gasoline

Specific weight γ (kN/m³)	Density ρ (kN/m³)	Dynamic viscosity η (Pa·s)	Kinematic viscosity (m²/s)
6.67	680	2.87×10^{-4}	4.22×10^{-7}

You are hired to complete the design of a system an engineer left unfinished. The system delivers gasoline (sg=0.68) at a temperature of 25 °C to a truck as shown in the figure (please note that the U-tube manometer on the left is a schematic representation only).

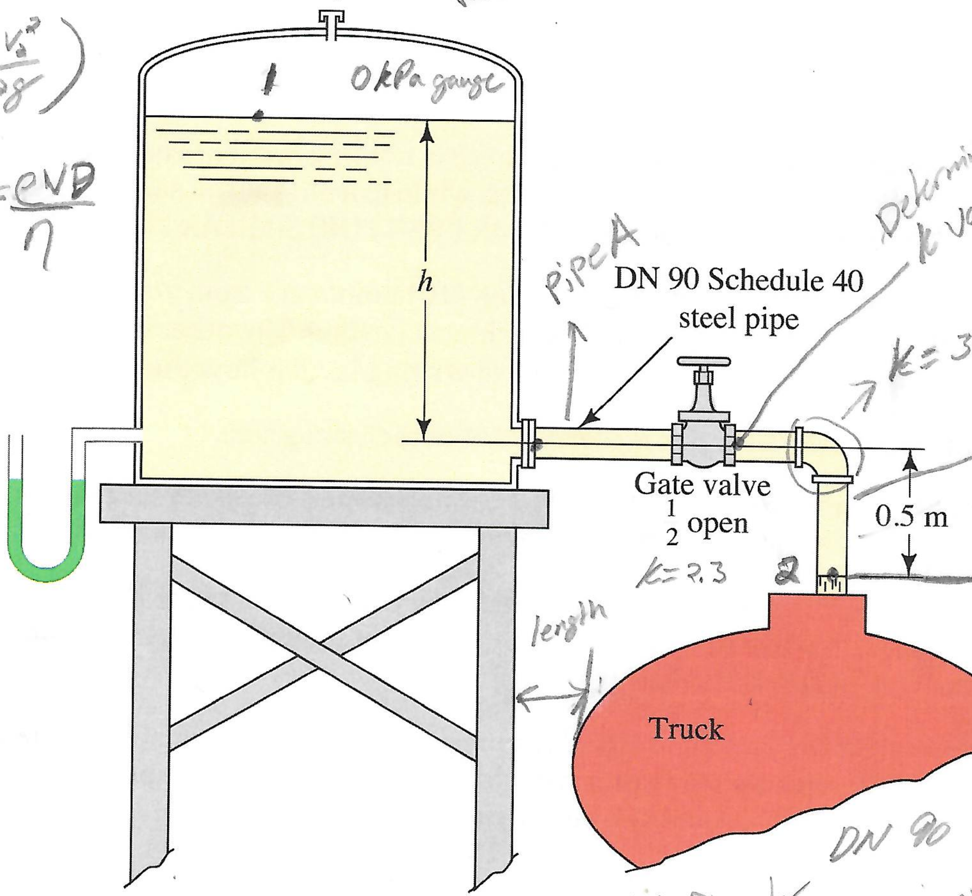
$h_{L,1-2} = f \frac{L}{D}\frac{V_2^2}{2g} + k_{entrance}\frac{V_2^2}{2g} + k_{elbow}\frac{V_2^2}{2g}$

$Q = V \cdot A \rightarrow V = \frac{Q}{A}$

$\frac{\varepsilon}{D}$ or $Re = \frac{\rho V D}{\eta}$

Table 10.5 Friction factor f_T 0.017

Determine k valve opening Table 10.4: $L/D = 160$, $160 \cdot (.017) = 2.72$, $k = 2.3$



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

DN 90: Outside Diameter 4.00 in / 101.6 mm; Inside diameter 3.548 in / 90.1 mm; Wall thickness .226 in / 5.74 mm; Flow Area 6.381×10^{-3} m²

1. The first set of tasks you are in charge of is:

   a. Determine the required depth *h* in the tank to produce a flow of 400 gpm. While keeping most of what the previous engineer decided (shown in the picture), you will need to decide the separation distance between the truck and the elevated tank. It is important to note that the previous engineer decided to use a gate valve that is ½ open, thus be careful selecting the proper way of computing the valve minor loss.

   b. Fully design the mercury U-tube manometer. For that, you need to select a clear PVC plastic tubing (use Table G.3 in the book) and determine the minimum U-tube manometer length. Make sure the mercury does not overflow when the tank is full, neither it goes into the tank when the tank is empty. Also, determine how much mercury and tubing you would need. It is important to note that the U-tube manometer is on the other side of the tank away from the discharge pipe where the fluid moves.

