Test 1

Daniel Erdogan

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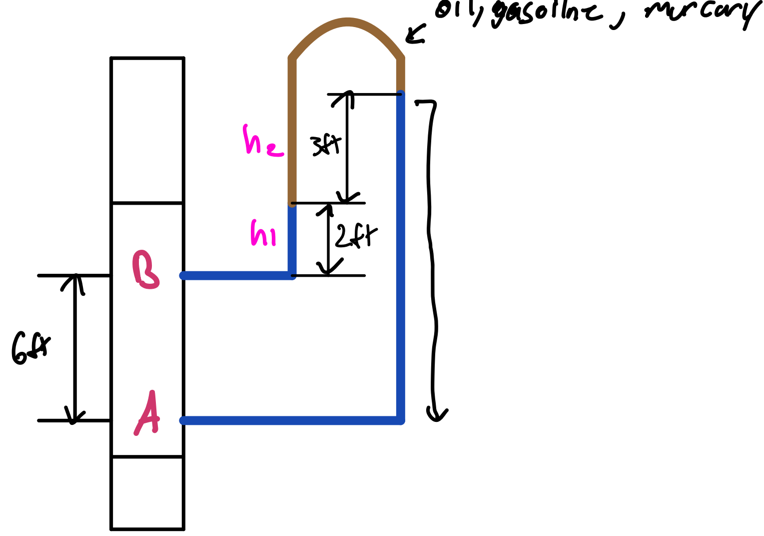
Daniel E

Purpose:

- determine deflection in mano meter using gasoline instead of oil.
- minimum hight of manometer so gasoline doesn't go into system
- using excel, find displacement using murcury

Drawings:



Sources:

- Mott, R., Untener, J.A., "Applied Fluid Mechanics", 7th edition Pearson Education, inc, (2014), Page(S): 504, 502

Considerations:

Constants

Incompressible fluids

Pressure difference A→B = 2.1177 psi

Temp: 77°F

Data / Variables:

γ_{water} : 62.2 lb/ft³ @ 80°F

γ_{gas} : 42.40 lb/ft³

$\gamma_{murcury}$ 844.9 lb/ft³

@ 77°F

Sg_{oil} : 0.9

$Sg_{gasoline}$: 0.68

Procedure:

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Part A.

Using gama H equation, we already have constant pressure. set ΔP = to γh, where γh is equal to the properties starting from b, going up, then going down to point A.

Part B:

h_1 cancels, we already solved for h_2. So h_2 must be the answer

Part C:

Using equation of $\gamma \cdot h$, from part A, we swap γ_{gas} with $\gamma_{mercury}$. excel will be doing the calculations so no need to expand further

Calculations:

Part A:

$\Delta P = \gamma \cdot h$, $\quad \underline{P_A - P_B = 2.7177 \text{ psi}} \quad \underline{\gamma \text{ will be @ } 77\ °F}$

psi = lb/in²
γ = lb/ft³

So: $\dfrac{2.7177 \ \frac{lb}{in^2} \ \big| \ 12 \text{ in} \ \big| \ 12 \text{ in}}{\big| \ 1 \text{ ft} \ \big| \ 1 \text{ ft}} = 391.35 \ lb/ft^2$

$$\Delta P = -\gamma_w \cdot h_1 - \gamma_{gas} \cdot h_2 + \gamma_{water}(h_1 + h_2 + 6) \quad \text{[equation]}$$

$$391.35 \ lb/ft^2 = \cancel{-62.2 \ lb/ft^3 \cdot h_1} - 42.4 \ lb/ft^3 \cdot h_2 + (\cancel{h_1} + h_2 + 6) \cdot 62.2 \ lb/ft^3$$

=0 so

So: $391.35 \ lb/ft^2 = (-42.4 \ lb/ft^3 \cdot h_2) + (h_2 + 6)(62.2 \ lb/ft^3)$ distribute

