Old Dominion University

MET 330

Full System Design to Transport Pine Logs

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ABSTRACT

West Rock as bought pine logs from a 3rd party company. They want to transport the logs to a pneumatic system. These types of systems keep the pressure of the trapped air constant. Using a pump from the system, air can be compressed. We are creating a system that carries logs across from the river 300 ft to an open channel. The open channel will be man-made. The water will be supplied steady from a river 600 ft from the system. This system should run at least 1 hour independently. The company wants solid estimation of this design we are creating in Keysville, VA. What will be required is understanding the type of tank, pump, water, and other specifics in order to complete this design.

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Introduction

WestRock is located in Keysville, VA. Average wind speed is 20.37 mph in that area. We need to create a system that can carry 4 logs from a building to the river. The logs are 14 inches in diameter. Specifications are presented within tank, open channel, steel pipe, and pumps and flow nozzle. The use of this system is to accommodate for possible power outages,

List of Figures & List of Tables

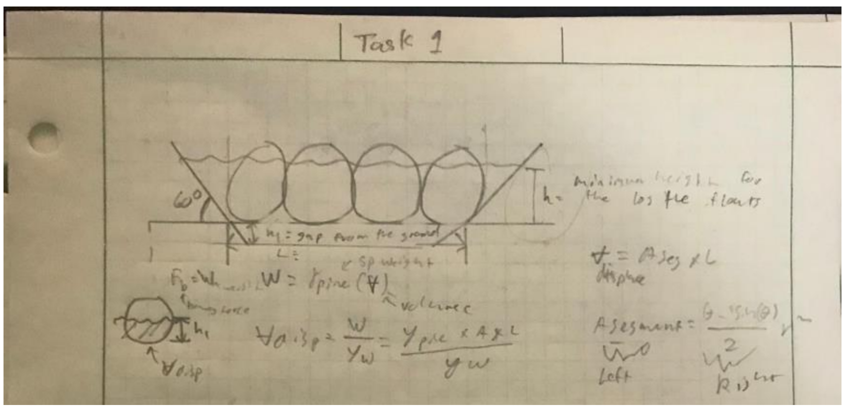
Report/Tasks & Design

Task 1: Open Channel

Purpose

Design an open channel such that four 14 inch logs can float in the channel without touching the ground.

Drawings and Diagrams



Sources

Matt R., Untener, A “Applied Fluid Mechanics”, 7th edition Pearson, Inc (2015)

Design Considerations

We look over the project’s requirements. We understood that a log was at 14”. These logs will be traveling to the trapezoidal open channel. We first look for the buoyancy of the log in water.

Data and Variables

- Slope = 0.01%
- (SG) Water @ 60 F = 62.4 lb/ft3
- Log = 14 inches
- Concrete n= 0.017

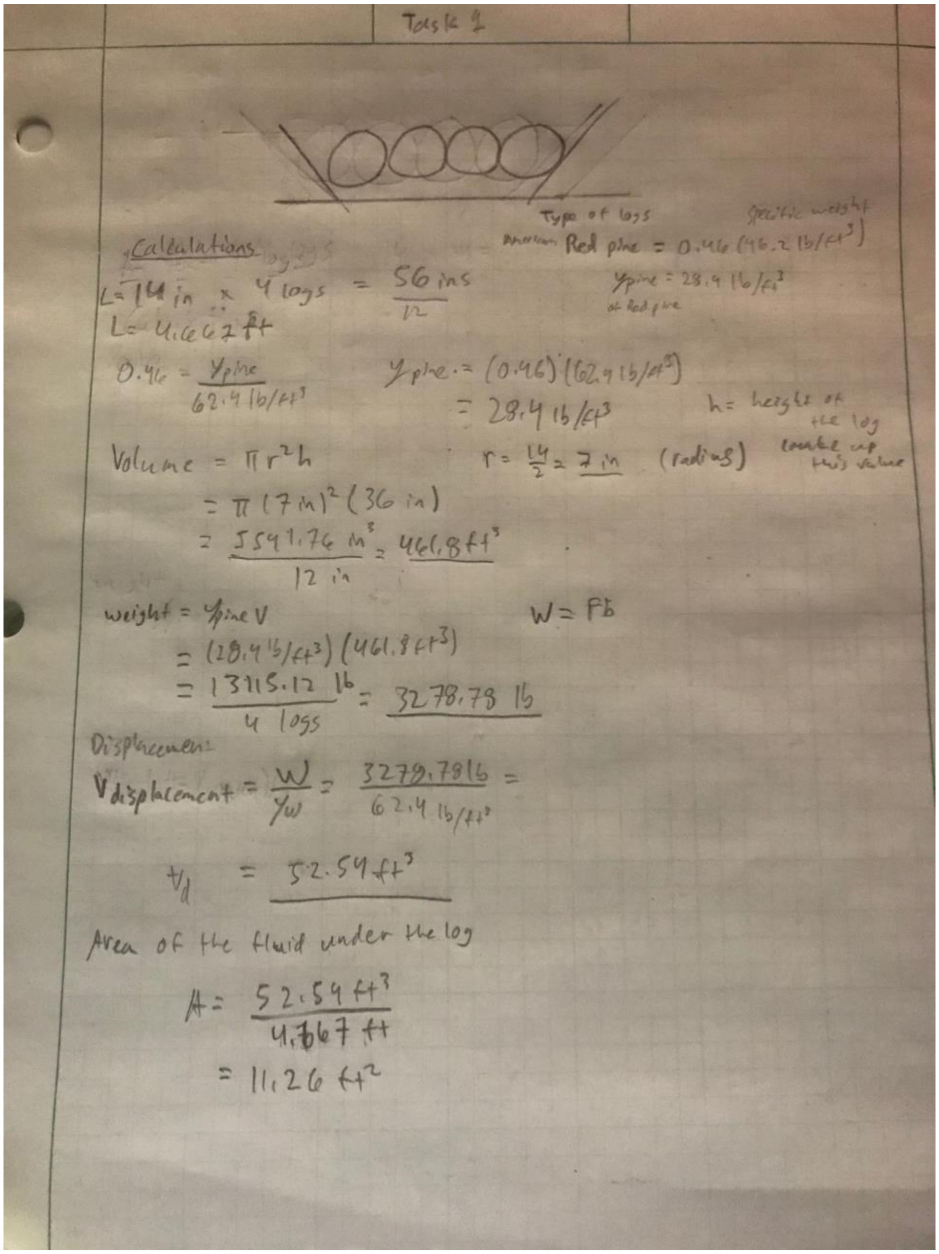
Materials

-Water
-**Pine Logs**

-Open channel

Procedure & Calculations:

In order to design the channel for four 14 inch logs, we must first establish the water level in order to maintain one log. This involves determining what makes one log float. To do this, we must find the buoyancy force on the log. After we find this, we will establish the log dimensions and run calculations for the open channel system.



Task 1

Type of logs — Specific weight

American Red pine $= 0.46\ (46.2\ lb/ft^3)$

$\gamma_{pine} = 28.4\ lb/ft^3$ of Red pine

Calculations

$L = 14\ in \times 4\ logs = \frac{56\ ins}{12}$

$L = 4.667\ ft$

$0.46 = \frac{\gamma_{pine}}{62.4\ lb/ft^3}$

$\gamma_{pine} = (0.46)(62.4\ lb/ft^3)$

$= 28.4\ lb/ft^3$

h = height of the log (look up this value)

Volume $= \pi r^2 h$

$r = \frac{14}{2} = 7\ in$ (radius)

$= \pi (7\ in)^2 (36\ in)$

$= \frac{5541.76\ in^3}{12\ in} = 461.8\ ft^3$

weight $= \gamma_{pine} V$

$W = F_b$

$= (28.4\ lb/ft^3)(461.8\ ft^3)$

$= \frac{13115.12\ lb}{4\ logs} = 3278.78\ lb$

Displacement

$V_{displacement} = \frac{W}{\gamma_w} = \frac{3278.78\ lb}{62.4\ lb/ft^3} =$

$V_d = 52.54\ ft^3$

Area of the fluid under the log

$A = \frac{52.54\ ft^3}{4.667\ ft}$

$= 11.26\ ft^2$

Task 1

Calculations – Angle of the sector submerged in water

$A = \left(\frac{2\pi r^2 \theta}{360}\right)$

Left hand side = Right hand side

Based spread sheet / After iteration

$\theta = \left(\frac{A}{2\pi \cdot r^2}\right) 360 = 262^{0}$

$LHS = 0.947\ ft^2$

After iteration

$\theta_{rad} = \frac{2\pi\theta}{360} = \underline{4.573}$

minimum height of water needed in the channel

$y = \frac{D}{2}\left[1 - \sin\left(\frac{\pi - \theta}{2}\right)\right] = \frac{14}{2}\left[1 - \sin\left(\frac{\pi - 4.573}{2}\right)\right]$

$y = 11.593\,in = \underline{0.966\ ft}$

Channel design (Trapezoidal design

$z = \tan(60°) = \frac{1}{z}$ $\quad z = \frac{1}{\tan(60°)} = .577$ slope of the walls of the channel

$B = T - (2zy) = (56\,in) - (2 \cdot .577 \cdot 11.593\,in)$

$B = \underline{42.42\,in}$

$A = (b + (zy)) \cdot y = (42.62\,in + (.577 \cdot 11.593\,in))(11.593\,in)$

$A = 571.64\,in^2 = \frac{571.64\,in^2}{(12\,in)^2} = \underline{3.970\ ft^2}$

wetted

$W_P = b + (2y\sqrt{1+z^2})$

$= (42.62\,in) + (2(11.59) \cdot \sqrt{1 + .577^2})$

$W_P = 69.38\ in$

$= \underline{5.782\ ft}$

$R = \frac{A}{W_P} = \frac{3.970\,ft^2}{5.782\,ft}$

$= \underline{0.687\ ft}$

Calculation
Flow rate

$V = \left(\frac{1.49}{n}\right) R^{\frac{2}{3}} S^{\frac{1}{2}}$

$V = \left(\frac{1.49}{0.012}\right)(0.1687)^{\frac{2}{3}}(0.001)^{\frac{1}{2}}$

$V = 2.158$ ft/s. (volumetric flow rate)

$Q = AV$

$= (3.970\ ft^2)(2.158\ ft/s)$

$= \boxed{8.567\ ft^3/s}$ flow rate

Froude # $N_f = \frac{V}{\sqrt{gy}}$

$N_f = \frac{2.158\ ft/s}{\sqrt{(32.2\ ft/s^2)(0.966\ ft)}}$

$\boxed{N_f = 0.387 < 1}$ less than 1

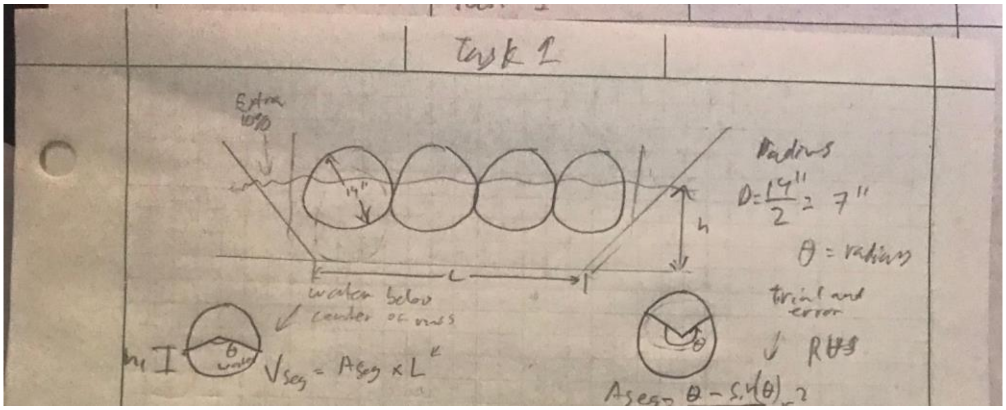


Figure 2

In figure 2, we then designed the open channel system and established the flow rate

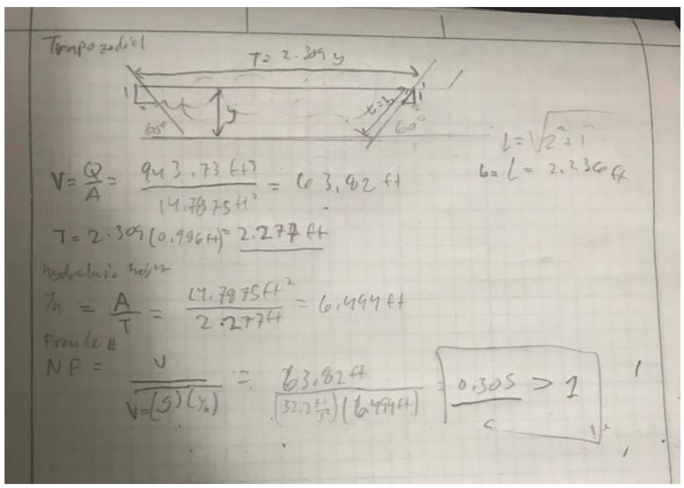


Figure 3

Here we solve for the Velocity (v), Hydraulic Depth (yh), Width of the surface (T) and Froude Number (Nf)

