PURPOSE

A

1) (Revisiting old design) Find how much the total flow rate would I get using the modified pipe line in figure 2.

2) Prove that the new modify branching (figure 3) has an equal flow rate.

DRAWINGS AND DIAGRAMS

Fig 1

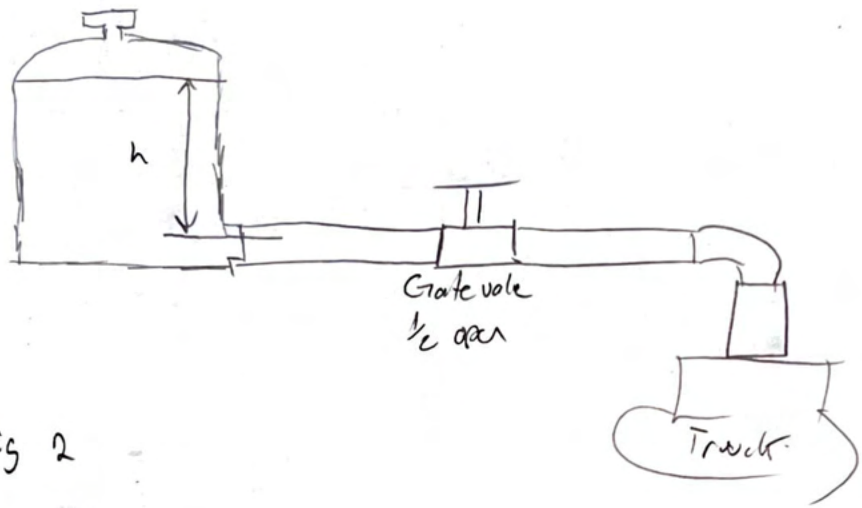
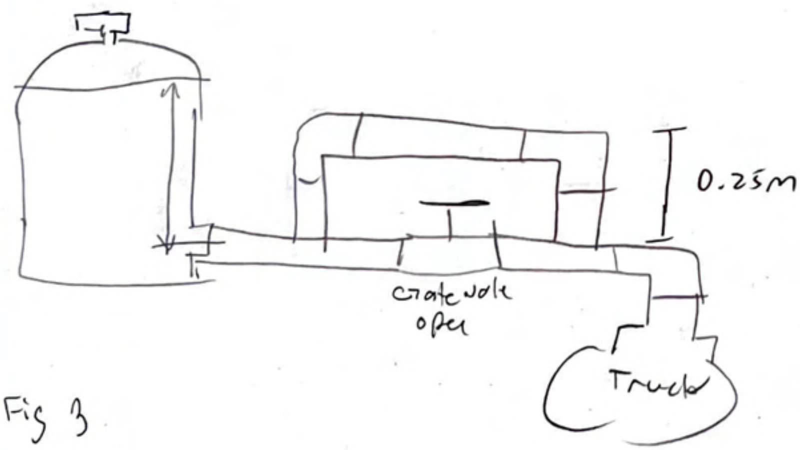


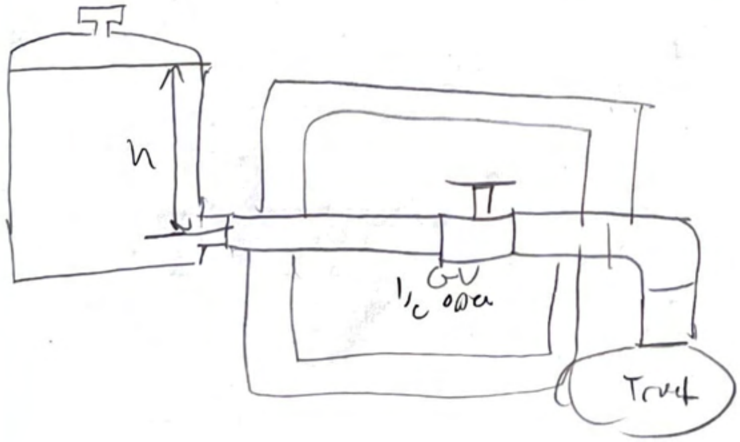
Fig 2



$h = 3.65m$

$D_{tank} = 16.237m$

Fig 3



Sources:

- ODU CANVAS LECTURE SLIDES
- MATT, R, UNTES, TA, "Applied Fluid Mechanics," 7th Edition Pearson Education Inc (2015)