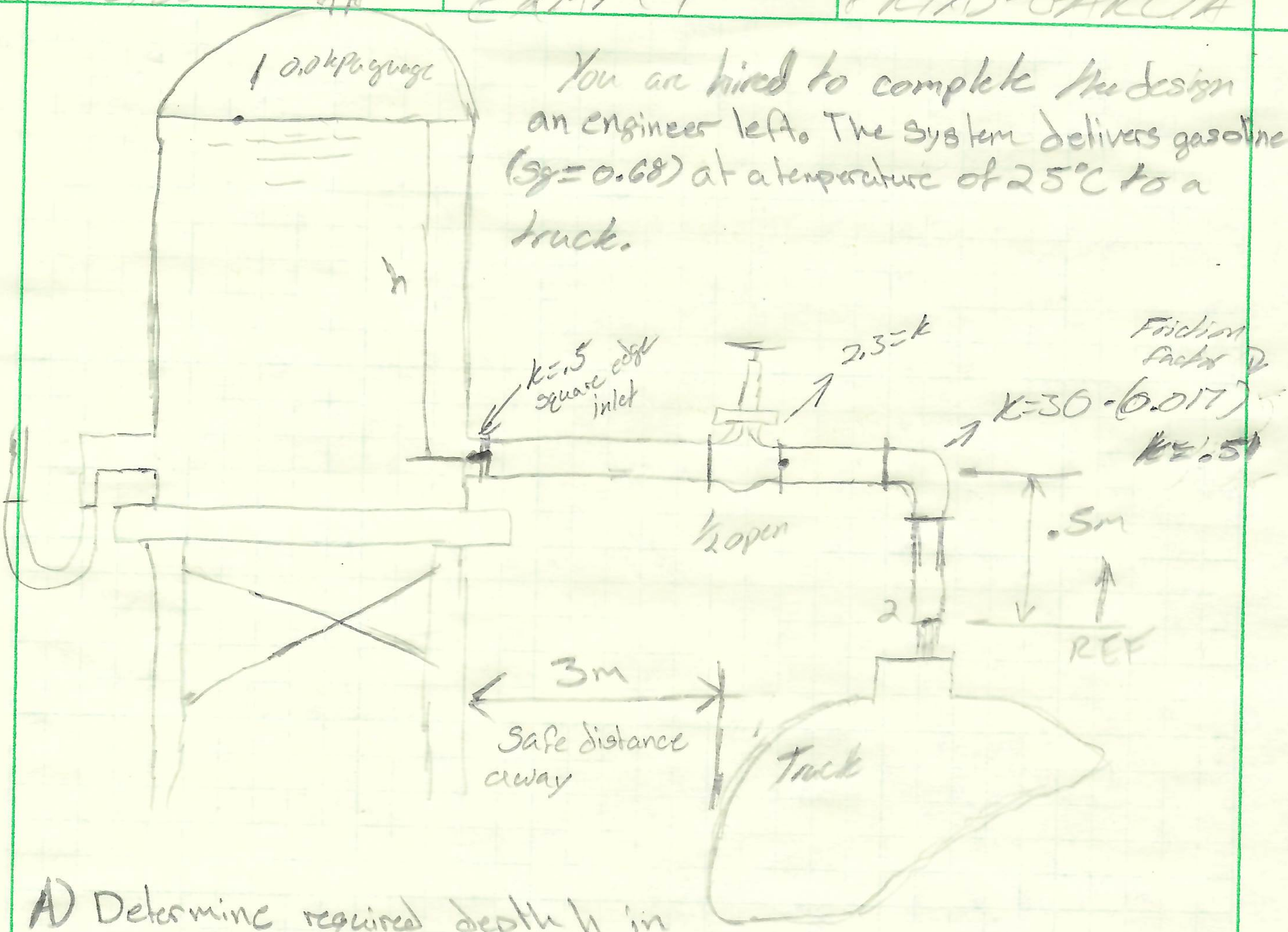
c. Determine the tank diameter if the gasoline level should not drop more than 1% of its depth after 5 minutes. In addition, determine what is larger (compute percentages): the minor losses or pipe losses?

The company would like you to do all your work by hand but also, they need you to create an excel spreadsheet to run automatically all calculations. You must make sure the excel solutions match the hand calculations.

