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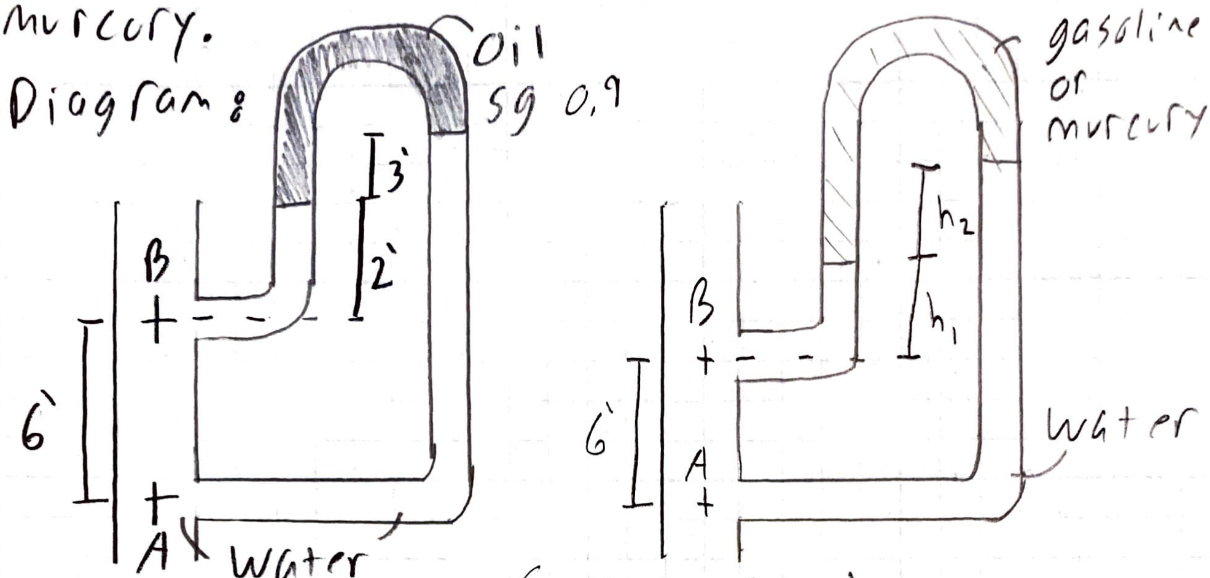
1) Purpose: to determine the change in height (deflection) of a manomiter with a change in fluid, from oil to gasoline, then to murcury.

Diagram:



(not to scale)

Source: Applied fluid mechanics 7^{th} edition by Robert L. Matt, Joseph A. Untener.
Thermodynamics: an engineering approach by Yunus Cengel.

Design considerations: Incompresable fluid, constant properties.

Data: $S.G_{oil} = 0.9$ $\gamma_w = 62.4 lb/ft^3$

$\gamma_{oil} = 56.16\ lb/ft^3$ $\gamma_{gasoline} = \gamma_g = 42.4\ lb/ft^3$

$P_A - P_B = \Delta P = 2.7177 psi = 391.35\ lb/ft^2$

$\gamma_{murcury} = \gamma_m = 844.9\ lb/ft^3$

Procidure: I will use the $\Delta P = \gamma h$ equation using the known ΔP and γ of fluids to determine h_2 for gas and murcury.

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1) Calculations:

$$P_B - \cancel{h_1 \gamma_w} - h_2 \gamma_g + h_2 \gamma_w + \cancel{h_1 \gamma_w} + 6ft\,\gamma_w = P_A$$

$$P_A - P_B = h_2(\gamma_w - \gamma_g) + 6ft\,\gamma_w$$

$$h_2 = \frac{\Delta P - 6ft\,\gamma_w}{\gamma_w - \gamma_g} = \frac{391.35\ \frac{lb}{ft^2} - 6ft\,(62.4\ lb/ft^3)}{62.4\ lb/ft^3 - 42.4\ lb/ft^3}$$