$= (-42.4 \ lb/ft^3 \cdot h_2) + (62.2 \ lb/ft^3 \cdot h_2) + (373 \ lb/ft^2)$

So: $391.35 \ lb/ft^2 = (-42.4 \ lb/ft^3 + 62.2 \ lb/ft^3) h_2 + 373 \ lb/ft^2$

then: $-373 \ lb/ft^2 \qquad\qquad -373 \ lb/ft^2$

$18.35 \ lb/ft^2 = 19.8 \ lb/ft^3 \ h_2$

so: $h_2 = \dfrac{18.35\ \cancel{lb/ft^2}}{19.8\ \cancel{lb/ft^3}}$ Daniel E

then: $h_2 = 0.927\ ft$

Part B =

minimum distance $= h_2 = 0.927\ ft$

Part C =

formula $= \Delta P = \underbrace{-\gamma_{water} \cdot h_1}_{=0} - \gamma_{merc} \cdot h_2 + \gamma_{water} \cdot (h_1 + h_2 + 6)$

$\Delta P = (-\gamma_{merc} \cdot h_2 + \gamma_{water}\, h_2) + (\gamma_{water} \cdot 6\ ft)$

$\Delta P = (-\gamma_{merc} + \gamma_{water})\, h_2 + (\gamma_{water} \cdot 6\ ft)$

$h_2 = \dfrac{\Delta P - (\gamma_{water} \cdot 6\ ft)}{(-\gamma_{merc} + \gamma_{water})}$

look @ ecell sheet for Calculations (copy attached below)

Calculation of Deflection (Murcary		
	Equation	
$h_2 = \dfrac{\Delta P - (\gamma_{water} * 6_{ft})}{(-\gamma_{murcary} + \gamma_{water})}$		
ΔP (lb/ft^2)	γ_water (lb/ft^3)	$-\gamma\_murcary$ (lb/ft^3)
391.35	62.2	-844.9
	Calculation	
h2 (ft)=	-0.023188961	

Summary:

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Part A:

the deflection of system when using gasoline instead of oil is equal to

$$\boxed{h_2 = 0.927 \text{ ft}}$$

Part B:

we have found the deflection in Part A, well, we are asked about the <u>Minimum</u> distance. h1 is equal to the hight of water from b, but the hight cancels in the equation, so h_2 is left, and h2 is the minimum hight.

so

$$\boxed{\text{Minimum distance} = h_2 = 0.927 \text{ ft}}$$

Part C:

for Part C, we derived an equation. Same one in Part A, but with $\gamma_{mercury}$ instead of $\gamma_{gasoline}$. It was a easy plug and chug. we got:

$$\boxed{h_2 = -0.0232 \text{ ft}}$$

Material:

- water
- oil
- gasoline
- murcury

Analysis:

- The main part of the problem was to read the drawing. we were informed of the equation we should use which was $\Delta P = \gamma \cdot h$
- Part b was confusing at first but we just had to keep in mind h1 canceled out, and we already solved for h2.
- Part C gave us a negative h_2 value. I assume that is due to the γ being so heavy. so the pressure of the water wasnt able to keep the murcury up.

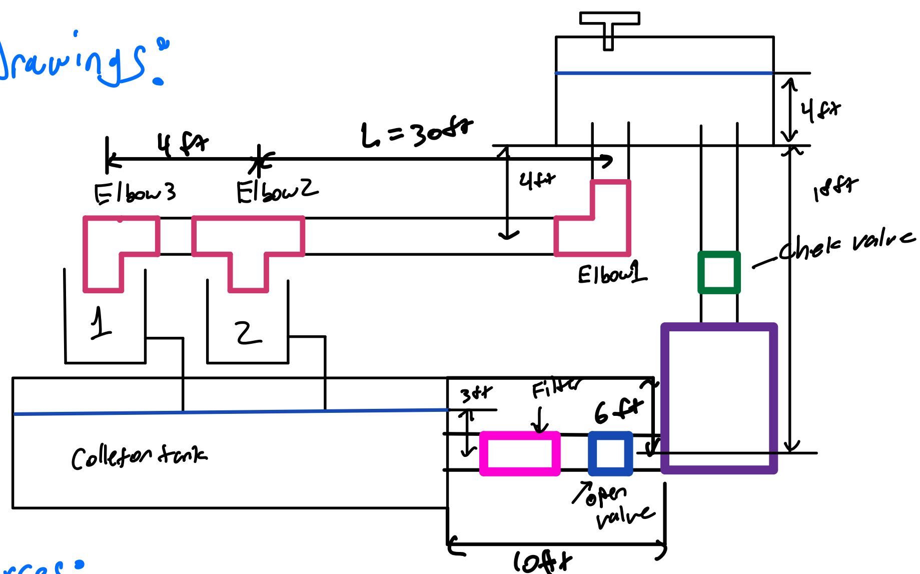
2

Denzel E

Purpose:

A: with the given system, we are to choose a pipe that will supply requested flow rate.
B: we will have to determine pressure and hp the pump needs to deliver to keep up with demand.
C: finally we will determine the cost to run the system.

