Ben Smithson Fluid mechanics pre-test

1. Solve this problem by hand and also create an excel spreadsheet with its solution. Make sure the excel solutions match the hand calculations.

How many sections in excel are needed?

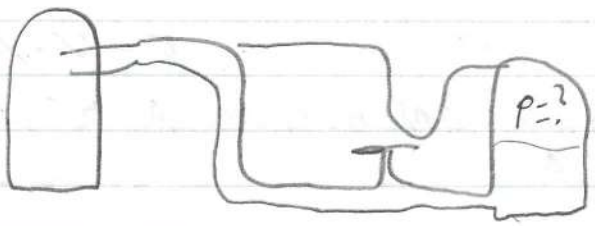
How many air pressures are we testing until 250 gpm of ethyl alcohol?

Now at some point of the system operation, the air pressure in the tank on the right stops to drop. At what air pressure the flow of alcohol stops?

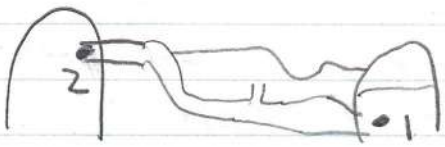
Is this where we are solving ρ just based on the right tank?

When solving at no flow are we using a certain pressure or solving for pressure?

2. First, as with every problem, draw out the diagram we are using.



Next find the points of interest for the problem where we need to find pressure



Next getting into the equation needed to find the air pressure for moving 250 gallons of ethyl alcohol per minute through the system, we use Bernoulli's equation.

Bernoulis equation

$$\cancel{h_A} + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_L$$

- Since we have P_2 (exiting Pressure) and we're trying to find P_1 we make it equal to P_1

$$\frac{P_1}{\gamma} = \frac{P_2}{\gamma} + Z_1 + \frac{V_1^2}{2g} - Z_2 - \frac{V_2^2}{2g}$$

$$P_1 = P_2 + \gamma\left(Z_1 - Z_2 + \frac{V_1^2 - V_2^2}{2g}\right) + h_L$$

↑

- this should be our equation to find the pressure because we are looking for the entrance pressure (P_1) for question 1.

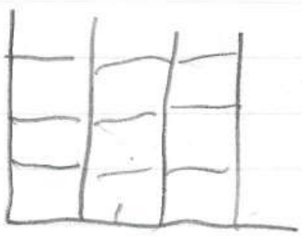
$$\overset{?}{P_1} = \overset{\checkmark}{P_2} + \left(Z_1 - Z_2 + \frac{V_1^2 - V_2^2}{2g}\right) + h_L \quad ?$$

($V_1^2 - V_2^2$: Vpipe, Vpipe; ↖ Sg ethyl alcohol)

- when finding V_1^2 and V_2^2 we can use $Q = V \cdot A$ convert to $V = \frac{Q}{A}$, knowing Q and needing A to find V. we can use this to find A

$A = \frac{\pi}{4} D^2$ where D is diameter of the pipe

when using all of these equations we are able to find the pressure of air ($P = ?$) in order to create the table needed for Part 1. of the question



(honestly not sure which colomns need to be in the table)

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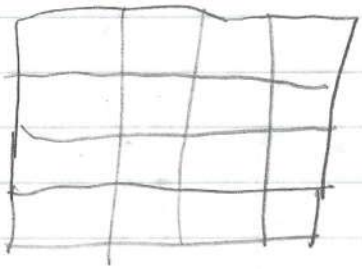
2 continued.

For the second part of the Problem we will use Bernoulli's equation in order to find the flow at zero since the question asks the pressure when the flow goes to zero.

$$P_1 = P_2 + \left(z_1 - z_2 + \frac{V_1^2 - V_2^2}{2g}\right) + h_L$$

as said before using the equation above we set flow equal to zero which will give the answer for part two.

For part three of the problem, we will use the same excel chart used in part one and add in multiple different air pressures. This should be converted in excel to the different pressures. Using the different pressures, we can get the flow rate at 75 PSI



3. When starting the test, we should use the layout of the rubric provided for the test. This includes purpose, sources, Drawings, Design considerations, Data, materials, procedure, calculations, summary, and analysis. Breaking down the question into this will help separate and make the calculations a little easier by separating and visualizing steps to the final solution.