Summary

We concluded that the 14” logs are able to float by finding buoyancy force which then helped us to determine the water level needed. After doing this, we designed the open channel system and found the flow rate to be 8.567

Analysis

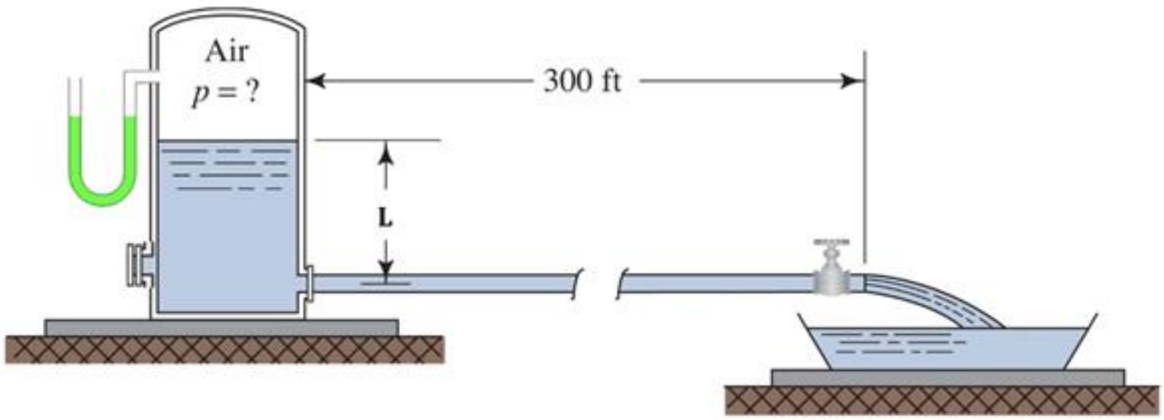
The channel is an efficient way to transport the logs. By determining water displacement, buoyancy force of the water on the log, and then designing the open channel, we determined that logs have plenty of space to float without restriction to allow smooth transportation.

Task 2: Pneumatic Tank Specifications

Purpose

Design pneumatic tank to guarantee a one-hour operation without power.

Drawings and Diagrams



Sources

Matt R., Untener, A "Applied Fluid Mechanics", 7th edition Pearson, Inc (2015)

Design Considerations

-Flow rate

-Tank dimensions

-Tank material

-Pressure in tank

-Volume of water

-1 hour of operation in case of power loss

Data and Variables

D = 40 ft

Q= 8.567 ft^3/s

Materials

Procedure & Calculations:

We shall determine the tank dimensions such that they allow enough water to supply water to the open channel for one hour without dramatically changing the tank pressure . The flow rate that has been found will help determine the tank dimensions.

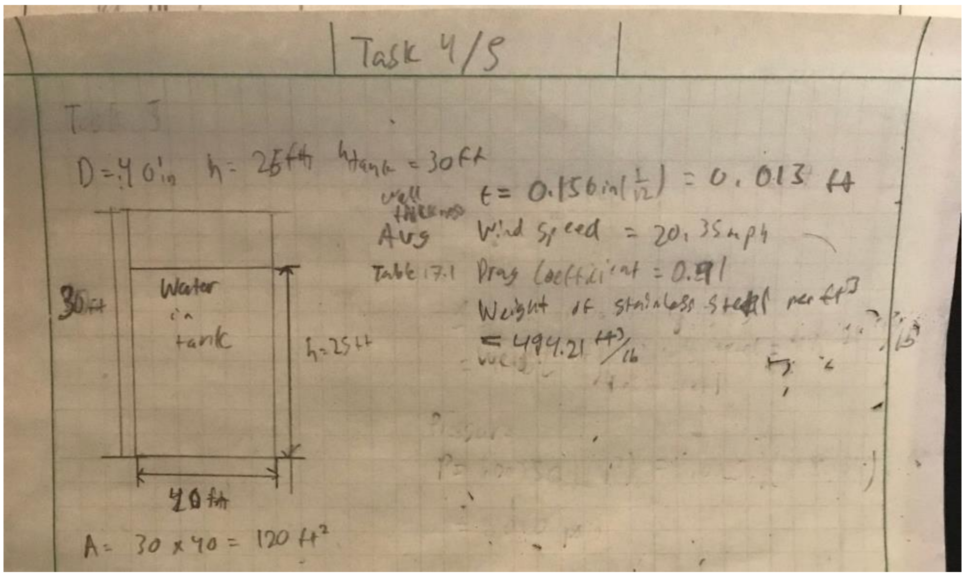


Figure 3

In figure 3, the tank dimensions were determined. The diameter of the tank was found to be 16ft. We left space in the tank for air. Additionally, it was found that the tank can be ran for 1 hour by finding the volume for 1 hour which was 0.0279. Δh was found to be 0.5ft.

Summary

We decided that the tanks diameter will be at least 30 ft. We found out the tank can guarantee 1 hour while running without power.

Analysis

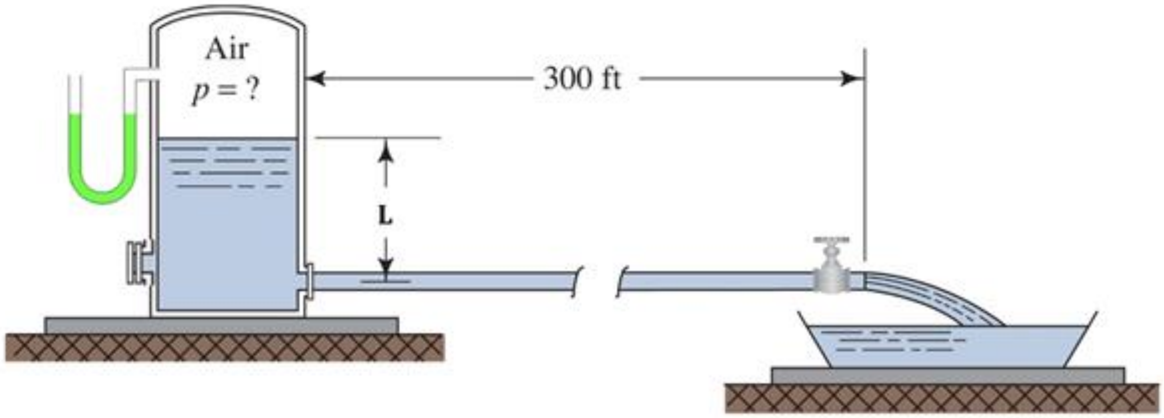
We decided to find the values based on previous problems we work on in class. The tank's dimensions are 30 ft in length and 40 ft diameter. Area would 1200 ft^2 The volume would be 3216.99

Task 3: Pipe/Air pressure design

Purpose

The Purpose of this task is to determine piping composition (Material, Diameter, and Schedule). In selecting the pipe, minor losses are neglected

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

Design Considerations

Incompressible fluid

Isothermal process

Neglect minor losses include energy losses

Data and Variables

Specific weight of water = 62.4 lb/ft^3

Q = 8.567 ft^3/s

Pipe roughness for steel = 1.5*10^-4

Procedure

Pipe diameter, schedule, and material is selected by using appendix F dimensions of steel pipe. Utilizing a diagram of the tank, specific points and a reference is placed in order to calculate pressure. The pressure is then calculated using Bernoulli's equation.

Calculations

Appendix F Dimensions of Steel Pipe

Table F.1 Schedule 40

Nominal Pipe Size		Outside Diameter		Wall Thickness		Inside Diameter			Flow Area	
NPS (in)	DN (mm)	(in)	(mm)	(in)	(mm)	(in)	(ft)	(mm)	(ft^2)	(m^2)
⅛	6	0.405	10.3	0.068	1.73	0.269	0.0224	6.8	0.000 394	3.660×10^{-5}
¼	8	0.540	13.7	0.088	2.24	0.364	0.0303	9.2	0.000 723	6.717×10^{-5}
5	125	5.563	141.3	0.258	6.55	5.047	0.4206	128.2	0.139 0	1.291×10^{-2}
6	150	6.625	168.3	0.280	7.11	6.065	0.5054	154.1	0.200 6	1.864×10^{-2}
8	200	8.625	219.1	0.322	8.18	7.981	0.6651	202.7	0.347 2	3.226×10^{-2}
10	250	10.750	273.1	0.365	9.27	10.020	0.8350	254.5	0.547 9	5.090×10^{-2}
12	300	12.750	323.9	0.406	10.31	11.938	0.9948	303.2	0.777 1	7.219×10^{-2}

Figure 1)

Task 3

a) $Q = 8.567\ ft^3/s \times \left(\frac{0.02831685\ m^3}{1\ s}\right) = 0.243\ m^3/s$

$V = 2.158\ m/s$

$A = \frac{Q}{V} = \frac{0.243\ m^3/s}{2.158\ m/s} = 0.1126\ m^2 = 1.126 \times 10^{-1}\ m^2$

material of pipe - Steel pipe schedule 40

diameter of steel pipe

Pipe dimensions of steel pipe (must have a flow area of 0.1126 m^2 or greater) schedule 40

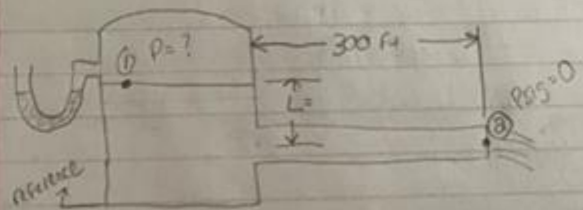
DN400 - inside diameter = 15 inches = 0.381 m

outside diameter = 16 inches = 0.4064 m

Flow area = 0.1140 m^2

wall thickness = 0.500 inches

B)



$\gamma_{water} = 62.4\ lb/ft^3$

$Q_{in} = Q_{out}$

$A_{in} V_{in} = Q_{out}$ $\quad A = 0.1140\ m^2 = 1.227\ ft^2$

$V_{in} = 8.567\ ft^3/s \,/\, 1.227\ ft^2 = 6.98\ ft/s$

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

$P_1 = \left(\frac{V_2^2}{2g} + h_L - z_L\right) \times \gamma_{water}$ $\qquad h_L = f \times \left(\frac{L}{D}\right) \times \left(\frac{V_2^2}{2g}\right)$

$P_1 = \left(\frac{(6.98\ ft/s)^2}{2 \times 32.2\ ft/s^2} + \left(0.015 \times \frac{200\ ft}{1.25\ ft} \times \frac{(6.98\ ft/s)^2}{2 \times 32.2\ ft/s^2}\right) - 5\ ft\right) \times 62.4\ lb/ft^3$

$P_1 = 584.64\ lb/ft^2$ or 4.06 psig

Summary

The pressure above the tank was calculated to be 8.03 psig. This pressure will ensure water will supply the open channel.

Materials

Steel pipe

Water

Analysis

The air in the tank is essential for it to remain constant in order for the operation to be successful. The flow rate must remain the same so that the open channel will have the correct amount of water to transfer the logs.

Task 4: Storage Tank Material and Tank Wall Thickness

Purpose

The purpose of this task is to select the material and thickness of the tank. The selection of the material of the tank is based on whether the material chemically reacts at contact with the fluid, especially over a long period of time.

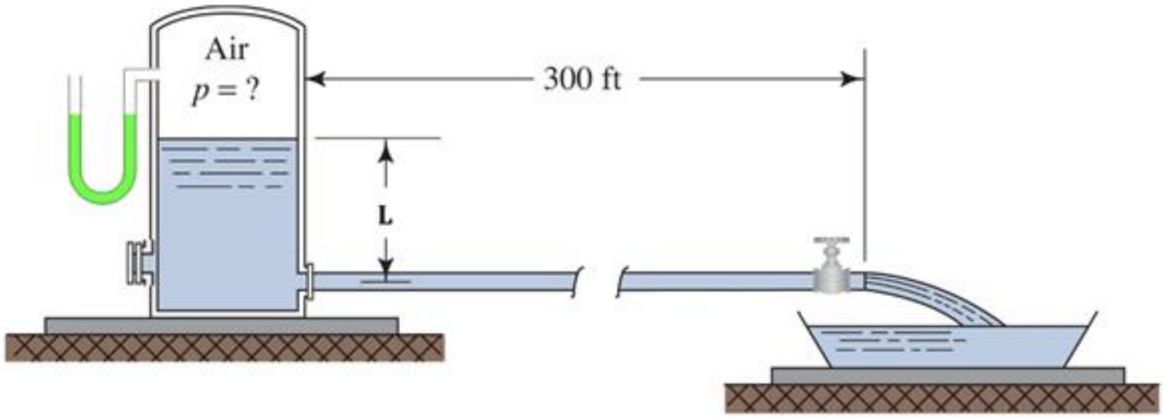
Sources:

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Design Considerations

The tank we are using will be stainless steel. We used one of the equations from the book to solve for the minimum wall thickness for the tank. The characteristics of material, weather, and cost will also be considered.

