MET 330 TEST 3 | M. VAUGHN

PURPOSE

I WILL CONTINUE THE DESIGN OF THE SYSTEM FROM THE PREVIOUS REPORT. THIS TIME, THE DESIGN REQUIRES TO:

1) DETERMINE IF YOU MODIFY THE PIPELINE SYSTEM TO ADD A SECOND BRANCH WITH THE HORIZONTAL PIPE 2/3 LENGTH OF HORIZONTAL LENGTH OF 2.25 m AND THE VERTICAL PORTIONS ARE 0.25 m LONG HOW MUCH TOTAL FLOW RATE WOULD YOU GET (FIGURER 2)

2) DETERMINE IF YOU MODIFY THE PIPELINE SYSTEM TO ADD A NEW LOWER BRANCH. USING THE HARDY-CROSS METHOD THAT THE FLOW RATE WILL BE EQUAL TO THE UPPER BRANCH ADDED IN ABOVE (FIGURE 3)

SOURCES

MOTT, R UNTENER, J.A, "APPLIED FLUID MECHANICS", 7TH EDITION, PEARSON EDUCATION INC (2015)

DESIGN CONSIDERATIONS

- CONSTANT PROPERTIES
- ISOTHERMAL CONDITIONS
- INCOMPRESSIBLE FLUIDS
- STEADY STATE

DRAWINGS & DIAGRAMS

FIGURE 2

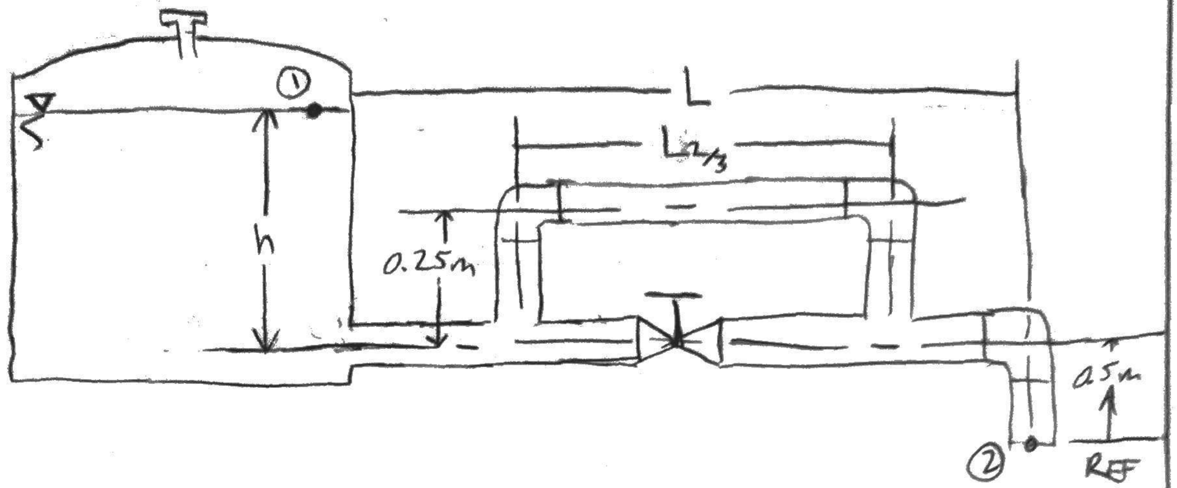
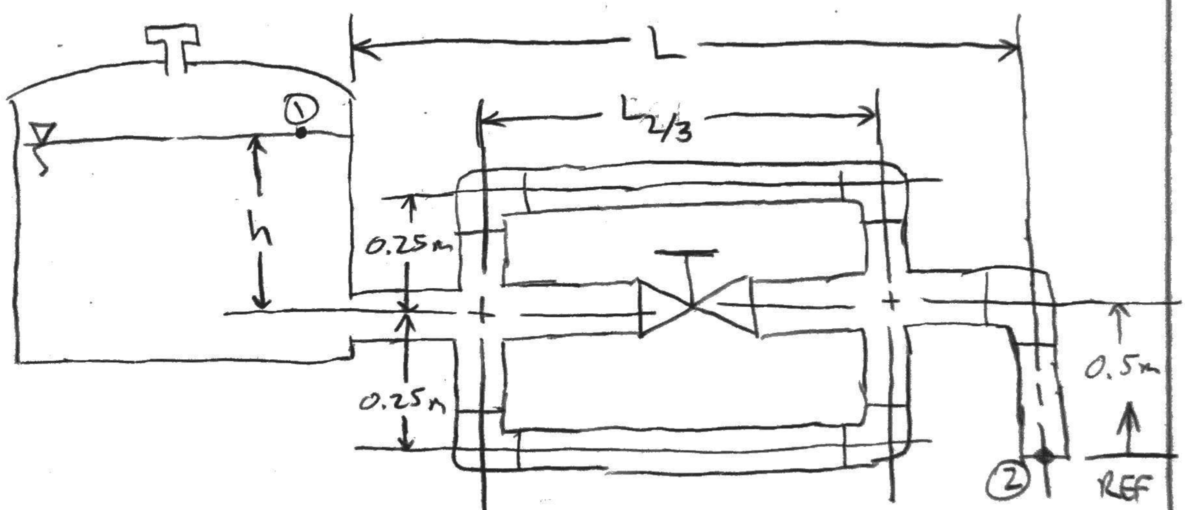


