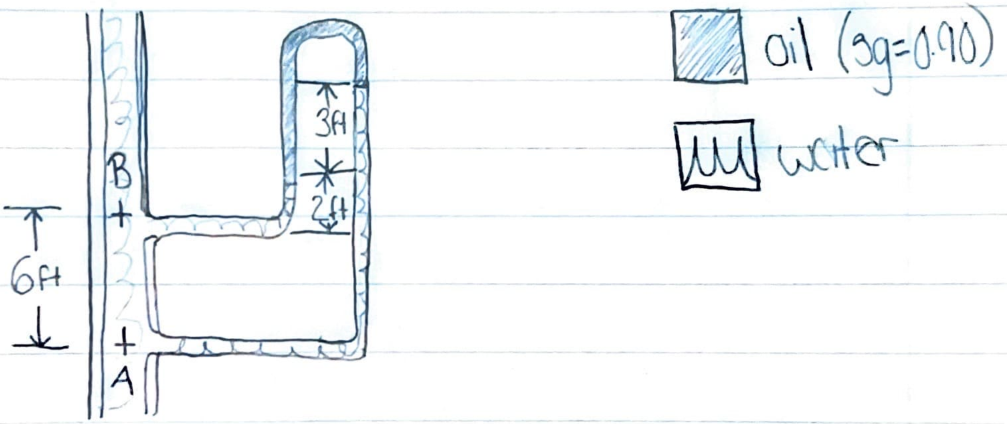
MET 330 Test 1

Devon Kigler

1) Purpose: To calculate the deflection in a manometer if the oil inside with a specific gravity of 0.90 was switched out with gasoline. Also determine the minimum height of the manometer so that gasoline does not go into the system.

Drawings:



Sources: Mott, Robert L., and Joseph A Untener. Applied Fluid Mechanics. Pearson, 2016.

Design considerations: The pressure difference between points one and two is 2.7177 psi

Honor code: This test was completed to the best of my ability

Data and Variables: Specific gravity of oil = 0.90
Specific gravity of gasoline (per appendix b) = 0.68
Total height = 11ft   1ft = 0.3048m

Procedure: To solve this problem, I will use Bournoulli's equation to find both solutions. Looking at what's given in the problem, I'll eliminate factors from the equation and substitute values in order to find the pressure difference if the fluid inside was gasoline. That value will then be used to find deflection and the minimum height value.

Calculations: Bournoulli's $= h_A + P_1/\gamma + V_1^2/2g + Z_1 = P_2/\gamma + V_2^2/2g + Z_2 + h_R + h_L$

Rewrite equation $= P_B - \gamma(\text{water} \times \text{gravity} \times h_1) - \gamma_{oil} g h_2 + \gamma_{water} g h_3 = P_A$

1ft = 0.3048in

Pressure difference: $P_A - P_B$

$10^3 \cdot 9.81 \cdot 3.33528 - 10^3 \cdot 9.81 \cdot 0.6096 - 900 + 9.81 + 0.9144$

$= 18,837.554\,Pa = 2.73222\,psi$

$P_A - P_B = 10^3 \cdot 9.81 \cdot 3.5528 - 10^3 \cdot 9.81 \cdot 0.6096 - 680 \cdot 9.81 \cdot 0.9144$

$= 20811.01248_{kpa} \rightarrow \underline{3.01838_{psi}}$

calculations (cont'd)

Deflection - rewrite bournoulli's equation again

$\gamma_{water}\, g\, height_{water} = \gamma_{gas}\, g\, h_{gas} - h_{water}$

$10^3 \cdot 9.81 \cdot (11-2) = 680 \cdot 9.81\, h_{gas} - (11 - 2ft)$

$4.07524 - 2.7432 = 1.33204m \rightarrow$ 4.3702ft deflection

Height Required

$P_1 + \gamma g h_1 = P_2 + \gamma g h_2$ $\quad \Delta P = P_1 - P_2 = 20.811$ Kpa

$P_1 - P_2 + \gamma_{water}\, g\, h_{water} = \gamma_{gas} h_{gas}$

$= 20.811$ kpa $+ 1000 \cdot 9.81 \cdot 2.7432 = 680 h_{gas\,min} =$ 4.03723 meter

Summary: If there was gasoline in the manometer, the deflection would be 4.37026ft. Furthermore, the minimum height of the manometer required to prevent gasoline from going into the system is 4.03723.

Materials: Manometer, gasoline, oil, water.

Analysis: The design of the manometer is sufficient to satisfy the fluid composition inside. However, it is not set up to properly store a fluid with a high specific gravity. To make it more suitable, a greater height would be needed.