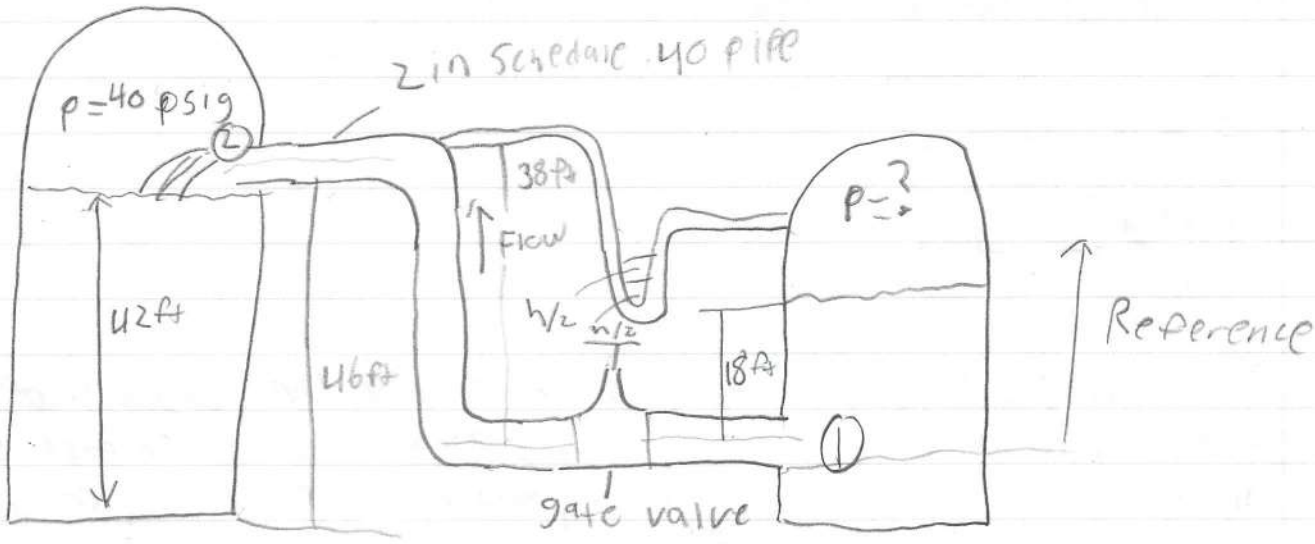
4.

purpose: Determine the air pressure in the smaller tank that is required in order to push 250 gallons of ethyl alcohol through the system per minute.

purpose 2: Determine the air pressure of the tank in which the flow of ethyl alcohol stops or goes to zero through the system.

purpose 3: Using excel, determine the air pressure in the smaller tank for different flow rates. (you choose) Using this method determine the flow rate of the system when the air pressure is 75 psi.

Drawing/Diagram:



Sources: Applied Fluid Mechanics 7th edition
Robert L Mott & Joseph Untener

Design considerations: 1) Incompressible fluids (ethyl alcohol)
2) water & alcohol don't mix
3) Pressure problem with $P_2 = 40$ psig
4) Temp = 77°F

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4. Continued

Data & variables

P_2 tank = 40 psig

T = 77°F

h fluid tank 2 = 42ft

h Fluid from gate = 18 ft

2in schedule 40 pipe =

Pipe diameter = 2.067 inches

procedure:

First Find Bernoulis equation (steps in part 2 of pre test)

Next, when creating the excel spreadsheet use pressure found in part one.

Then find pressure when flow rate is zero (steps in part 2 of pretest)

Next use the excel sheet to find different pressures and flow rate (still confused on excel guidelines.

Finally use excel to find flow rate at 75psi.

5.

Io- Describe nature of fluids and define fluid properties such as viscocity

- Compute pressure and forces associated with stagnant fluid
- Explain fluid dynamics in pipes and fittings
- Apply principles of conservation of energy and mass to fluid flow system (Bernoullis equation
- Compute friction losses in pipes for a variety of configurations

II.

- Although this may not be an industrial problem, this problem does use forms of pipes and open flow
- This section already has the pipe selected but could have asked what is the appropriate pipe for the configurations