1 $Q_{in} = Q_{out}$ 100GPM

$P_B = 10psig$

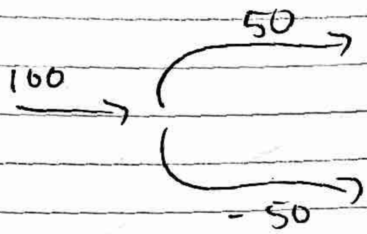
Line 1 = 150ft $D = 2.375$ $A = 1.08 in^2$

Line 2 = 125 ft $D = 1.61$ $A = .80 in^2$

Turp $\gamma = 53.06 lb/ft^3$

$h_{L_1} = h_{L_2}$ $Q_T = \sum Q_i$

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_A = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_B + h_{L_{AB}}$$



$Q_A = .003153\ m^3/s$

$Q_B = -.00315\ m^3/s$

$A_1 = \frac{\pi(.1979)^2}{4} = .03075 ft^2$ $R_1 = \frac{.03075}{.0448}$ 68.6%

$A_2 = \frac{\pi(.1342)^2}{4} = .01414 ft^2$ $R_2 = \frac{.01414}{.0448}$ 31.4%

$A_T = A_1 + A_2$

$= \cancel{.0446}$

$= .0448 ft^2$

$Q_1 = .1526\ ft^3/s$

$Q_2 = .0699\ ft^3/s$

Hardy Cross - Excel

$$h_L = \frac{fL}{2gD} \cdot \frac{Q_2^2}{A_2^2}$$

$$\frac{.025}{2(32.174)\left(\frac{1.61}{12}\right)} \left(\frac{.0699}{\left(\frac{.00}{12^2}\right)^2}\right)$$

$$\frac{P_A}{\gamma} = \frac{P_B}{\gamma} + 820.48 \text{ ft}$$

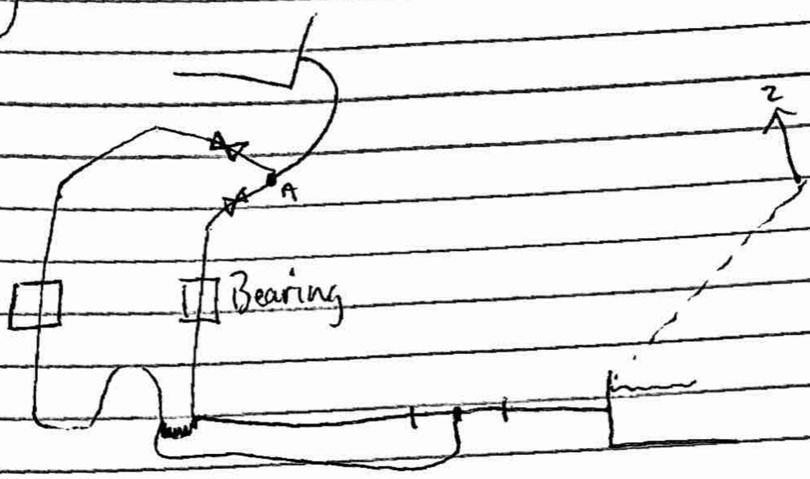
If increase flow rate to 150 w/o change
then ϕ $D_1 = 2.968$ in or .0754 m
$D_2 = 2.012$ in or .0511 m

Excel, plugged in # til got it.

Test 2

2 Purpose: Determine the flow rate of oil to each bearing

Drawing



Source: Lecture / Book

Design Consideration: Isothermal Process
Incompressible Fluid
Friction

Data & Variable

sg : .888

ν : $9 \times 10^{-4}\ m^2/s$

K_B : 10

$R_{AB} = 15'$ - 4.572m

$L_{AB} = 30'$ - 9.144m

$z = 12'$ - 3.657m

1/2" standard k copper : .01338m

$\varepsilon = 1.5 \times 10^{-6}\ m$

Procedure & Equation

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_A = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_B + h_{L1-2}$$

$$Q = VA \quad V = \frac{Q}{A} = \frac{4Q}{\pi D^2} \qquad A_{AB} = \frac{\pi D^2}{4} = \frac{\pi(.01338m)^2}{4}$$

$$= 1.406 \times 10^{-4}$$

$$h_{L1-2} = f_a \frac{L_a}{D}\left(\frac{v_a^2}{2g}\right) + \frac{30 f_t}{g}\left(\frac{v_a^2}{2g}\right) + \frac{60 f_t}{g}\left(\frac{v_a^2}{2g}\right)$$

$$+ 30 f_t\left(\frac{v_c^2}{2g}\right) + 8 f_t\left(\frac{v_c^2}{2g}\right) + \frac{10}{g}\left(\frac{v_c^2}{2g}\right) + 60 f_t\left(\frac{v_d^2}{2g}\right)$$

$$+ f_c\left(\frac{L_c}{D_c}\right)\left(\frac{v_c^2}{2g}\right) + f_d\left(\frac{L_d}{D_d}\right)\frac{v_d^2}{2g} + \frac{.5}{g}\left(\frac{v_a^2}{2g}\right) + 1\frac{v_d^2}{2g}$$

$$h_{L_{1-2}} = \frac{8Q_a^2}{\pi^2 D^4 g}\left(f_a \frac{L_a}{D} + 30 + 60 + 60 + f_a \frac{L_D}{D} + .5 + 1\right)$$

$$= \frac{8Q_c^2}{\pi^2 D^4 g}\left(60 + 8 + 10 + f_c \frac{L_c}{D}\right)$$

$$f_T = \frac{.25}{\log\left(\frac{1}{3.7(.0388 \times 9)}\right)}$$

$$h_{1-2} = \left(\frac{8Q_a^2}{\pi^2(.01338)^4(9.81)}\right) f_a\left(\frac{.3046}{.01338}\right) + 150\left(.008208\right) + 1.5$$

$$+ \frac{8Q_c^2}{\pi^2(.01338)^4(9.81)}\left(68(.008208) + 60 + f_c\left(\frac{4.572}{.01338}\right)\right)$$

$$= 2570389.42Q_a^2(45.52f_a + 2.731) + 2570389.42$$
$$(10.55 + 341.4f_c)$$

$$z_1 = 3.657 = 2570389.42(45.52f_a + 2.731) +$$
$$2570389.42Q_c^2(10.55 + 341.4f_c)$$

$$Q_a = \frac{8Q_a^2}{\pi^2 D^4 g}\left(f_s \cdot \frac{L_a}{D} + 90ft + f_s(18.57) + 60(.008108)\right.$$

$$\left. + 1.5\right) + \frac{8Q_b^2}{\pi^2 D^4 g}\left(13 + 60(.008208) \; f_5(341.4\right.$$

$$\left.\left. + 60(.008208)\right)\right)$$

$$Q_A = Q_B + Q_c$$

$$Q_A = Q_D$$

$Q_A = 1.88 \times 10^{-5}$

$Q_D = 1.88 \times 10^{-5}$

$Q_B = 1.9 \times 10^{-6} \; m^3/s$

$Q_c = 1.71 \times 10^{-5} \; m^3/s$

Summary: Applied Bernoullis Equation. I chose a reference point to start from. Solved for flow rate for all variables

Materials: Copper tube
Bearings
Oil
Gate valve

Analysis: Flow rate increased