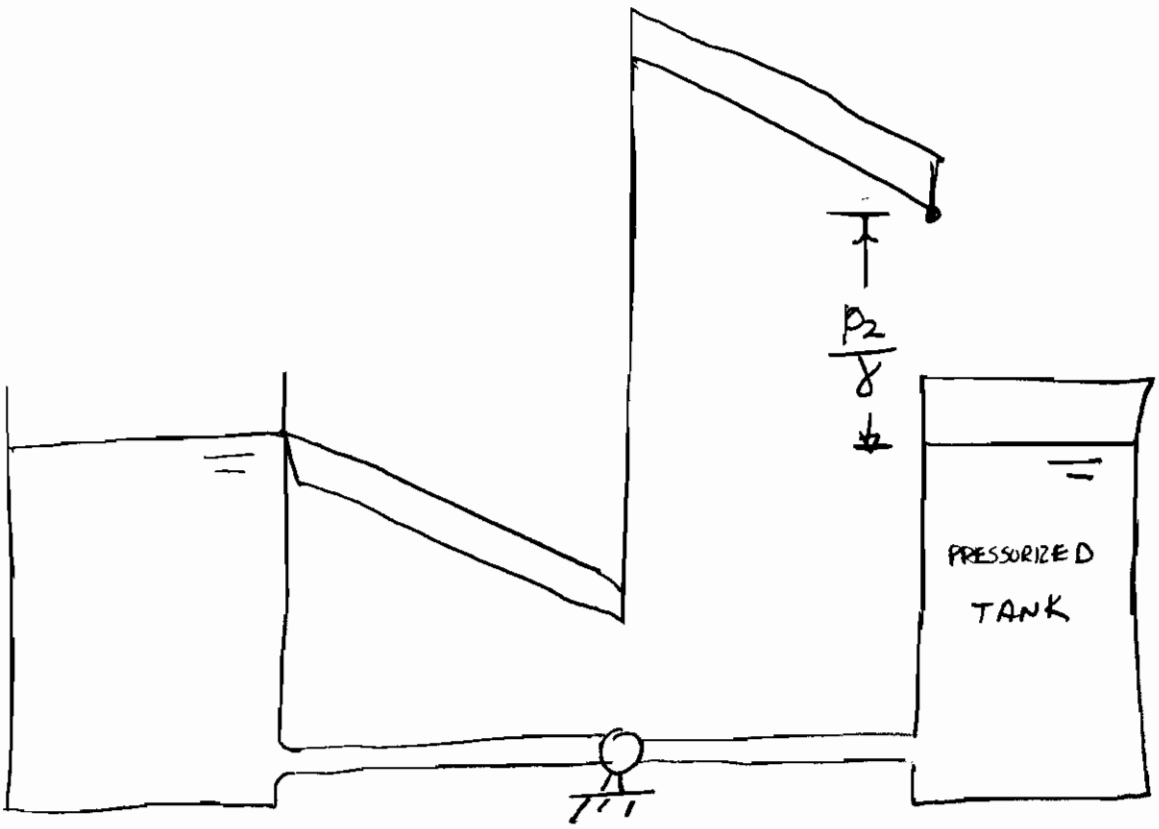
$$h_p = 23.1 \text{ FT} + 36.9 \text{ FT} = 60.0$$

$$\dot{W}_p = \gamma Q h_p = (62.37)(1)(60.0)$$

$$\dot{W}_p = 3743 \frac{\text{FT-LBf}}{\text{S}}$$

$$\dot{W}_{IN} = \frac{3743}{0.90} = 4159 \frac{\text{FT-LBf}}{\text{S}}$$

$$\boxed{\dot{W}_{IN} = 7.56 \text{ hp}}$$



10.68 (1)

GIVEN: COMMERCIAL STEEL PIPE TO CARRY $Q = 300 \frac{FT^3}{S}$ OF WATER AT 60°F. $h_L = 1$ FT FOR $L = 1000$ FT.

FIND: D

SOLUTION:

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

$$V = \frac{Q}{A} = \frac{4Q}{\pi D^2} \qquad h_L = f\left(\frac{L}{D}\right)\frac{8Q^2}{\pi^2 D^4 g}$$

$$D^5 = \frac{f}{h_L}\ \frac{8Q^2 L}{\pi^2 g}$$

1ST GUESS: $D = 1$FT $\qquad k_s = 1.5 \times 10^{-4}$ FT

$$\frac{k_s}{D} = 0.00015 \qquad Re = \frac{DV}{\nu} = \frac{4Q}{\pi D \nu}$$

$$Re = 3.13 \times 10^7 \qquad Re = \frac{4(300)}{\pi(1)(1.22 \times 10^{-5})}$$

$$f = 0.013$$

$$D = \left(\frac{0.013}{1}\ \frac{8\ (300)^2\ 1000}{\pi^2\ (32.2)}\right)^{\frac{1}{5}} = 7.83 \text{ FT}$$

$$= 94 \text{ IN.}$$

10.68 (2)

2ND GUESS: $D = 94$ IN. $= 7.833$ FT

$\frac{k_s}{D} = 0.000019$

$Re = 4.00 \times 10^6$ $\quad f = 0.010$

$D = 7.430$ FT $= 89.2$ IN

CHOOSE PIPE DIAMETER OF 90",

THIS IS THE CLOSEST "EVEN" INCH

DIAMETER TO LAST RESULT.

$D = 90"$