FIGURE 3



MATERIALS

- GASOLINE @ 25°C

DATA VARIABLES

- $\gamma_{GAS} = 6.67\ kN/m^3$
- $\nu = 4.22 \times 10^{-7}\ m^2/s$
- $D_i = 90.1 \times 10^{-3}\ m$
- $A_i = 6.381 \times 10^{-3}\ m^2$
- $Q = 400\,GPM = 0.0252\ m^3/s$
- $\rho_{GAS} = 680\ kg/m^3$
- $K_{ELBOW} = 30 f_T$
- $K_{VALVE_{1/2}} = 160 f_T$
- $K_{ENTRANCE} = 0.5$
- $\varepsilon = 4.6 \times 10^{-5}\ m$
- $f_T = 0.0168$
- $L = 2.25\ m$
- $L_{2/3} = 1.5\ m$
- $h = 3.65\ m$
- $V_2 = 3.95\ m/s$

PROCEDURE: FOR FIGURE 2, I WILL APPLY BERNOULLI'S EQUATION FROM POINT 1 TO POINT 2 SHOWN IN FIGURE 2. FROM TEST 1, I USED ALL DIMENSION AND AND DATA VARIABLES. I CALCULATED THE NEW FLOW RATES FROM THE BERNOULLI'S EQUATION SEPERATING THE 2 BRANCHES.

FOR FIGURE 3, I WILL APPLY BERNOULLI'S EQUATION FROM POINT 1 TO POINT 2. FROM FIGURE 2, I USED THE FLOW RATES THAT WERE CALCULATED USING THE HARDY-CROSS METHOD. ALSO KNOWING THE UPPER & LOWER BRANCH SHOULD BE EQUAL

CALCULATIONS

FIGURE 2

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_2}{\gamma} + \frac{V_B^2}{2g} + z_B + h_{L A-B}$$

$$\frac{P_A - P_B}{\gamma} = h_{L A-B} \qquad h_{L A-B} = h_A = h_B$$

$$h_A = \left[0.0175\left(\frac{2.25}{90.1\times10^{-3}}\right) + 0.0168(160) + 0.0168(30)\right]\frac{V_A^2}{2g}$$

$$\boxed{h_A = 3.63\left(\frac{V_A^2}{2g}\right)}$$

$$h_B = \left[0.0175\left(\frac{1.5}{90.1\times10^{-3}}\right) + 0.0168(60)\right]\frac{V_B^2}{2g}$$

$$h_B = 1.3\,\frac{V_B^2}{2g}$$

$$3.63\,V_A^2 = 1.3\,V_B^2$$

$$V_B^2 = 2.792\,V_A$$

CALCULATIONS CONT.

$Q = Q_A = Q_B \qquad Q = A_A V_A + A_B V_B$

$0.0252 = (6.381 \times 10^{-3}) V_A + (6.381 \times 10^{-3})(2.792 V_A)$

$0.0252 = 6.381 \times 10^{-3} V_A + 0.0178 V_A$

$0.0252 = 0.0242 V_A$

$\boxed{V_A = 1.0413 \ m/s}$

$V_B = 2.792(1.0413)$

$\boxed{V_B = 2.9075 \ m/s}$

$Q_A = V_A A_A$

$= 1.0413(6.381 \times 10^{-3})$

$\boxed{Q_A = 0.006 \ m^3/s = 95 \ GPM}$

$Q_B = V_B A_B$

$= 2.9075(6.381 \times 10^{-3})$

$\boxed{Q_B = 0.0186 \ m^3/s = 294 \ GPM}$

FIGURE 3

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + \Sigma h_L$$

$$P_1 - P_2 = \gamma(z_A - z_B) + \frac{(V_B^2 - V_A^2)}{2g} + h_L$$

$Q_1 = Q_2 = Q_a + Q_b + Q_c$

$h_{L_{A-B}} = h_a = h_b = h_c$

$h = kQ^n$

$Q_A = 0.006 \ m^3/s \qquad Q_B = Q_C = 0.0186 \ m^3/s$

$N_{R_A} = 8.433 \times 10^{-5}(0.006) = 5059.8$

$N_{R_B} = 8.433 \times 10^{-5}(0.0186) = 15685.38$

$N_{R_C} = 8.433 \times 10^{-5}(0.0186) = 15685.38$

CALCULATIONS CONT.