2. The second set of tasks you are in charge of is to use the spreadsheet you created to check the design under a different operation condition. For a gate valve ¼ open, determine the required depth *h* in the tank for different flow rate values. Make a plot of required depth *h* vs flow rate. Using the plot, determine the flow rate when the gate valve is ¼ open and the required depth *h* is equal to the one when the gate valve is ½ open. Also, for when the gate valve is ¼ open, determine: a) the U-tube manometer reading, b) the percentage of gasoline depth drop after 10 minutes of operation, and c) the percentage of minor losses.

MET330 | EXAM 1 | FRIAS-GARCIA

You are hired to complete the design an engineer left. The system delivers gasoline ($sg = 0.68$) at a temperature of 25°C to a truck.



A) Determine required depth h in tank to produce a flow of 400 gpm. Decide separation distance between the truck and the elevated tank. Previous engineer decided to use a gate valve 1/2 open.

1.) $\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L$

2). Find $V_2 \rightarrow V_2 = \frac{Q}{A}$

$400 \frac{gal}{min} \times \frac{.00379\ m^3}{1\ gal} \times \frac{1\ min}{60\ sec}$

$V_2 = \frac{.0253\ m^3/s}{6.38 \times 10^{-3}\ m^2} = 3.960\ m/s$

3). Find h_L add up k values

$h_L = k\left(\frac{V_2^2}{2g}\right)$ $k_{total} = .5 + 2.3 + .51$

$k_{total} = 3.31$

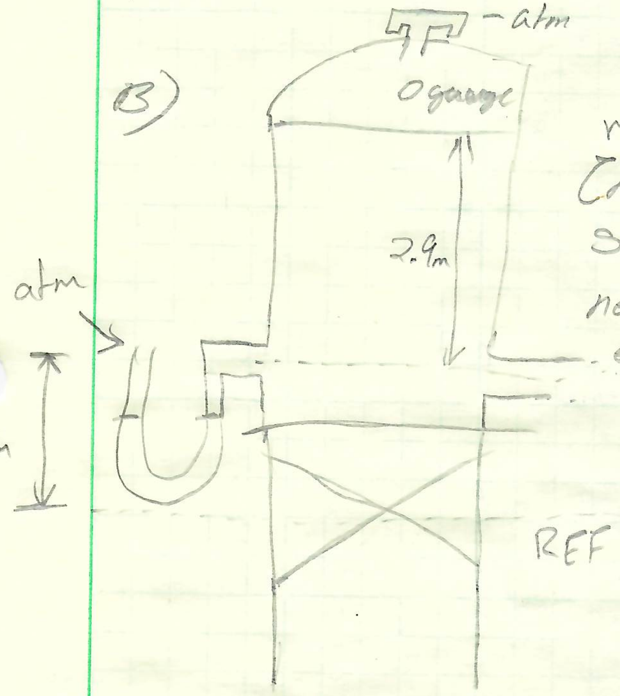
$h_L = 3.31\left(\frac{3.960\ m/s^2}{2(9.81\ m/s^2)}\right) = 2.6456 \rightarrow 2.65\ m$

$z_1 = \left(\frac{3.960\ m/s^2}{2(9.81\ m/s^2)}\right) + 2.65\ m \Rightarrow z_1 = 3.449\ m \rightarrow 3.4\ m$

$z_1 = 3.4\ m - .5\ m = \boxed{2.9\ m = h}$

We had to use Bernoulli's equation to find the depth. But first we need to find the volume at point 2 marked on the FBD. We did so by using $V = \frac{Q}{A}$; dividing flow rate over Area. Then we had to find k values for the elbow, gate valve and pipe entrance. We got values from chapter 10 and tables 10.4 and 10.5 to also get friction factor of f_T. Plugged in values since the system is open to the atmosphere the pressures on both sides are zero.

(3)



Fully design the mercury U-tube manometer. Select clear PVC plastic tubing [table G.3] Determine minimum length. Make sure it does not overflow when tank is full neither it goes into the tank when the tank is empty. Determine how much mercury

Mercury $Sg = 13.54$

$\gamma = 132.8\ kN/m^3$

$\rho = 13540\ kN/m^3$

Dynamic Vis. $\eta = 1.53 \times 10^{-3}\ Pa{\cdot}s$

kinematic Vis. $\nu = 1.13 \times 10^{-7}\ m^2/s$

Table G.3

OD	wall thickness t	inside Diameter ID	Flow Area	Pressure Rating
32 mm	2.4 mm	27.2 mm	$5.811 \times 10^{-4}\ m^2$	16 bar

pressure for left side of the tube is open to the atmosphere. Pressure to the right is pressure inside the tank. The tank is also exposed to the atmosphere. Standard amount of mercury for a manometer is 30-75 g. about 2.5 oz. The height of mercury could be determined by the equations $\Delta P = \rho g h$ or $\Delta P = \gamma h$ if the pressure in the tank changes