Drawings and Diagrams



Data and Variables

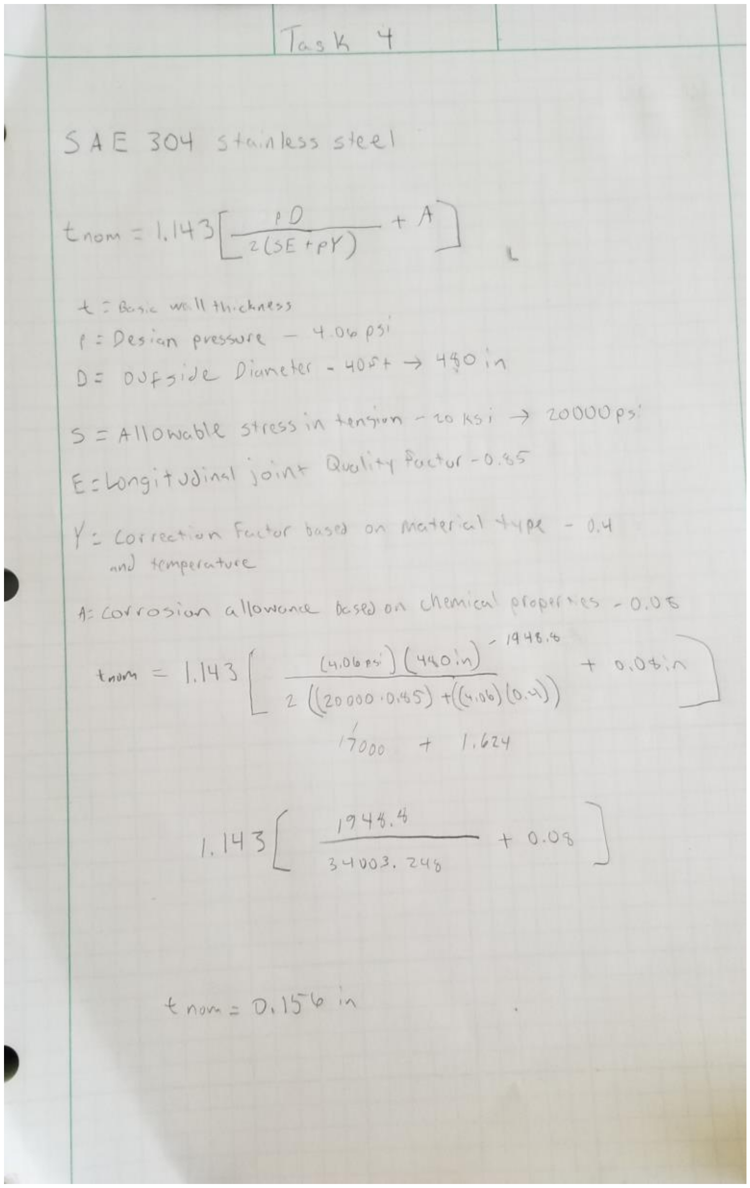
Ultimate stress of stainless steel = 20,000 psi

P = 4.06 psig

Procedure

First the material must be selected from the list of materials that pressure vessels can be construction out of. The minimum wall thickness equation found in the textbook is used to specify the tank wall thickness.

Calculations



Task 4

SAE 304 stainless steel

$$t_{nom} = 1.143\left[\frac{PD}{2(SE + PY)} + A\right]$$

t : Basic wall thickness

P : Design pressure — 4.06 psi

D = Outside Diameter - 40 ft → 480 in

S = Allowable stress in tension - 20 ksi → 20000 psi

E : Longitudinal joint Quality Factor - 0.85

Y : Correction Factor based on material type and temperature - 0.4

A : Corrosion allowance based on chemical properties - 0.08

$$t_{nom} = 1.143\left[\frac{(4.06\,psi)(480\,in)}{2\left((20000 \cdot 0.85) + ((4.06)(0.4))\right)} + 0.08\,in\right]$$

1948.8

17000 + 1.624

$$1.143\left[\frac{1948.8}{34003.248} + 0.08\right]$$

$t_{nom} = 0.156$ in

Summary

The tank material was determined to be stainless steel due the materials ability to withstand the weather. Using the minimum wall thickness equation, it was calculated that the wall thickness has to be greater than 0.156 in.

Materials:

- Stainless Steel Tank

Analysis

The material and thickness of the tank is important in the designing process. The tank must be able to hold the fluid for many years without failure. Leaks or failure will cause many issues if it occurs which will negative effects on the project.

Task 5: Determine Tank weight and Wind load

Purpose:

The purpose of this task is to specify the wind load and weight of the tank for the civil engineering department.The tank will be in Keysville, VA. The tank will be 300 lbs. Drag force of the air must be required to understand the wind load. The average wind speed in Keysville is 20.35 mph.

Drawings and Diagrams

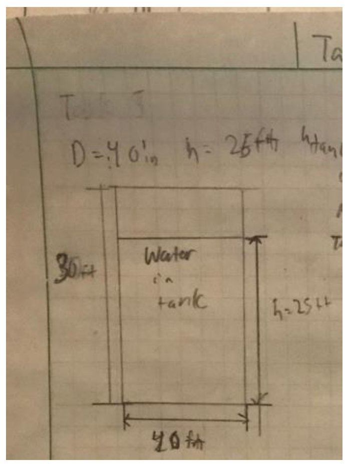


Figure 1 Cylindrical tank with Wind load

Source:

http://myforecast.co/bin/climate.m?city=31977&zip_code=23947&metric=false

http://www.usa.com/keysville-va-weather.htm

Design Considerations

- Weight of the tank
- Wind speed in the area
- Wind Load

Data and Variables

- A - Area = 1200 ft^3
- CD- Draft Coefficient =0.91
- Stainless steel per cubic feet = 494.21 ft^3/lb
- thickness wall = .105

Materials

-Steel Tank

Procedure & Calculations:

$A = 30 \times 40 = 120\ ft^2$

Calculations

$= \pi\,(A)(t)$ (cubic feet)

$= \pi\,(1200ft^2)(0.013\ ft)(494.21\ ft^3/lb)$

$= \boxed{24220.66\ lb}$ weight of tank

$\text{Pressure} = (.00256\ v^2) = (.00256 \times 20.35mph)$

$= 1.060\ psis$

$\text{Wind load} = APC_d$

$= (1200ft^2)(1.060\ psb)(0.91)$

$= \boxed{1157.52\ \text{Wind load}}$

Summary

This 24220.66 cylindrical tank has a wind pressure of 1.060. The Wind load being 1157.52 lb.

Analysis

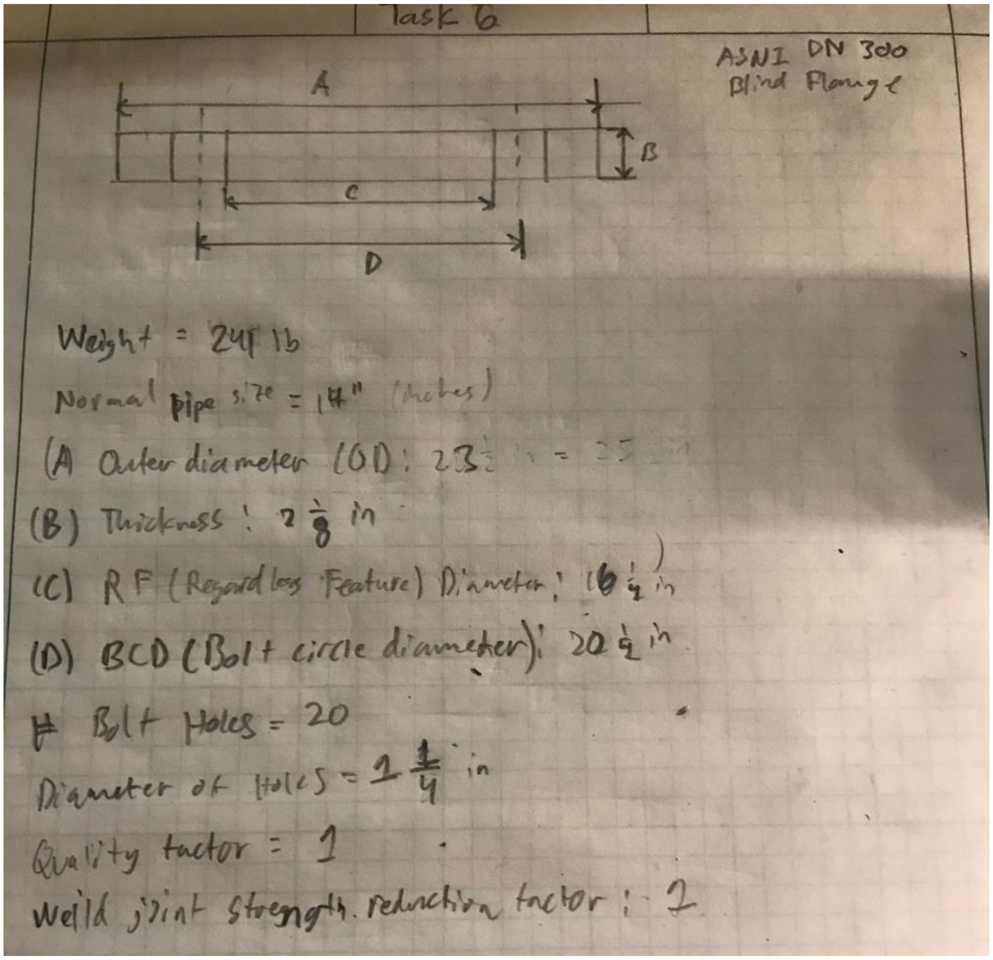
We calculate the variables that were given from the previous task.

Task 6: Design of the blind flange to hold the pressure in the facility for future connections

Purpose:

Figure out what type of bling flange to use. Specify its specifics for future connections. Use an equation to figure if it could hold the pressure.

Drawings and Diagrams



Sources:

https://www.warrenelectriccorp.com/technical/ansi-flange-dimension-chart/default.asp

https://www.texasflange.com/index.php/flange-dims-weights/flange-bolting-chart

https://en.wikipedia.org/wiki/Engineering_drawing_abbreviations_and_symbols#B

Design Considerations

- Material
- Thickness
- Pressure

Data and Variables

- Tank pressure
- Allowable stress

Procedure & Calculations:

Task 6

Future Connection Calculations

Formula for thickness of blind flange

d_g = Inside diameter of pipe = $16\frac{1}{4}$ in

P = 14.06 psig pressure in tank

S = 20000 psig (stress, from Task 4)

E = Quality Factor = 1 (From website)

W = weld strength reduction factor = 1 (from website)

$$T_{Bf} = d_g \sqrt{\frac{3P}{16SEW}}$$

$$= 16.25\text{ in} \sqrt{\frac{3(14.06\text{ psig})}{16(20\text{k psig})(1)(1)}}$$

$$\boxed{T_{Bf} = 0.1002\text{ in}}$$

Summary

The blind flange has a thickness of 0.1002 inches. DN 300 is what we used for the blind flange.

Materials

- DN 300 Steel Blind Flange

Analysis

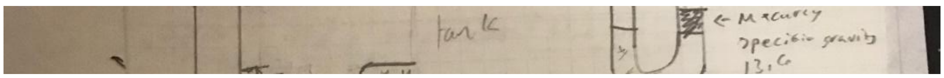
We are looking for a blind flange with its dimensions. We used different websites to figure out what type of Flange we wanted to use. We stuck with a DN 300 241 lb flange that is 14” in pipe size. We used the equation to help specify the thickness. This helps us consider using pipes that are around 16” mark.

Task 7: Manometer Design

Purpose

U-tube manometer (as shown in the figure) to measure the air pressure using mercury. What should be the minimum dimension (length) of the U-tube measured from the connection to the tank to the lowest point of the U-tube so it works properly?