DESIGN CONSIDERATIONS:

- TEMP: 25°C
- New Branch made up at horiz. pipe length 2/3 of previous
- Gate valve 1/2 open

DATA & VARIABLES:

- $h = 3.65 m$ $Q = 400 gpm = 0.0252 m^3/s$
- $D_{tank} = 16.239 m$
- $\gamma_{gas} = 6.67 kN/m^3$ height of tank = 3.65 m
- $D_{gas} = 4.02$

PROCEDURE:

1) To find out the total flow rate using the modified design, I would use Bernoulli's Equation. Since the tank is open to the atmosphere, $\frac{1}{2}\rho v_1^2$ will be canceled out. Using the height, we can cancel out $\rho g h_2$ hence giving me the equation to find flow rate

$$\rho g h = \frac{1}{2}\rho v_2^2$$ Use excel.

2) Rework what I did with the first question. I have to take into account that the flow rate is the same so I would have to double it since there is 2 Branching pipelines.

A) After looking through the test questions, I can see that it applies to the course objectives: Pipe/Fittings, ~~Fluid machinery work~~, And it heavily applies Bernoulli's Equation due to finding the flow rate, and proving how the duplicate pipe systems are equivalent.

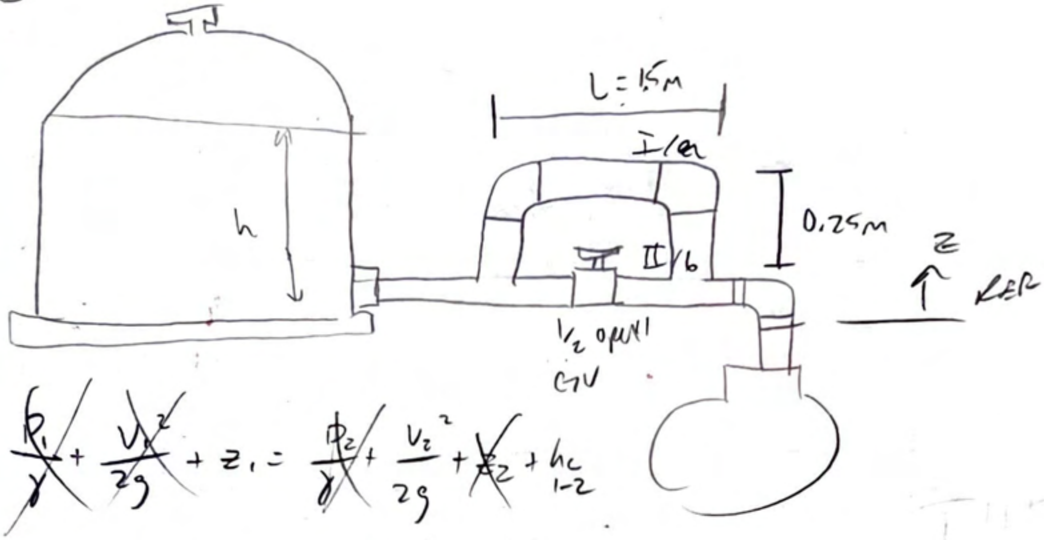
B) Fluid machinery is one of the COs that is being indirectly applied. Although we are given values to figure the problem out, it is important to know the concepts on how the tank and truck stores or moves the fluid.

Questions:

1) When it mentions the hori. pipe length is 2/3 the previous, what's that refering to exactly, I can't find a value

CALCULATIONS:

①



$$\cancel{\frac{P_1}{\gamma}} + \cancel{\frac{V_1^2}{2g}} + z_1 = \cancel{\frac{P_2}{\gamma}} + \frac{V_2^2}{2g} + \cancel{z_2} + h_{L_{1-2}}$$

$$z_1 = \frac{V_2^2}{2g} + h_{L_{1-2}} = \frac{16Q^2}{\pi^2 D^4} \cdot \frac{1}{2g} + h_{L_{1-2}}$$

$$z_1 = \frac{8Q^2}{\pi^2 D^4 g} + h_{L_{1-2}}$$

$$\left.\begin{array}{l} V = \frac{4Q}{\pi D^2} \\ V^2 = \frac{16Q^2}{\pi^2 D^4} \end{array}\right\} \text{Pg. 299}$$