$h_2 = 0.8475$ ft for gasoline

deflection $= 3ft - 0.8475ft = \underline{2.15\ ft}$

$h_2 = -0.022$ ft for murcury (from excel

deflection $= 3ft - (-0.022ft) = \underline{3.022ft.}$

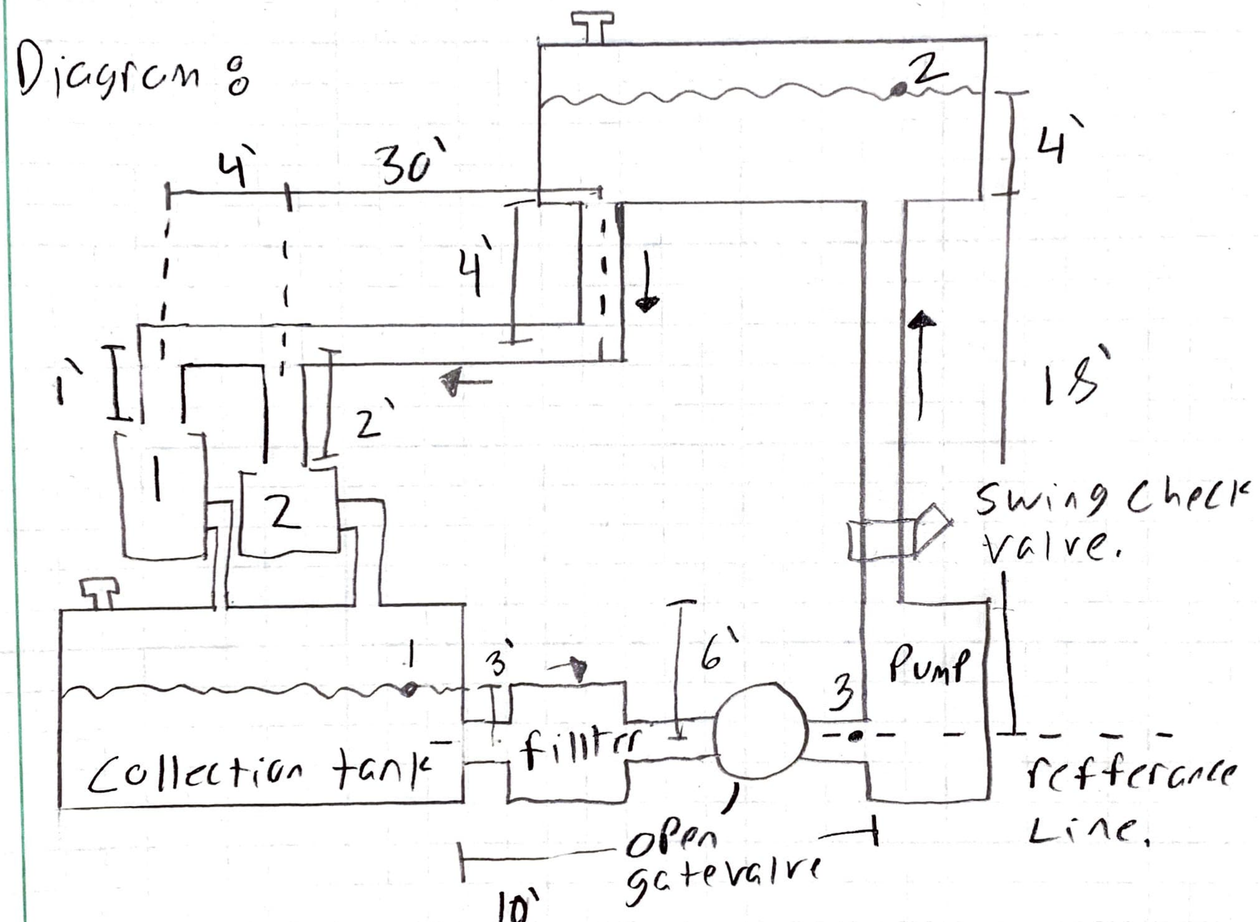
Summary: deflection for gas = 2.15 ft
deflection for murcury = 3.022 ft.
the minimum height on the left side of the manomiter would have to be just over 0.8475 ft. The minimum height for murcury would not matter since the change in pressure could not hold up the murcury at any height.

materials: manomiter, oil, murcury, gasoline, water, calculator.