Drawings and Diagrams



Sources:

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Design Considerations

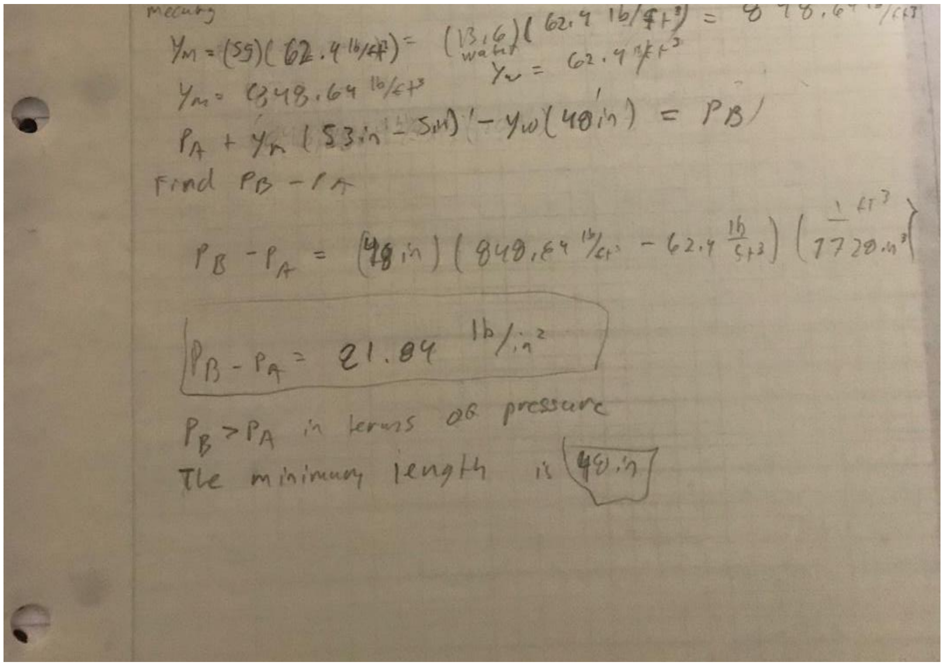
There’s Mercury inside the Manometer.

Data and Variables

Materials

- Steel Pipe

Procedure & Calculations:



mecury

$\gamma_m = (SG)(62.4\ lb/ft^3) = (13.6)(62.4\ lb/ft^3) = 848.64\ lb/ft^3$

water $\gamma_w = 62.4\ lb/ft^3$

$\gamma_m = 848.64\ lb/ft^3$

$P_A + \gamma_m(53in - 5in) - \gamma_w(48in) = P_B$

Find $P_B - P_A$

$P_B - P_A = (48\ in)(848.64\ lb/ft^3 - 62.4\ lb/ft^3)\left(\frac{1\ ft^3}{1728\ in^3}\right)$

$\boxed{P_B - P_A = 21.84\ lb/in^2}$

$P_B > P_A$ in terms of pressure

The minimum length is $\boxed{48\ in}$

Summary

The minimum length of the U tube is 48 in. Pressure difference between point A and B are 21.84 lb/in^2

Analysis

Recognize that mercury is within the manometer. Measure specific points in that tube to find out the difference in pressure between B and A. 5 inches from the beginning of the tube. Calculate values based on the specific weight of mecury. 48 inches was the result

Task 8: Flowmeter

Purpose

Specify the dimensions of the flowmeter, including the U-tube manometer to read the pressure differential.

Drawings and Diagrams

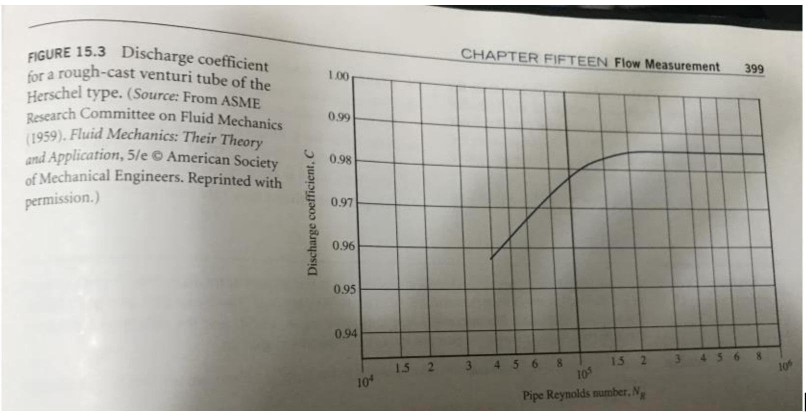
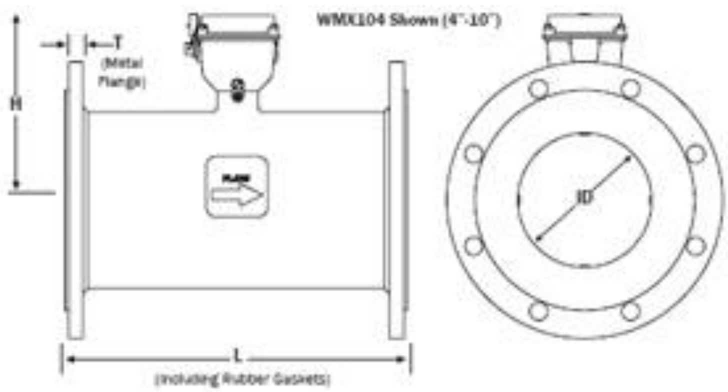
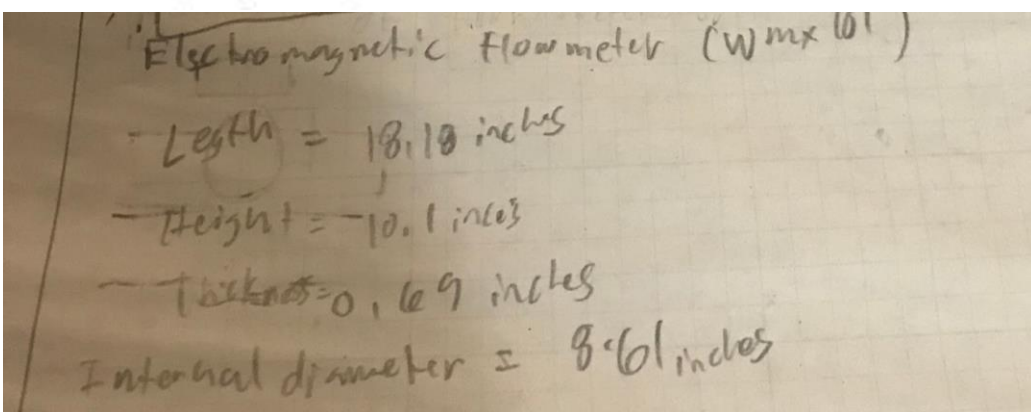


Figure 2)





Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

http://www.globalw.com/products/wmx101.html

Design Considerations

-Pipe diameter is 10 inches

- Fits with the u tube

Data and Variables

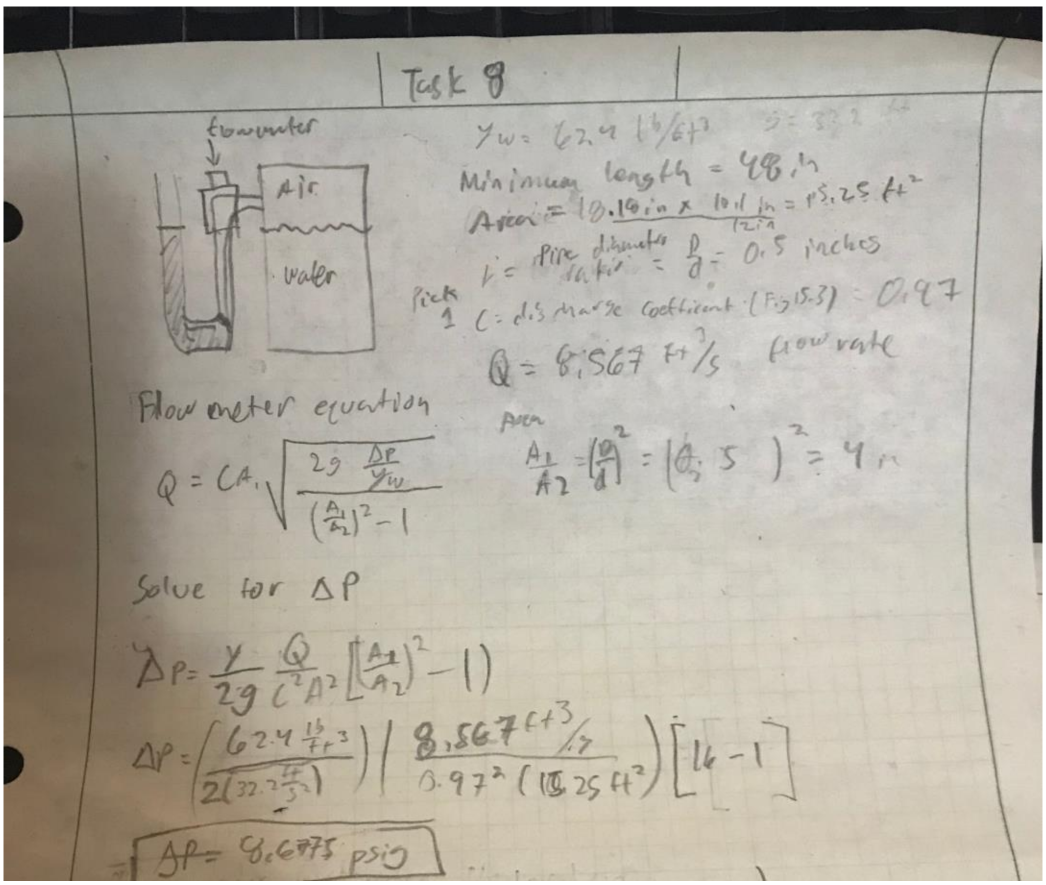
Specific weight of water = 62.4 lb/ft^3

Minimum length of the tube = 48 in

Materials

- Flowmeter

Procedure & Calculations:



Task 8

flowmeter

Air

water

$\gamma_w = 62.4\ \text{lb/ft}^3$

Minimum length = 48 in

Area = 10.10 in x 10.1 in / 12 in = 15.25 ft²

Pipe diameter ratio = $\frac{D}{d}$ = 0.5 inches

Pick 1

C = discharge coefficient (Fig 15-3) = 0.97

$Q = 8.567\ \text{ft}^3/\text{s}$ flow rate

Flow meter equation

$$Q = CA_1\sqrt{\frac{2g\frac{\Delta P}{\gamma_w}}{\left(\frac{A_1}{A_2}\right)^2 - 1}}$$

Area

$$\frac{A_1}{A_2} = \left(\frac{D}{d}\right)^2 = (0.5)^2 = 4\ \text{in}$$

Solve for ΔP

$$\Delta P = \frac{\gamma}{2g}\frac{Q}{C^2A^2}\left[\left(\frac{A_1}{A_2}\right)^2 - 1\right)$$

$$\Delta P = \left(\frac{62.4\ \frac{\text{lb}}{\text{ft}^3}}{2(32.2\frac{\text{ft}}{\text{s}^2})}\right)\left(\frac{8.567\ \text{ft}^3/\text{s}}{0.97^2(15.25\ \text{ft}^2)}\right)[16 - 1]$$

$$\boxed{\Delta P = 8.6775\ \text{psig}}$$

Summary

We are using an electromagnetic flowmeter (WMx101). Pressure differential is read to be 8.6775 psig.

Analysis

Electromagnetic flowmeter (WMx101) is placed. It has dimension that will fit the manometer filled with water and mercury. This tracks how much ia flowing through the tube into the tank

Task 9: Description of system/Final Remarks

Purpose

Determine the pressure increment after a possible sudden closing of the valve in the system.

Drawings and Diagrams

Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

https://www.engineeringtoolbox.com/water-density-specific-weight-d_595.html?vA=8-&units=F#

https://www.lmnoeng.com/WaterHammer/impulse.php

Design Considerations

- minor losses are neglected

Data and Variables

- Water Density @ 80 F = 62.217 lb/ft3

Materials

- Steel pipe

Procedure & Calculations:

Used the water hammer equation

Task 9

Water hammer equation

$$\Delta P = \rho C \Delta V$$

ρ = fluid density of water = $62.217 \frac{lb}{ft^3}$

C = velocity in the pipe = ?