Drawings:



Sources:

- Mott, A., Unterer, J.A., "Applied Fluid Mechanics", 7th edition Pearson Education, inc, (2014), Page(S):
- online converter
- google search: aqua amonia = coolant

Considerations:

Steady flow | Incompressible fluid
Constant properties | Energy loss

Data / Variables:

$Q = 2_{\text{machines}} \cdot 30_{\text{gpm needed per machine}} = 60$ gpm $\Rightarrow$ $0.1337\ ft^3/s$

$V_{max} = 3\ m/s \Rightarrow 9.843\ ft/s$

$Sg_{coolant} = 0.92$ (0.01 more than aqua amonia (25%)) (will use aqua amonia data from P: 504)

$\mu = 3.6 \times 10^{-5}\ lbs/ft^2$

$K_{filter} = 1.85$

$\gamma_{coolant}: 56.78\ lb/ft^3$ $\rho = 1.77\ slug/ft^3$

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Procedure:

- determine pipe size using $A = \frac{Q}{V}$, using A, look at Chart and find a suitable pipe.
- use Bernulies to find pump head & pressure @ inlet.
- use $P_A = \gamma Q h_A$ to find HP
- use table of cost in corresspondence of your selected pipe to solve for cost of system.

Calculations:

A: selection of pipe

$$A = \frac{Q}{V} \quad \text{where} \quad Q = 60\,gpm \Rightarrow 0.1337\ ft^3/sec, \quad V = 9.843\ ft/sec$$

$$A = \frac{0.1337\ \cancel{ft^3}/\cancel{sec}}{9.843\ \cancel{ft}/\cancel{sec}} = 0.0135\ ft^2$$

Pipe Selection: 1½" schedual 40

(Now Check p: 513 to select pipe)

Size(in) (Chart schedual 40) ID (ft) flow area ft^2

1¼	32	1.660	42.2	0.140	3.56	1.380	0.1150	35.1	0.010 39	9.653×10^{-4}
1½	40	1.900	48.3	0.145	3.68	1.610	0.1342	40.9	0.014 14	1.314×10^{-3}
2	50	2.375	60.3	0.154	3.91	2.067	0.1723	52.5	0.023 33	2.168×10^{-3}

If we select 1¼", It will not meet demand of $0.135\ ft^2$, so next size up = 1½, wich will allow and supply demand upto $0.01414\ ft^2$ wich is more than $0.135\ ft^2$. 1½ pipe will be our selection.

B: Compute pump head & HP of pump

Bernulies eq:

$$\underset{(pump)}{h_A} \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + \underset{(turbine)}{h_R} + \underset{(losses)}{h_L}$$

no turbine

$$\text{so: } h_A \underbrace{\cancel{\frac{P_1}{\gamma}}}_{=0} + \underbrace{\cancel{\frac{V_1^2}{2g}}}_{=0} + z_1 = \underbrace{\cancel{\frac{P_2}{\gamma}}}_{=0} + \underbrace{\cancel{\frac{V_2^2}{2g}}}_{=0} + z_2 + h_L$$

$$\text{then } \underset{\text{(Find pump)}}{h_A} + z_1 = z_2 + h_L \overset{eq}{\Longrightarrow} h_A = (z_2 - z_1) + h_L$$

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$h_A = (z_2 - z_1) + h_L$

$z_2 = 22\text{ ft}$

$z_1 = 3\text{ ft}$

$h_L = h_{L\,Exit} + h_{L\,entrance} + h_{L\,friction} + h_{L\,check\,valve} + h_{L\,filter} + h_{L\,open\,gate}$