Analysis: the deflection of gas is less than murcury is accureate since the specific weight of gas is closer to oil than murcury is. the negative h_2 for murcury is also likley, as stated in summary the murcury is to heavy for the pressure.

2) Purpose: for this problem we are given a system and tasked to choose a new set of Pipes to accomadate a new Volumetric flow rate to two machenes. I will also be determining the pressure and power a pump would need with the new Pipes. Analyzing the cost of installation and operation. (2 years)

Diagram:



Sources: Applied fluid mechanics 7th edition by Robert L. Matt and Joseph A. Untener
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Design Concideration: Stedy flow, incompresable liquid, Constant Properties.

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2) Data : $Q = 60\ gpm = 0.134\ ft^3/s$

$V_{mean} = 3\ m/s = 9.84\ ft/s$ $S.G_{coolant} = 0.92$

$\eta_{coolant} = 3.6 \times 10^{-5}\ lb.s/ft^2$ $K_{filter} = 1.85$

$\gamma_{coolant} = 57.41\ lb/ft^3$

Procedure: To determine pipe size I will use Q and V to find $A = Q/V$, then using Bernoullies to find pump head and pressure at pump inlet I will use the power equation $P_A = \gamma Q h_A$ to find power. using the table of costs given to determine install costs. Finally using power of pump and the \$730 kw to find operation cost.

Calculations: $A = \frac{Q}{V}$ $Q = 0.134\ ft^3/s$
$V = 9.84\ ft/s$

$A = \frac{0.134\ ft^3/s}{9.84\ ft/s}$

$A = 0.0136\ ft^2$ Using a 1½ in Schedule 40 Pipe will give an flow area $= 0.01414\ ft^2$ whitch will yeald a 9.48 ft/s V. (I will be using this V as V_{avg} for pipes in system)

Points 1 & 2

$$h_A + \cancel{\frac{V_1^2}{2g}}^{0} + \cancel{\frac{P_1}{\gamma}}^{0} + z_1 = \cancel{\frac{P_2}{\gamma}}^{0} + \cancel{\frac{V_2^2}{2g}}^{0} + \cancel{h_R}^{0} + h_L + z_2$$

$$h_A = h_L + z_2 - z_1$$

$f_t = 0.02$ for 1½in Schedule 40 pipe.

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2) $h_L = h_{L\,exit\,Loss} + h_{L\,entrance\,Loss} + h_{L\,fillter} + h_{L\,open\,gate\,valve} + h_{L\,swing\,check\,valve} + h_{L\,pipe\,friction}$

$h_{L\,exit} = K \frac{v^2}{2g}$ $K = 1$ $h_{L\,exit} = 1 \cdot \frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s} = \underline{1.4 ft}$

$h_{L\,entrance} = K \frac{v^2}{2g}$ $K = 0.5$ $h_{L\,entrance} = .5 \cdot \frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s} = \underline{0.7 ft}$

$h_{L\,fillter} = K \frac{v^2}{2g}$ $K = 1.85$ $h_{L\,fillter} = 1.85 \cdot \frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s} = \underline{2.58 ft}$

$h_{L\,open\,gate\,valve} = 8 f_t \frac{v^2}{2g} = 8 \cdot 0.02 \cdot \frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s} = \underline{0.22 ft}$

$h_{L\,swing\,check\,valve} = 100 f_t \frac{v^2}{2g} = 100 \cdot 0.02 \cdot \frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s} = \underline{2.79 ft}$

$h_{L\,pipe\,friction} = f\left(\frac{L}{D}\right)\left(\frac{v^2}{2g}\right)$ $N_R = \frac{vD\rho}{\eta}$ $\rho = 1.785 slug/ft^3$