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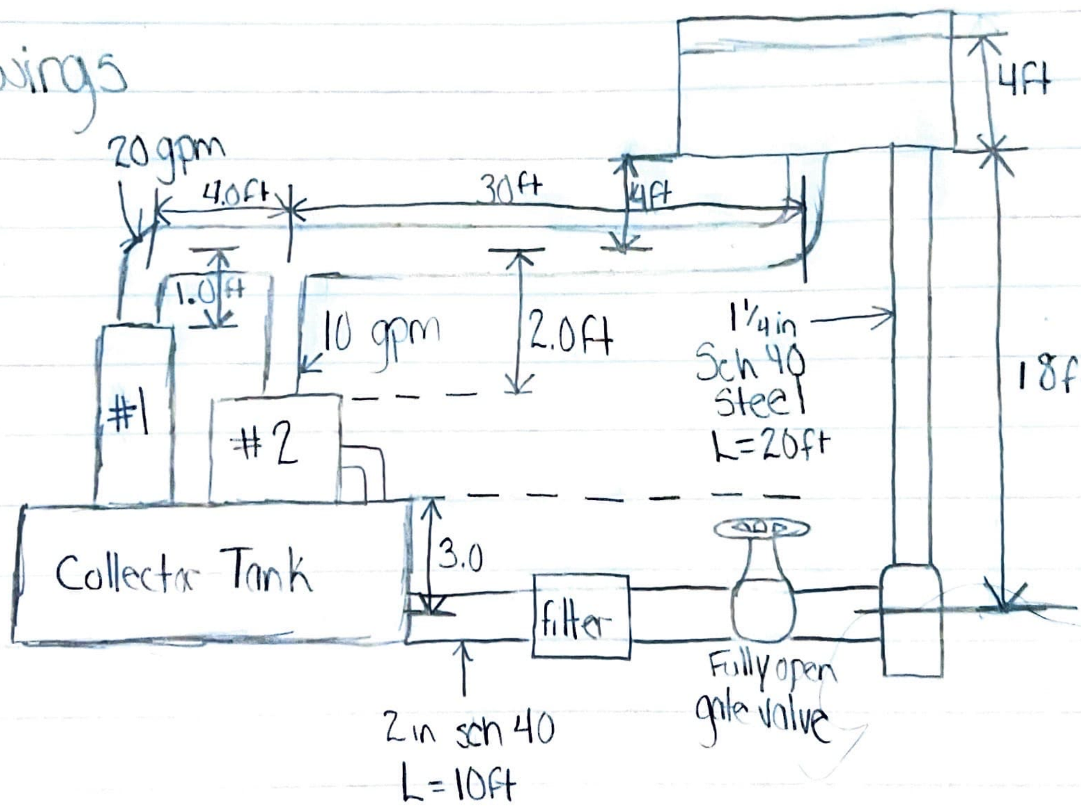
2) Purpose: To redesign a pumped system by choosing new pipe to best satisfy the desired flow rate of the system, and to calculate various economic factors required by the system.

Drawings



Sources: Mott, Robert L., and Joseph A Untener. Applied fluid mechanics. Pearson, 2016

Design Considerations: There are two machines in the upper system, and one in the pumped system. All pipes are schedule 40. Gate valve stays fully open. Pump goes directly upwards. keep in mind the small pipes near joints and ones that go into

Data and Variables: Flow rate = 30gpm / 0.06634 ft^3/s

Specific gravity = 0.92 dynamic viscosity = 3.6×10^{-5} $lb \cdot s/ft^2$

Resistance coefficient(K) = 1.85 (based on velocity head in suction)

Length of all given pipe = 71 ft

Inner diameter = 1.048 in → 0.0254 m

Procedure: First, to find the correct pipe that satisfies the flowrate and flow velocity, the equation Q=VA (flowrate equation) will be used. After the pipe is selected, find pump head, power delivered, and the pressure at the pump. Once those calculations are made, those values will be used in excel for parts c-h.

Calculations: First, list equations to be used.

Bournoulli's: $h_A + P_1/\gamma + V_1^2/2g + Z_1 = P_2/\gamma + V_2^2/2g + Z_2 + h_R + h_L$

γ coolant = 785.7 kg/m3

Pump head = $\Delta \gamma g h$ + Length P_{Loss}

$\Delta P = 785.7 \cdot 9.81 \cdot 5.4864 + 6.096 \times 0.000175769$ (d viscosity)

$= \underline{42{,}287.619}$ pa

Pump power = $3 \cdot 0.92 \cdot 42{,}287.618 = \underline{116.714}$ kw
(Q)(Sg)(pumphead)

Inlet Pressure $= P_1 + \frac{1}{2}\gamma v^2 \cdot d + \gamma \cdot g \cdot h = P_2 + \frac{1}{2} \cdot \gamma \cdot v^2 \cdot d + \gamma g L$

$42{,}287.619 + \frac{1}{2} \cdot 785.7 \cdot 3^2 \cdot 0.0254 + 785.7 \cdot 9.81 \cdot 6.096$

$= P_2 + \frac{1}{2} \cdot 785.7 \cdot 3^2 \cdot 0.0254 + 785.7 \cdot 9.81 \cdot 5.4864$

$\rightarrow P_2 = \underline{46{,}986.244}$ pa

Summary: In this experiment, the value for the pump head came out to be 42,287.619 Pa. The power at the pump came out to be 116.719 KW, and the inlet pessure value came out to be 46,986.244 pa.

Materials: Coolant, 2 in schedule 40 steel pipe, 1 1/4 in schedule 40 steel pipe, 1/2 in schedule 40 steel pipe, 3/4 in schedule 40 steel pipe, 1 1/2 in schedule 40 steel pipe.

Analysis: The correct pipe size that would sufficently satisfy the system is 1 in schedule 40 steel pipe. Any pipe smaller would not give a sufficient flow rate, and any pipe larger would provide a rate too high for the system.