$h_L = k\frac{v^2}{2g}$ find k from tables

v = velocity

$g = 32.2\text{ ft/s}^2$

So $h_{L\,Exit} + h_{L\,entrance} + h_{L\,friction} + h_{L\,check\,valve} + h_{L\,filter} + h_{L\,open\,gate}$

k= $1\frac{v^2}{2g}$ $\frac{1}{2}\frac{v^2}{2g}$? $100 \cdot f_t \frac{v^2}{2g}$ $1.85\frac{v^2}{2g}$ $8 \cdot f_t \frac{v^2}{2g}$

where $f_t = 0.02$ for $1\frac{1}{2}$" pipe (table 10.5)

h_L friction in pipe = $f\left(\frac{L}{D}\right)\left(\frac{v^2}{g}\right)$

assum full terbulance, so 0.02

$h_{L\,Exit} = 1 \cdot \frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 1.54 ft

$h_{L\,entrance} = \frac{1}{2} \cdot \frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 0.752 ft

$h_{L\,friction} = 0.02\,(22\text{ ft}/0.1342\text{ ft}) \cdot \frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 4.03 ft

$h_{L\,check\,valve} = (100 \cdot 0.02)\frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 3.01 ft

$h_{L\,filter} = 1.85 \cdot \frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 2.78 ft

$h_{L\,open\,gate} = (8 \cdot 0.02) \cdot \frac{9.843^2\text{ ft/se}}{2 \cdot 32.2\text{ ft}^2\text{/sec}} = $ 0.241 ft

+

13.253

SO

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$h_A = (z_2 - z_1) + h_L$

$z_2 = 22\text{ ft}$

$z_1 = 3\text{ ft}$

$h_L = 2h_{L\,Exit} + h_{L\,entrance} + h_{L\,friction} + h_{L\,checkvalve} + h_{L\,filter} + h_{L\,opengate}$

$h_L = \boxed{13.253\text{ ft}}$

$h_A = (22\text{ ft} - 3\text{ ft}) + 13.253\text{ ft} = \boxed{32.253\text{ ft}}$

$P_A = h_A \cdot Q \cdot \gamma_{cooling} = 32.253\text{ ft} \cdot 0.1337\ \cancel{\text{ft}^3}/\text{sec} \cdot 56.78\ \text{lb}/\cancel{\text{ft}^3}$

$= 244.85\ \text{ft lb/s}$

$P_A = 244.85\ \text{ft lb/sec}$ $\qquad 1\text{ hp} = 550\ \text{ft lb/sec}$

SO $\dfrac{244.85\ \cancel{\text{ft lb/sec}}}{\;} \Big| \dfrac{1\text{ hp}}{550\ \cancel{\text{ft lb/sec}}} = \boxed{0.445\text{ hp motor}}$

Part c: find pressure @ inlet:

Bernlies eq:

$\underset{(Pump)}{h_A} + \underbrace{\cancel{\frac{P}{\gamma}}}_{=0} + \underbrace{\cancel{\frac{V^2}{2g}}}_{=0} + z_1 = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + \underbrace{\cancel{z_3}}_{=0} + \underset{(turbine)}{\overset{no\ turbine}{\cancel{h_R}}} + \underset{(losses)}{h_L}$

so $h_A + z_1 = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + h_L$ (solve for P_3)

$\gamma \cdot \frac{P_3}{\gamma} = \left(h_A + z_1 - \frac{V_3^2}{2g} - h_L\right)\gamma$

then eq = $P_3 = \left(h_A + z_1 - \frac{V_3^2}{2g} - h_L\right)\cdot\gamma$ ✓ ✓ ✓ ✓ ✓ Just Plug & chug

$$P_3 = \left(32.253\ ft + 3\ ft - \frac{0.843^2\ ft/s}{2 \cdot 32.2\ ft/s} - 13.253\ ft\right) 56.70\ lb/ft^3$$

$$= (20.496\ \cancel{ft})\ 56.70\ lb/ft^{\cancel{3}\,2}$$

Darryl E

$$= 1163.763\ lb/ft^2$$

$$P_3 = 1163.763\ lb/ft^2 \qquad 1\ psi = 144\ lb/ft^2$$

$$P_3 = \frac{1163.763\ \cancel{lb/ft^2}}{} \left| \frac{1\ psi}{144\ \cancel{lb/ft^2}} \right. = \boxed{8.08\ psi}$$

Cost of installation for 1½ sched 40 pipe

1½" pipe @ 6 ft = \$33.95

69' of total piping needed

$$\frac{69'}{6} = 11.5$$ sections needed, round up to 12 sections.