$$h_{L_I} = 2h_{L_{elbow_I}} + h_{L_{pipe_I}}$$

$$\underbrace{Q_2 = Q_a + Q_b}_{\text{Pg. 292}}$$

$$h_{L_{II}} = 2h_{L_{elbow_{II}}} + h_{L_{valve_{II}}} + h_{L_{pipe_{II}}}$$

$$h_L = \left(2k_{elb} + f_I \frac{L_I}{D_I}\right) \frac{8}{g\pi^2 D_I^4} Q_I^2$$

$$z_1 = \frac{8Q_a^2}{\pi^2 D^4 g} + \left(2k_{elb} + f_I \frac{L_I}{D_I}\right) \frac{8}{g\pi^2 D_I^4} Q_I^2$$

$$z_1 - \frac{8Q^2}{\pi^2 D^4 g} = \frac{16k_{elb} + 8f_I \frac{L_I}{D_I}}{g\pi^2 D_I^4} Q_I^2$$

$$Q_I = \sqrt{\frac{z_1 - \frac{8Q_a^2}{\pi^2 D^4 g}}{\frac{16k_{elb} + 8f_I \frac{L_I}{D_I}}{g\pi^2 D_I^4}}}$$

Rest of calculations on excel.

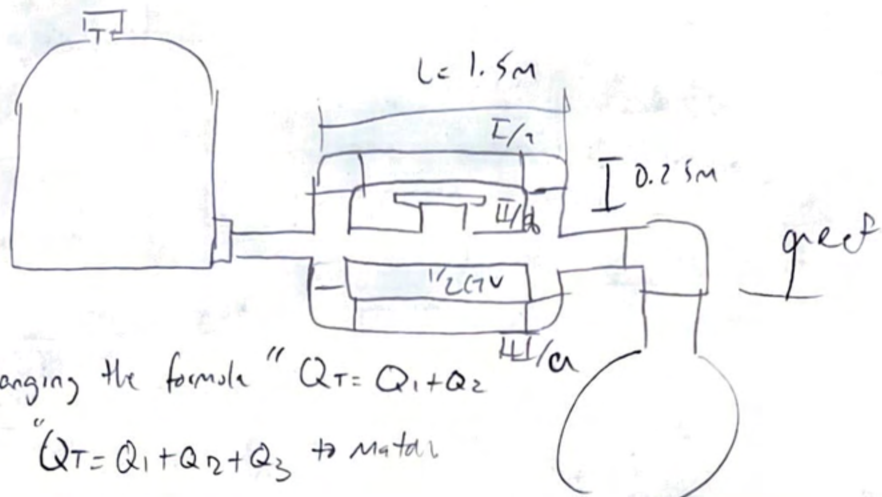
$$Q_T = \bigcirc + \bigcirc = \boxed{0.0667}$$

$$z_1 = \frac{8Q_b^2}{\pi^2 D^4 g} + \left(k_{elb} Q_b + k_{valve} + f_{II} \frac{L_{II}}{D_{II}}\right) \frac{8}{g\pi^2 D_{II}^2} Q_{II}$$

$$Q_{II} = \sqrt{\frac{z - \frac{8Q_b^2}{\pi^2 D^4 g}}{\frac{8k_{elb} Q_b + 8k_{valve} + 8 f_{II} \frac{L_{II}}{D_{II}}}{g\pi^2 D_{II}^2}}}$$

(2)

D



Changing the formula " $Q_T = Q_1 + Q_2$ "
to " $Q_T = Q_1 + Q_2 + Q_3$ " to match
the modified desingn

Same

$$Q_T = Q_I \sqrt{\frac{\frac{z_1 - 8Q_a^2}{\pi^2 D^4 g}}{\frac{16ke16 + 8f_I \frac{L_I}{D_I}}{\frac{16ke16 + 8f_I \frac{L_I}{D_I}}{g\pi^2 D_I^4}}}} + Q_{II} \sqrt{\frac{\frac{z - 8Q_1^2}{\pi^2 D^4 g}}{\frac{8ke16 Q_b + 8k\,valve + 8k_{II} \frac{L_{II}}{D_{II}}}{g\pi^2 D^4 t}}} + Q_{III}$$

$$\boxed{Q_T = 0.108}$$

Rest of calculatany
an on spreadsheet excel