$h_A = 3.63\left(\frac{1.0413^2}{2(9.81)}\right) = 0.2$ $h_B = 1.3\left(\frac{2.9075^2}{2(9.81)}\right) = 0.560$

$h_C = 0.560$

$\Sigma(2kQ)_1 = 5059.8 + 15685.38$
$= 20744.8$

$\Delta Q_A = \frac{\Sigma h_A}{\Sigma(2kQ_1)} = \frac{0.2}{20744.8} = 9.641 \times 10^{-6}$

$\Sigma(2kQ)_2 = 15685.38(2) = 31370.76$

$\Delta Q_B = \frac{\Sigma h_B}{\Sigma(2kQ_2)} = \frac{0.560}{31370.76} = 1.594 \times 10^{-5}$

$Q_a' = Q_a - \Delta Q_A = 0.006 - 9.641 \times 10^{-6}$
$= 0.00599 \ m^3/s$

$Q_b' = Q_b - \Delta Q_B = 0.0186 - 1.594 \times 10^{-5}$
$= 0.01858 \ m^3/s$

$Q_c' = 0.01858 \ m^3/s$

$\Sigma Q = 0.0059 + 0.01858(2)$

$\boxed{\Sigma Q = 0.04315 \ m^3/s = 684 \text{ GPM}}$

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SUMMARY

YOU CAN SEE IN FIGURE 2 WITH CALCULATIONS THE FLOW IS LESS AT THE GATE VALVE BRANCH AND THE UPPER BRANCH HAS 3 TIMES THE FLOW RATE
IN FIGURE 3 WITH CALCULATIONS THE FLOW RATE IS DOUBLE IF YOU ADD THE BANCHES TOGETHER FROM FIGURE 2.

ANALYSIS

THESE CALCULATIONS SHOW THAT IT MIGHT OVER EXTEND THE FLOW RATE THE TANKER TRUCK CAN HANDLE IF THESE MODIFICATIONS WERE MADE. THIS IS GOOD JUST AS A GUIDELINE TO SHOW THE CLIENT

After taking a careful look at everything shown in the visit, please answer the following questions:
a. Did you watch the videos using a 3D virtual headset? Do you own one? If not, would be interested in owning one? Whether you are interested in owing one or not, explain why.
b. What systems did you identify in the virtual plan visits that are related to a fluid mechanics system?
c. What fluid mechanics concepts you have learned in this course you would use to study the performance or design such systems you observed?

Brooklyn's M Factory

a. No. No. Yes, I think it would the tour more interesting and you would probably notice more things going on in the Brooklyn's M Factory.
b. The plant has what looks like a water system for fire, I see gate valves, ball valves, tees, elbows.
c. This is a network pipeline system delivering water in the case of a fire. So this systems is dealing with pipe minor losses.

Hershey's Factory

a. No. No. Yes, I think it would the tour more interesting and you would probably notice more things going on in the Hershey's Factory. This tour didn't need a 3D headset.
b. The plant has big tanks that hold large volumes of milk and delivers it through large pipes in a series pipeline system. The system has large pipes with flanges to connect to. There are also tanks with motors mixing the ingredients. All pipes were labeled. There are different viscosities of fluids that are being mixed. There are elbows, tees, gate valves
c. This could be a mix of network and series pipeline systems delivering milk to mix other ingredients with. So this systems is dealing with pipe minor losses, pump head loss.

Water Treatment Plant

a. No. No. Yes, I think it would the tour more interesting and you would probably notice more things going on in the Water Treatment Plant.
b. The plant has large water tanks (some that are 15 feet deep, and some that are 20 feet deep). The system has large pipes with flanges to connect to. There are also submersible pumps, transfer pumps, gate valves, flow meters to calculate the total volume of water, there are elbows, tees, gate valves, pipes are labeled, piping structures (including trellis style bridge supports over a creek), and reservoirs.
c. This is a mix of network and series pipeline systems delivering water to the city of Grande Prairie, Clairmont, and Sexsmith. So this system is dealing with pipe minor losses, pump head loss, flow measurements, and open channels.