ΔV = change in velocity = $9.15 \times 10^{-6} \, ft^3/s$

D = diameter = $1.543 \, ft$

E_v = Fluid Elastic mod = 3.170×10^6 psi

E = Pipe Elastic mod = 3.05×10^7 psi

$$C = \frac{\sqrt{\frac{E_v}{\rho}}}{1 + \frac{E_v D}{E s}}$$

$$C = \frac{\sqrt{\frac{3.170 \times 10^6}{62.217 \frac{lb}{ft^3}}}}{1 + \frac{(3.170 \times 10^6 \, psi)(1.543 \, ft)}{3.05 \times 10^7 \, psi \, (9.15 \times 10^{-6} \frac{ft^3}{s})}} = 2.907 \frac{ft}{s}$$

$$\Delta P = \left(62.217 \frac{lb}{ft^2}\right)(2.907 \, psi)\left(9.15 \times 10^{-6} \, ft^3/s\right)$$

$$\boxed{\Delta P = 1.655 \times 10^{-3} \, psi}$$

Summary

Analysis

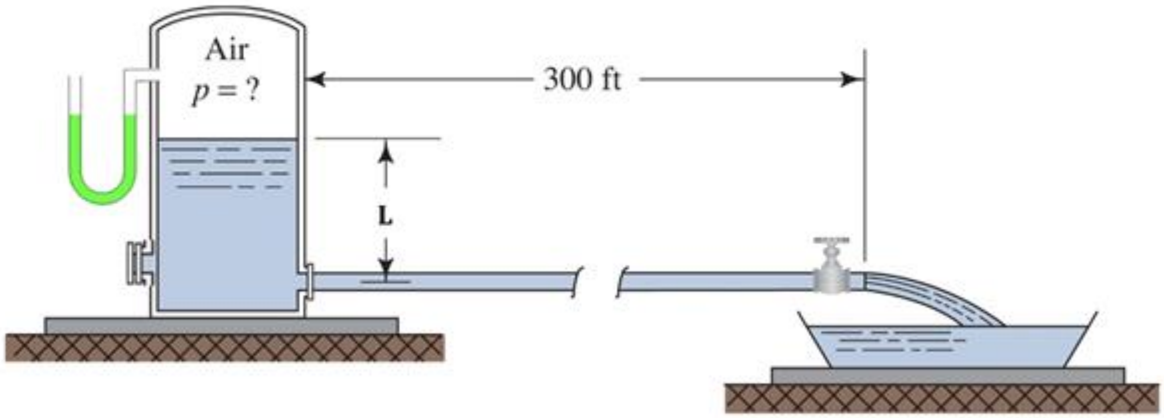
Water hammer is where water stops or change direction. It creates a loud noise inside the pipes. The water hammer equation is used to find the pressure increment.

Task 10: Pipe Wall Thickness

Purpose

Ensure that the wall thickness of the selected 16in schedule 40 selected steel pipe can withhold the pressure in the system.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

engineeringtoolbox.com

Design Considerations

Incompressible fluid

Isothermal process

Neglect minor losses include energy losses

Data and Variables

Specific weight of water = 62.4 lb/ft^3

Q = 18.33 ft^3/s

Inside diameter = 15.0 in

Minimum wall thickness for 16in schedule 40 steel pipe = 0.500 in

Procedure

Determine the pressure in the pipe using Bernoulli's equation then find the minimum wall thickness using the equation 11-12 from the textbook and compare it to the wall thickness of the pipe.

Calculations

Task 10

Inside diameter = 15.0 in = 0.381 m

velocity = 1.173 m/s

Tank pressure = 21.84 psi = 150581.5 N/m²

density = 992 KN/m³

$P = (21.84)(1.94)(9.81) - \frac{1}{2} \times 1.94 \times 3.85$

P = pressure + density × gravity + $\frac{1}{2}$ × density × velocity

$P = 150581.5\ N/m^2 + (992\ KN/m^3)(9.81\ m/s^2) + \frac{1}{2}(992\ KN/m^3)(1.173\ m/s)$

$P = 160894.8\ N/m^2 = 23.3\ psi$

Outside diameter = 16.0 in = 0.4064 m

$P = 150581.5\ N/m^2 + (992\ KN/m^3)(9.81\ m/s^2)(0.4064 - 0.381) + \frac{1}{2}(992\ KN/m^3)(1.173\ m/s)$

$P = 172117.8167 = 24.9\ psi$

Minimum wall thickness in pipe

$$t_{nom} = 1.143\left[\frac{PD}{2(SE + PY)} + A\right]$$

$$t_{nom} = 1.143\left[\frac{24.9\ psig \times 15.0\ in}{2(1531\ psi \times 1) + 24.9\ psig \times 0.4} + 0.125\ in\right] = 0.1532\ in$$

16 in minimum wall thickness = 0.500 in > 0.1532 in

Summary

The calculated minimum wall thickness comes out to be 0.1532in. From appendix F, the minimum wall thickness for 16in schedule 40 pipe is 0.500 in which means the pipe will work.

Materials

Steel pipe

Water

Analysis

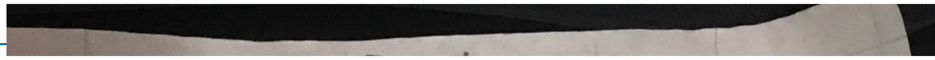
The wall thickness of a pipe in a design is important to ensure that it will withhold the pressure of the system and prevent failure within the pipe. The selected pipe proved to be qualified as it was greater than the required minimum wall thickness.

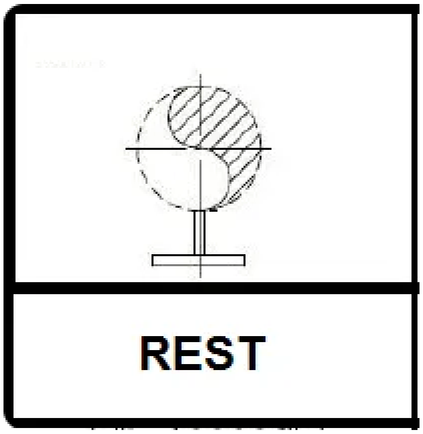
Task 11: Support Type and Support Forces

Purpose

Decide the type of support for the pipeline (it cannot be sitting on the ground) and determine the force acting on each support. Your work here includes the distance between supports so the pipe does not bend much.

Drawings and Diagrams





Sources

https://www.theprocesspiping.com/introduction-pipe-support/

Design Considerations

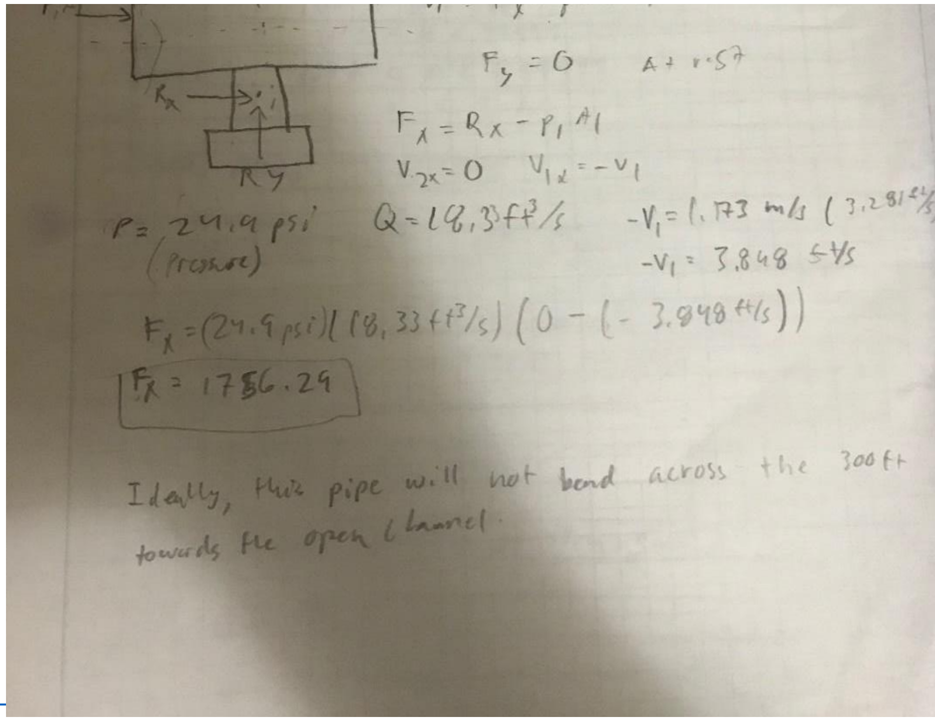
- Supports not bending
- Not grounded
- Force is acting on the support

Data and Variables

Materials

- Steel Pipes
- Rest Support

Procedure & Calculations:



$F_y = 0$ A + r.57

$F_x = R_x - P_1 A_1$

$V_{2x} = 0$ $V_{1x} = -V_1$

$P = 24.9$ psi (Pressure) $Q = 18.33\ ft^3/s$ $-V_1 = 1.173$ m/s (3.281 ft/s)

$-V_1 = 3.848$ ft/s

$F_x = (24.9\ psi)(18.33\ ft^3/s)(0 - (-3.848\ ft/s))$

$\boxed{F_x = 1756.29}$

Ideally, this pipe will not bend across the 300 ft towards the open channel.

Summary

The support chosen was a rest support. The distance between each support will be at least 10 ft.

Analysis

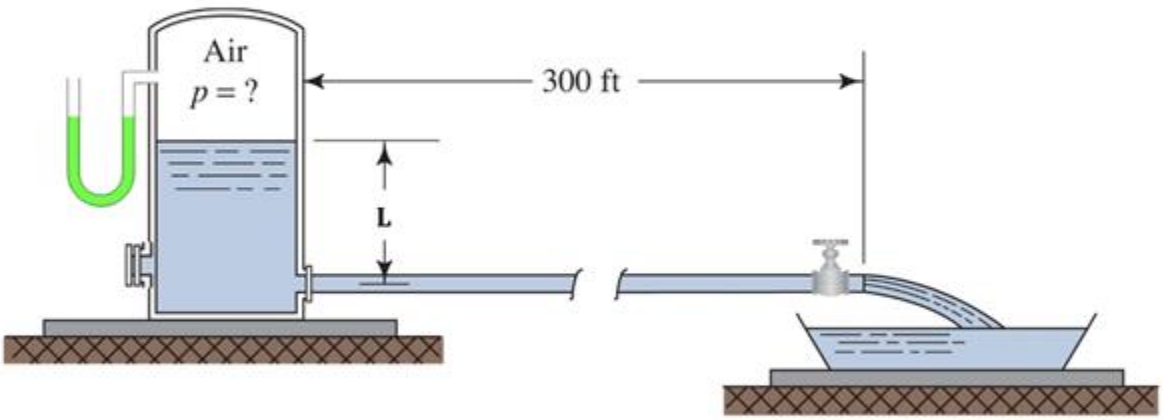
Distance between these supports can hold up the pipes we used. The flow of the pipes can be held down. This pipe is fixed with reference to vertical downward direction. Movement is not allowed downward

Task 12: Required Fitting

Purpose

List the fitting required in your design (add any you might consider). Now, revisit task 3 including minor losses

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

Design Considerations

Incompressible fluid

Isothermal process

Data and Variables

Specific weight of water = 62.4 lb/ft^3

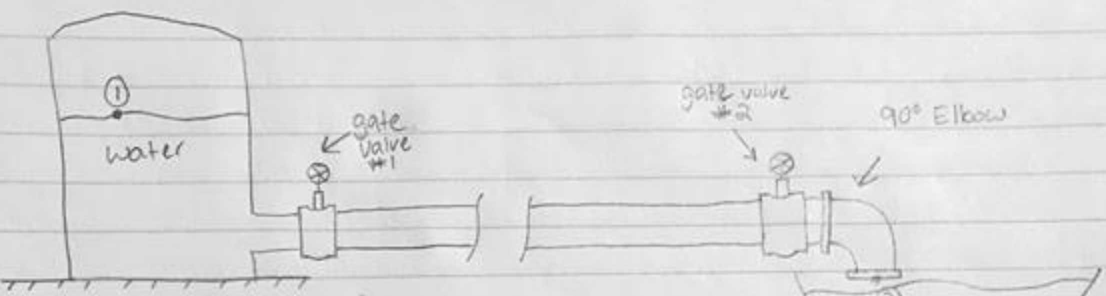
Q = 8.567 ft^3/s

Pipe roughness for steel = 1.5*10^-4

Procedure

Determine the necessary fittings required for the design. Make a list of the fittings. Add the minor losses to task 3 and include the new fittings.

Task 12



List of Fittings required
Two gates valves (Fully open $L_e/D = 8$)
└ in case future repairs are needed in pipe, water flow can be turned off for service.
One 90° elbow – To direct water towards channel water surface.
└ (90° standard elbow $L_e/D = 30$)
Including these addition minor losses to task 3

$$h_{L_{1-2}} = h_{L\,pipe} + 2\,h_{L\,gate\ valve} + h_{L\,elbow}$$
$$= 2.72 + \left[2\left(8 f_T \left(\frac{V_a^2}{2g}\right)\right)\right] + \left[30 f_T \left(\frac{V_a^2}{2g}\right)\right] \qquad \frac{V_a^2}{2g} = \frac{6.98^2}{2 \times 9.81} = 0.756$$

From Excel, f was determined to be 0.013225

$$h_{L_{1-2}} = 2.72 + \left[2(8)(0.013225)(0.756)\right] + \left[30(0.013225)(0.756)\right]$$
$$= 3.18\ ft$$
$$P_1 = \left(\frac{V_a^2}{2g} + h_L - Z_L\right) \times \gamma_{water}$$
$$= (0.756 + 13.62 - 5) \times 62.4 = 585.06\ \text{lb/ft}^2 \text{ or } 4.063\ \text{psig}$$

Calculations

To solve for the friction factors for both the valve and elbow I used excel. I first found Reynolds number (Re= VD/v) and relative roughness (D/e). Diameter and velocity were inputted. A percentage differences calculated the new friction factor.