12 sections of pipe needed

12 setions at \$33.95 = \$407.4 cost of piping.

Pump cost

assume 40% of piping cost

$ 407.4 · 0.40 = \$162.96

Extra costs

assume 15% of

$ 407.4 · 0.15 = \$61.11

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total installation cost

$407.4 + 162.96 + 61.11 = \boxed{\$631.47 \text{ total installation cost}}$

Operation cost:

\$ 730 kW

1 kW = 1.3410 hp

$\dfrac{0.445 \cancel{hp} \mid 1 kW}{\mid 1.3410 \cancel{hp}} = 0.3318 \text{ kW}$

$\dfrac{0.3318 \cancel{kW} \mid \$730}{\mid 1 \cancel{kW}} = \boxed{\$242.214 \text{ cost of operation}}$

total cost of system:

$\underbrace{\$631.47}_{\text{cost of installation}} + \underbrace{242.21}_{\text{cost of operation}} = \boxed{\underbrace{\$873.68}_{\text{total cost}}}$

Summary:

pipe size: 1½ Schedule 40 pipe

h_A (Pumphead): 32.253 ft

P_A (power) : 0.445 HP

Pressure inlet : 8.08 psi

Cost:

\$631.47 installation

\$242.21 cost of operation

} \$873.68 cost of system

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Materials:

- Coolant
- 1½ sch 40 pipe (29 feet)
- gate valve
- fillter
- check valve
- pump

Analysis

The only thing I focused on was the area befor and right after the pump. I assumed that once the coolant was pumped into main tank, It was fed into matching via gravity. the main reson we our hp is as high as it is is due to the h_L along the system. with the filter and gate and check valve, the pump must over come these units and still pump enough fluid into tank to maintain 30 gpm to Both matchis. And from our excell sheet, we Can see that our 1½ pipe selection may not have been the best Choice for cost, But its better than any larger pipe.

Calculation of Deflection (Murcary			
	Equation		ha
$$h_2 = \frac{\Delta P - (\gamma_{water} * 6_{ft})}{(-\gamma_{murcary} + \gamma_{water})}$$			hp gamma
ΔP (lb/ft^2)	γ_water (lb/ft^3)	$-\gamma\_murcary$ (lb/ft^3)	divided
391.35	62.2	-844.9	
	Calculation		
h2 (ft)=	-0.023188961		

v 1.504420016

Equation for pipes	pipe size	ID	flow area	ft
(22-3)+hl	1 inch	0.0874	0.006	0.022
19	1.25 inch	0.115	0.01039	0.021
hp*q*gamma cool	2 inch	0.1723	0.0233	0.019
	2.5 inch	0.2058	0.03326	0.018
56.78				
550 ftlb/sec = 1 hp				

loss exit
loss ent
loss filt
loss fric
loss check
loss gate
h_L
h_A
Hp

COSTS

	6' section Price	sections needed	piping cost	labor cost	extra cost
1inch	$23.95	12	$287.40	$114.96	$43.11
1.25 inch	$28.95	12	$347.40	$138.96	$52.11
2 inch	$46.95	12	$563.40	$225.36	$84.51
2.5 inch	$71.95	12	$863.40	$345.36	$129.51
slected 1.5 inch	$33.95	12	$407.40	$162.96	$61.11

1.50442002				
0.75221001				
2.78317703				
1 inch	1.25 inch	2 inch	2.5 inch	units
8.33111313	6.04384389	3.649725	2.894802	ft
3.30972404	3.159282034	2.858398	2.707956	ft
0.26477792	0.252742563	0.228672	0.216636	ft
16.9454221	14.49567554	11.7766	10.8592	ft
35.9454221	33.49567554	30.7766	29.8592	ft
0.32433045	0.39766675	0.547443	0.63439	hp

at $730 kw

instalation cost	operation cost	total cost
$445.47	$176.56	$622.03
$538.47	$216.48	$754.95
$873.27	$298.01	$1,171.28
$1,338.27	$345.34	$1,683.61
$631.47	$242.24	$873.71