$N_R = \frac{9.48 \overset{ft/s}{} \cdot 0.1342 \overset{ft}{} \cdot 1.785 slug/ft^3}{3.6 \times 10^{-5} lb.s/ft} = \underline{169098.7}$

D/ϵ, $\epsilon = 0.00015 ft$ for steel pipe

$D/\epsilon = 0.1342 ft / 0.00015 ft = \underline{894.67}$

from moody diagram

$f = 0.02$ (guess I could have assumed complete turbulance for pipe)

$h_{L\,pipe} = 0.02 \cdot \left(\frac{22 ft}{0.1342 ft}\right) \cdot \left(\frac{9.48^2 ft/s}{2 \cdot 32.2 ft^2/s}\right) = \underline{4.58 ft}$

$h_L = 1.4 ft + 0.7 ft + 2.58 ft + 0.22 ft + 2.79 ft + 4.58 ft = 12.27 ft$

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2) $h_A = h_L + z_2 - z_1 = 12.27ft + 22ft - 3ft$

$h_A = 31.27\ ft$

$P_A = h_A Q \gamma = 31.27ft \cdot 0.134 ft^3/s \cdot 57.41 lb/ft^3$

$P_A = 240.55\ ft\,lb/s \cdot \frac{1\ hp}{550\ lbft/s} = \underline{0.44\ hp}$

use points 1 & 3 to find pressure at 3

$$h_A + \frac{\cancel{v_1^2}}{\cancel{2g}} + \frac{\cancel{P_1}}{\cancel{\gamma}} + z_1 = \frac{v_3^2}{2g} + \frac{P_3}{\gamma} + \cancel{z_3} + h_L$$

0 0 0

$$P_3 = \left(z_1 - h_L + h_A - \frac{v_3^2}{2g}\right)\gamma$$

$$P_3 = \left(3ft - 12.27ft + 31.27ft - \frac{9.48^2\ ft/s}{2 \cdot 32.2 ft^2/s}\right) 57.41 lb/ft^3$$

$P_3 = 1182.9\ lb/ft^2 \cdot \frac{1\ psi}{144\ lb/ft^2} = \underline{8.2\ psi}$

Installation cost: (for 1½ in pipe).

71 ft of pipe used in system

11.8' $\cdot$ \$33.95 = \$400.61

Pump costs 40% pipe so

0.4 $\cdot$ \$400.61 = \$160.24

extra cost

.15 $\cdot$ \$400.61 = \$60.09

Total install cost = \$620.94

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2) Operation cost for 0.44 hp Pump
If \$730 per kW

$0.44\,hp \cdot \frac{1\,kW}{1.341\,hp} = 0.33\,kW$

17520 hr in 2 year

$\frac{\$730}{kW} \cdot \frac{1}{17520\,hr} = \$0.04$ per kWh

0.33 kW · 17520 hr = 5781.6 kWh used in 2 year

$\frac{\$0.04}{\cancel{kWh}} \cdot 5781.6\,\cancel{kWh} = \$231.26$

Total cost = \$620.94 + \$231.26 = \$852.20

Summary: The size pipe I chose to use is a 1½ in section 40 pipe. This gives me a velocity of 9.48 ft/s through the system. This pipe makes the pump use 0.44 hP and a inlet pressure to the pump of 8.2 psi. The total cost of this system is \$852.20 after 2 year with minimal incident.

materials: Coolant, 1½ in section 40 pipe, (71 ft) gate valve, fillter, swing check valve, Pump

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2) Analysis : I am assuming that the pump only needs to pump the fluid from the collection tank on the left through the filter and gate valve to the pump then up to the upper tank. Once the coolant reaches the upper tank the gravity is taking it down to the machenes. When looking at the results from the excel tables and graph for the diffrent pipe size it shows that the 1½ in pipe is the cheapest option out of the five. This is because it balences power needed from pump with the cost of the pipe itself.