	A	B	C	D	E	F	G	H	I	J	K
1	Q=	0.243	m3/s								
2											
3	D_A=	3.81E-01	m								
4											
5	e=	4.60E-05	m								
6	L_A=										
7											
8											
9	PIPE	Q (m3/s)	D (m)	L (m)	Le (m)	e (m)	V (m/s)	D/e	Re	f	hL (m)
10	A	0.243	3.81E-01	91.44	3.05E+00	4.60E-05	2.13141	8282.609	2.00E+06	0.013225	0.759445
11											
12											
13											

Summary

The addition of the fittings to the design slightly affected the pressure at the top of the tank. It was found that the pressure increased to 585.06 lb/ft^2.

Materials

Steel pipe

Analysis

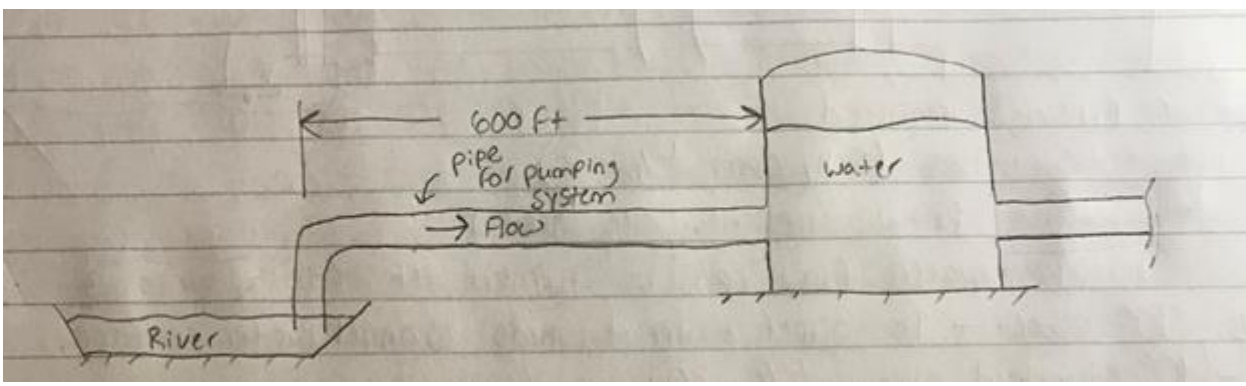
The addition of two gate valves and an elbow added slight friction to the system causing the pressure to barely increase. The reason for the two gate valve is due to serviceability of the pipe in case repair must be made. Water can be shut off at the gate valve closest to the tank. The elbow will assist the in the direction towards the water level in the open channel.

Task 13: Specifications of the pipe for the pumping system

Purpose

Specify material, diameter, schedule of the pipe for the pumping system.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

Design Considerations

Incompressible fluid

Isothermal process

Steady State

Data and Variables

Q = 8.567 ft^3/s

HL = 3.18 ft

Pipe roughness for steel pipe = 1.5*10^-4 ft

Viscosity of water at 80F = 9.15*10^-6 ft^s/s

L = 600 ft

Procedure

The river is 600 ft away from the storage tank and the system must support the losses found in previous tasks. The use of equation 11-8 will be utilized to find the diameter of pipe needed for the design. The temperature of water used was estimated to be 80F. After plugging in the known values 0the equation, the diameter was found.

Calculations

Task 13

Pipe material - Steel

Schedule - 40

$Q = 8.567 \text{ ft}^3/s$

The pump system is 600 ft away from the tank

$h_L = 3.18$ ft system must support losses found from other task

Equation (11-8) from the textbook

$$D = 0.66\left[\epsilon^{1.25}\left(\frac{LQ^2}{gh_L}\right)^{4.75} + vQ^{9.4}\left(\frac{L}{gh_L}\right)^{5.2}\right]^{0.04}$$

$\epsilon = 1.5 \times 10^{-4}$ ft

$v = 9.15 \times 10^{-6} \text{ ft}^2/s$ water at 80°F

$$D = 0.66\left[(1.5\times10^{-4})^{1.25}\left(\frac{(600)(8.567)^2}{(32.2)(3.18)}\right)^{4.75} + (9.15\times10^{-6})(8.567)^{9.4}\left(\frac{600}{(32.2)(3.18)}\right)^{5.2}\right]^{0.04}$$

$$D = 0.66\left[.000016 \cdot 1.9\times10^{17} + 1652559074\right]^{0.04}$$

$D = 1.543$ ft

DN 500 schedule 40 steel pipe has an inner diameter of 1.568 ft which is more than what I have calculated

From my calculations I have determined

Suction and discharge pipe will remain the same

NPS 20 in pipe

Outside diameter - 20.0 in

Inside diameter - 18.814 in

Wall thickness - 0.593 in

Flow area - 1.931 ft^2

Summary

The pipe required for the design came out to be a DN 500 schedule 40 steel pipe. This same diameter will be used for the suction and discharge pipe in the pumping system.

Materials

Steel Pipe

Analysis

The temperature of water used was 80F degrees. This is because the project is located in virginia where we have very hot and humid summers. The pipes will be sufficient enough for that temperature of water. The pipe diameter was calculated from information solved for the other tasks.

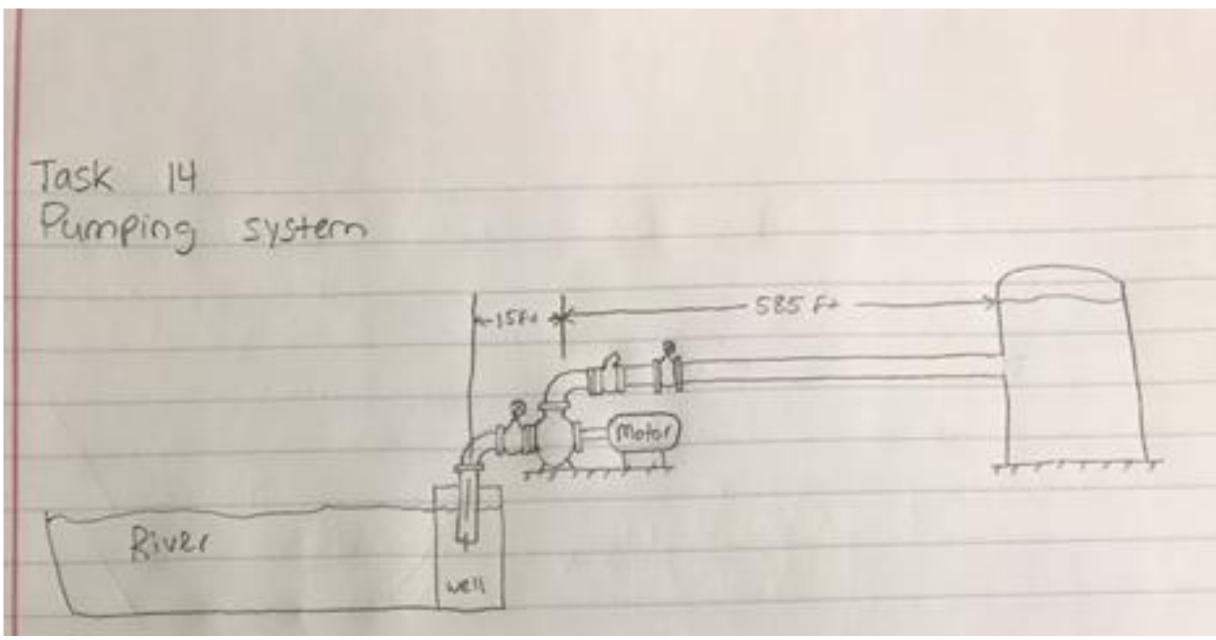
We recognize the pipe size would be smaller if the temperature of the water was only 60 F. Made the accommodations

Task 14: Specifications of all required fittings

Purpose

Specify all fittings you think the system might require.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)
www.sulzer.com

Design Considerations

Incompressible fluid

Isothermal process

Steady State

Data and Variables

Distance from tank to the river is 600ft

Procedure

First to determine the necessary fittings required, the design of the pumping system must be thought out. We know the river is 600 ft away from the storage tank. Assuming the ground from the river to the tank is level. The pump to be used is a sulzer pump with has a horizontal suction and a vertical discharge nozzle. The design must include gate valves in order to service the pump if for some reason it fails and needs to be replaced.

Calculations

List of Fitting required for pumping system

Suction pipe:

- 90° standard elbow $L_e/D = 30$
- Gate value - Fully open $L_e/D = 8$

Discharge Pipe:

- 90° standard elbow $L_e/D = 30$
- Check value - ball type $L_e/D = 150$
- Gate value - Fully open $L_e/D = 8$

After further along in the project it has been noticed that a pressure gage in the suction pipe has been missed. A pressure gage in the suction line near the pump will be useful to monitor the condition of the fluid and to detect the tendency for cavitation to develop.

Summary

The types of fittings we used are a 90 standard elbow and a gate valve in the suction pipe. The discharge pipe has a 90 standard elbow, check valve (ball type), and a gate valve.

Materials

Steel pipe

Steel fittings

Analysis

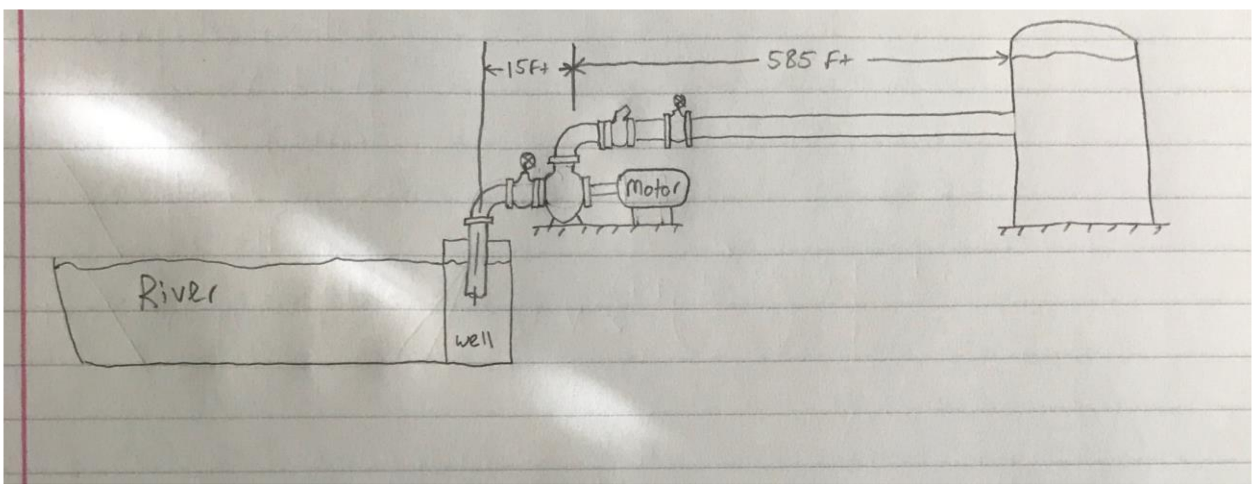
The system must be efficient at transferring water from the river to the tank. Elbows are needed to change the direction of the water and the gate valves are they so that water can be turned off to repair or replace the pump. The design is laid out in a way that assumes the ground is flat without any hills or obstacles between the river and the tank.

Task 15: Developing the hydraulic analysis of allparts in the pumping system

Purpose

Develop the hydraulic analysis of all parts in the pumping system; this includes energy losses due to friction and minor losses.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Design Considerations

Constant properties

Incompressible fluid

Isothermal conditions

Data and Variables
A=1.931ft^2

D=1.5688 ft^3/s

V=4.43 ft/s

v=9.15E-6

Ɛ=1.5^-4

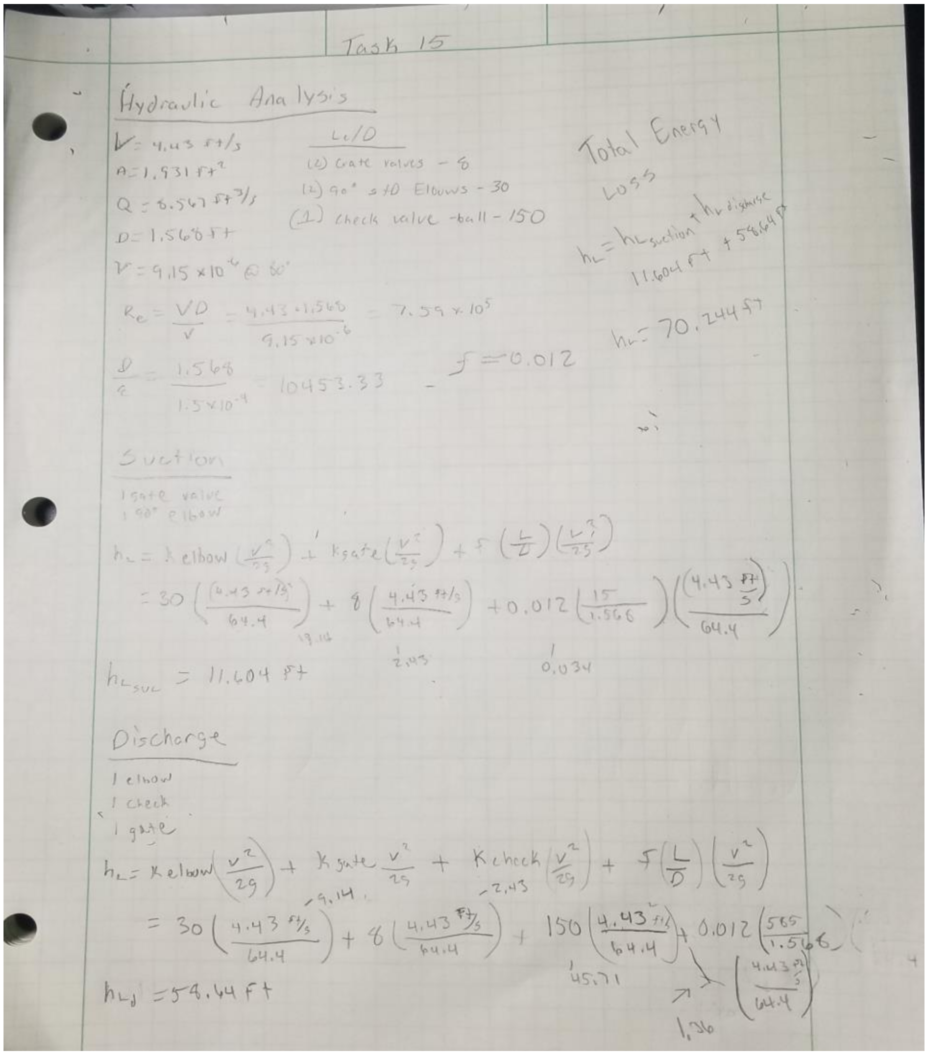
Materials
DN 500 SCH 40 pipe

2 Gate valves

2 90° standard elbows

1 Check valve -ball

Procedure & Calculations:
In order to develop a hydraulic analysis of all the parts in the pumping system, we must consider all of the energy losses from the system which are the losses from the suction pipe and discharge pipe. The system includes two gate valves, two 90 degree valves, and one check valve ball. There is a total of 600 feet of piping in the system, where 15 ft is from the suction line and 585 feet is the discharge line. First, the losses at the suction line of the system were calculated which contained 1 gate valve and 1 90 degree valve. The total losses from this were 11.604 ft. Next, the discharge line was calculated. The discharge line consisted of 1 elbow, 1 check ball type valve, and 1 gate valve. The discharge line came to a total 58.64 ft. The total losses were then combined for about 70.244ft of total losses.



Task 15

Hydraulic Analysis

$V = 4.43\ ft/s$

$A = 1.931\ ft^2$

$Q = 8.567\ ft^3/s$

$D = 1.568\ ft$

$\nu = 9.15 \times 10^{-6}$ @ 80°

Le/D

(2) Gate valves – 8

(2) 90° std Elbows – 30

(1) check valve -ball – 150

Total Energy Loss

$h_L = h_{L\,suction} + h_{L\,discharge}$

11.604 ft + 58.64 ft

$h_L = 70.244\ ft$

$R_e = \frac{VD}{\nu} = \frac{4.43 \cdot 1.568}{9.15 \times 10^{-6}} = 7.59 \times 10^5$

$\frac{D}{\epsilon} = \frac{1.568}{1.5 \times 10^{-4}} = 10453.33$

$f = 0.012$

Suction

1 gate valve

1 90° elbow

$h_L = K_{elbow}\left(\frac{v^2}{2g}\right) + K_{gate}\left(\frac{v^2}{2g}\right) + f\left(\frac{L}{D}\right)\left(\frac{v^2}{2g}\right)$

$= 30\left(\frac{(4.43\ ft/s)^2}{64.4}\right) + 8\left(\frac{4.43\ ft/s}{64.4}\right) + 0.012\left(\frac{15}{1.566}\right)\left(\frac{(4.43\ \frac{ft}{s})}{64.4}\right)$

9.14 2.43 0.034

$h_{L\,suc} = 11.604\ ft$

Discharge

1 elbow

1 check

1 gate

$h_L = K_{elbow}\left(\frac{v^2}{2g}\right) + K_{gate}\frac{v^2}{2g} + K_{check}\left(\frac{v^2}{2g}\right) + f\left(\frac{L}{D}\right)\left(\frac{v^2}{2g}\right)$

9.14 2.43

$= 30\left(\frac{4.43\ ft/s}{64.4}\right) + 8\left(\frac{4.43\ ft/s}{64.4}\right) + 150\left(\frac{4.43^2\ ft/s}{64.4}\right) + 0.012\left(\frac{565}{1.566}\right)\left(\frac{4.43\ \frac{ft}{s}}{64.4}\right)$

45.71 1.36

$h_{Ld} = 58.64\ ft$

Summary

After the discharge line and suction line were calculated, the total losses came out to 70.244 ft.

Analysis

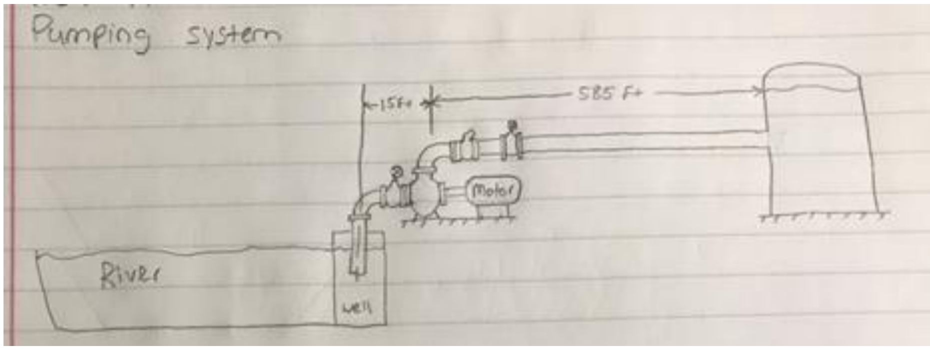
Performing a Hydraulic analysis is important when considering a pump. There are more losses in the discharge line than there are the suction line. This is due to the 2 elbows and check valve in this section of the system. Additionally, the discharge line is where majority of the piping is.

Task 16: Pump requirements

Purpose

Determine the requirements (this is, you have to provide pump head and flow rate) of the pump in the pumping system.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

www.sulzer.com

Design Considerations

Constant properties

Incompressible fluid

Isothermal conditions

Data and Variables

head loss = 70.224 ft

Q = 8.567 ft^3/s

Procedure & Calculations

The pump is required to maintain the flow of water from the river to supply the storage tank. The pump must be supported on a rigid base plate mount located on the group. The pump must also be reliable, serviceable, and effient. The pump head and flow rate is essential in determining the correct pump for the design. The pump must have connections large enough for the 20 inch suction and discharge pipe to connect. The motor will have to be powerful enough to supply the energy needed to move the water. The pump efficiency is also important.

Summary

The pump head and flow rate is used to determine the correct pump for the design. The suction and discharge pipe, liquid to be pumped, type of power sources, and the position limitations were all taken into consideration when selecting the pump.

Materials

Steel Pipe

Sulzer pump

Analysis

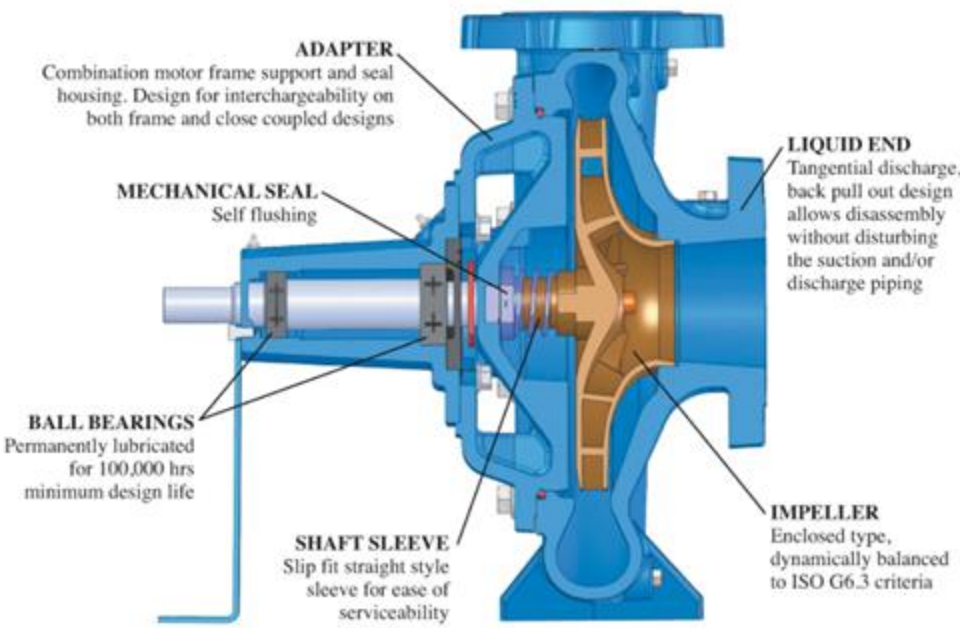
The pump plays a major role for the project to be successful. The proper pump must be selected in order for the water to get transferred to the tank reliably and efficiently.

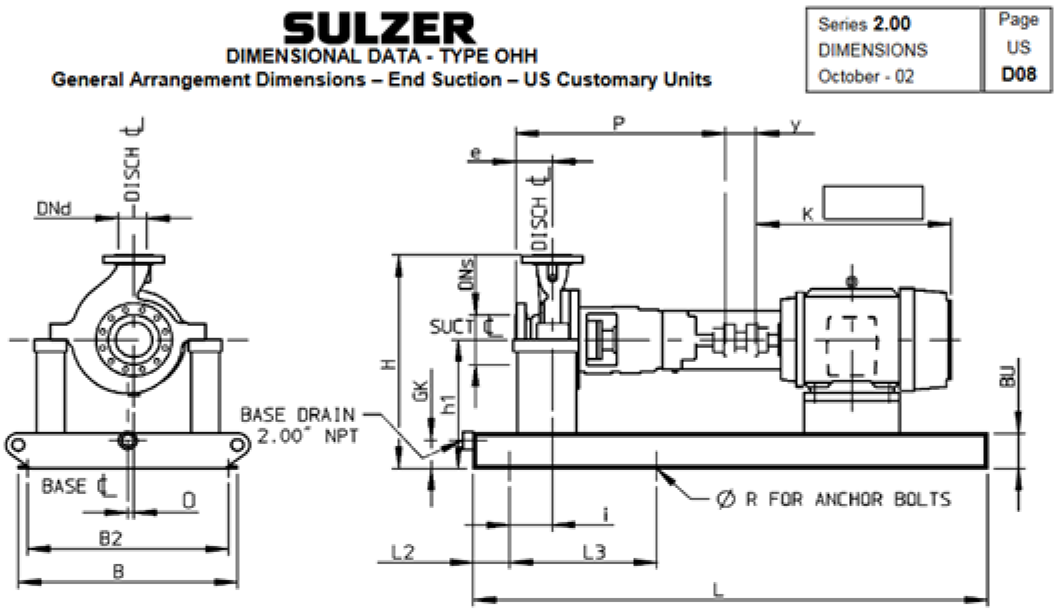
Task 17: Pump selection

Purpose

Specify the type of pump to use. Why did you choose the pump you chose? Argue why you need a kinetic pump (instead of a positive displacement) and prove that the radial pump is the type of kinetic pump you need.

Drawings and Diagrams





Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Sulzer Catalog

Design Considerations

Incompressible fluid

Isothermal process

Steady State

Data and Variables

Pump head = 51.244 ft

Q = 8.567 ft^3/s

Procedure & Calculations

Pumps are typically classified as either positive-displacement or kinetic pumps. In our case the radial flow (centrifugal) style kinetic pump will work best for our design. Kinetic pumps operate by transferring kinetic energy from a rotating impeller to the fluid as it moves into and through the pump. Energy is then converted to pressure energy at the pump outlet. Positive displacement pumps deliver a specific volume of fluid for each revolution of the pump shaft or each cycle of motion of the active pumping element. They often produce very high pressures at moderate volumes flow rates. Since this project does not require high pressure then the kinetic pump will work best. In a centrifugal pump, the pump shaft, bearings, seals, and the housing are critical to efficient, reliable pump operation and long life.

Summary

We went with pump that 12 x 12 x 20 OHH. This was 60 Hz.

Materials

Electric pump

Analysis

The pump selection process for a design project is important. It will determine if you system will work or not. The pump must be selective carefully so that the efficient, reliability, and effectiveness is better than other pumps. There are many different styles of pumps made specifically for certain fluids and situations. Picking the right pump for the application will affect the successfulness of the system.

Task 18: Characteristics of Pump

Purpose

Specify the characteristics of the chosen pump (impeller diameter, inlet, outlet, RPM, etc.) and point of operation. You must calculate the exact impeller diameter that will provide exactly the required flow rate

Drawings and Diagram

Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Sulzer Catalog

Design Considerations

-Constant properties

-Incompressible fluid

-Isothermal conditions

Data and Variables

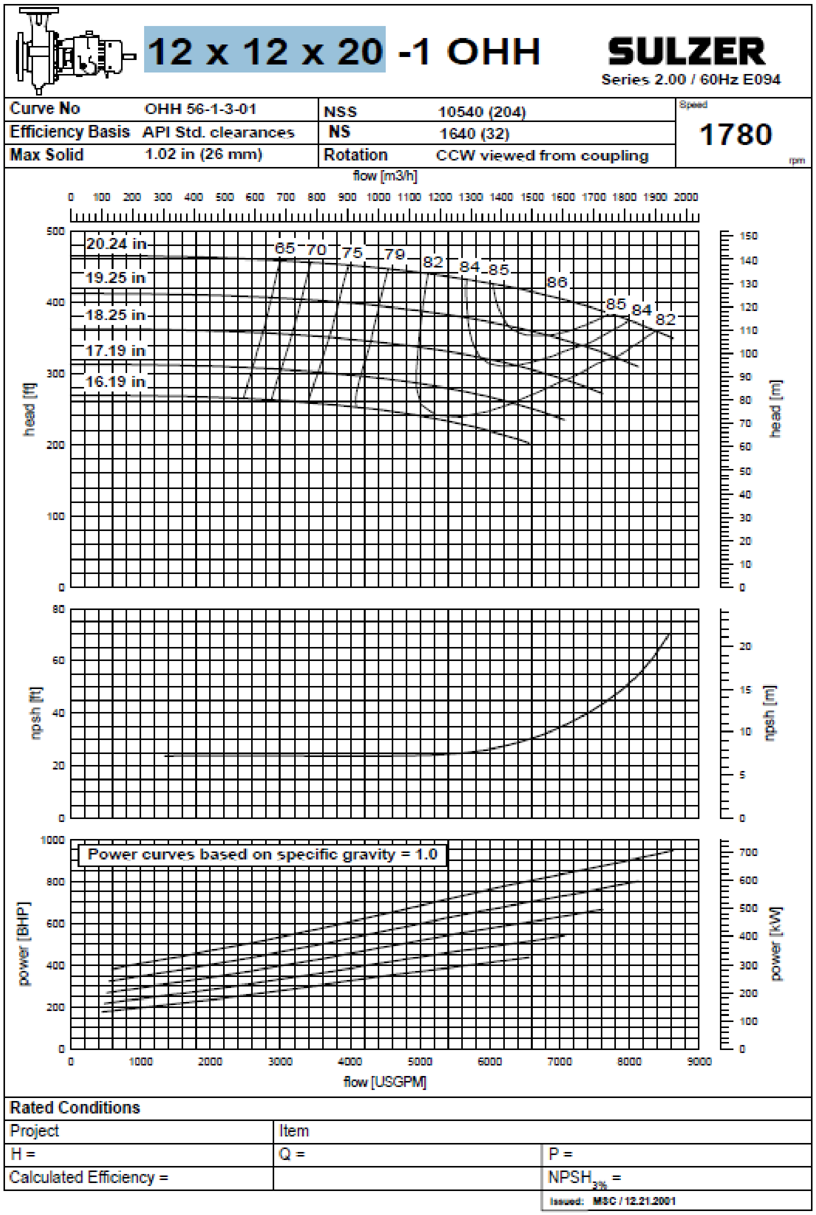
Pump head = 51.244 ft

Q = 8.567 ft^3/s

12 X 12 x 20 OHH

Materials

Procedure & Calculations:



Task 18

12 x 12 x 20 - 1 GHH 1740 rpm 60 Hz

$H_A = 51,224$ ft

$Q = 8,567 \frac{ft^3}{s} \rightarrow 3845,1366$ gpm

Inlet - 12 in

Outlet - 12 in

Impeller Diamter - 20,5 in

Summary

The pump inlet is 12in and the pump outlet is 12 in and the impeller diameter we used is 20.5in

Analysis

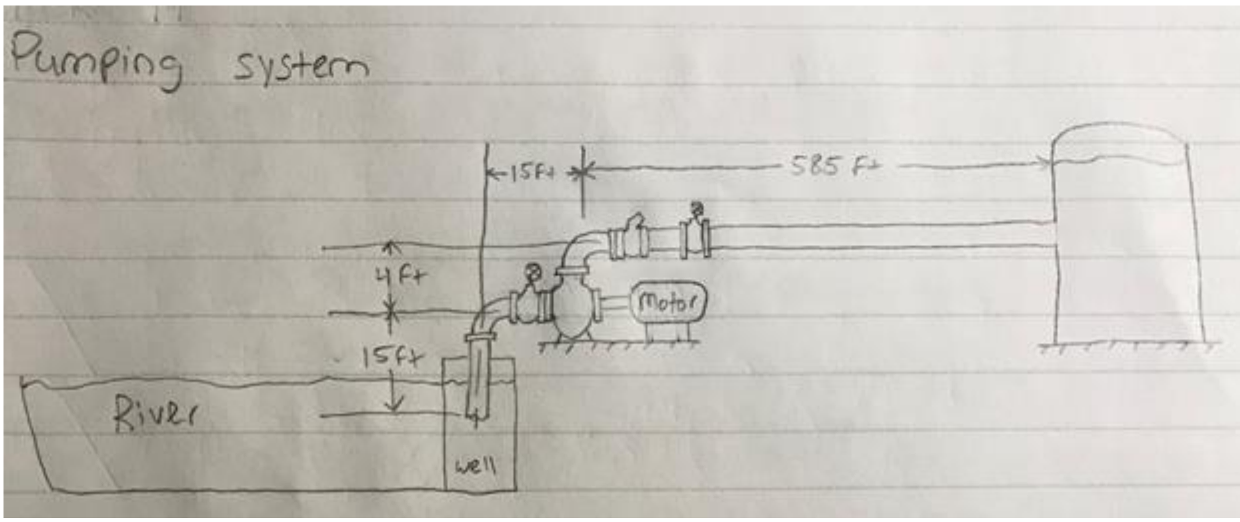
Selecting the right pump is essential in designing a system. Additionally, it is important to use a pump that has the right characteristics to efficiently run a system and to be cost effective.

Task 19: Electrical Motor Requirement for pump

Purpose

Specify electrical motor requirements for our pump for our electrical engineering colleagues.

Drawings and Diagrams



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

Design Considerations

Incompressible fluid

Isothermal process

Steady State

Data and Variables

Q = 8.567 ft^3/s

H L = 70.224

Z1 = 4

Z2 = 15

Procedure

First the pump head must be calculated using Bernoulli's equation. Plug in the head loss into the equation along with z1 and z2 to determine pump head. Power is found using the gamma h equation. The power of the electrical motor is about 1.10 times the power required so that power calculated must be multiplied.

Calculations

Task 19

$Q = 8.567 \ ft^3/s$

Power deliverd by a pump to the Fluid

$P_A = h_a \gamma Q$

h_A is solved from Bernoulli's

$$h_A + \cancel{\frac{p_1}{\gamma}}^{0} + \cancel{\frac{v_1^2}{2g}}^{0} + z_1 = \cancel{\frac{p_2}{\gamma}}^{0} + \cancel{\frac{v_2^2}{2g}}^{0} + z_2 + h_{L_{A-B}}$$

$h_L = 70.224 \ ft$

$$h_A = (z_2 - z_1) + h_L \rightarrow h_A = (-15 - 4) + 70.224 = 51.224 \ ft$$

$$P_A = (51.224 \ ft)(62.2 \ lb/ft^3)(8.567 \ ft^3/s)\left(\frac{1 \ hp}{550 \ lb \cdot ft/s}\right)$$

$P_A = 49.628 \ hp$

The power of the electrical motor is about 1.10 times the power required

$P = (49.628 \ hp)(1.10) = 54.59 \ hp$

Summary

The Hp required before the electrical motor estimate is 49.628 hp. After the estimated, the hp required is 54.59 hp.

Materials

Steel

Electric pump motor

Analysis

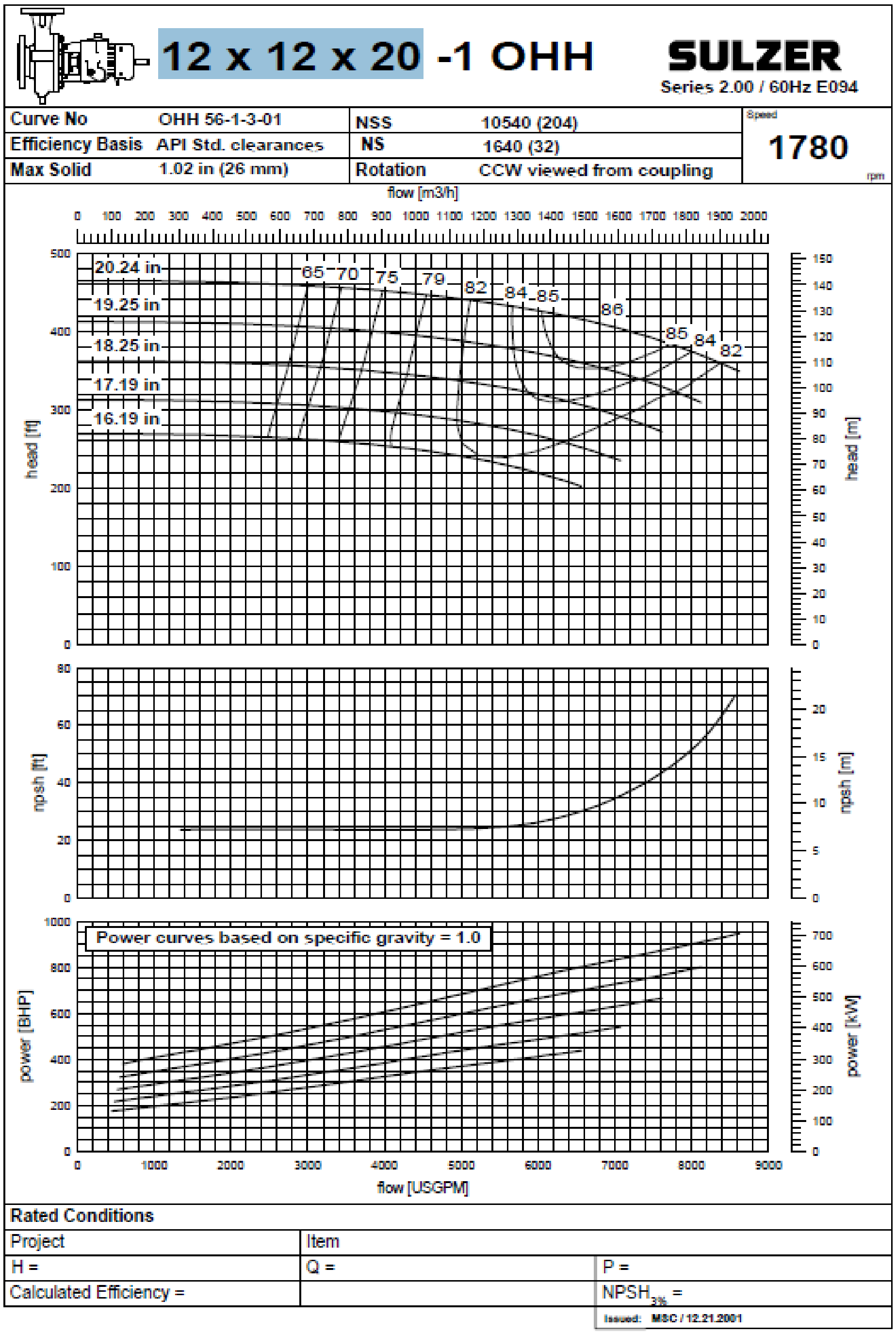
The estimated power required by the pump is necessary for the design team. It provides proof that the system will be efficient. The information calculated will be transfer to other engineering teams to gather the right motor for the design.

Task 20: Pump weight and overall dimensions

Purpose

Indicate the pump weight and overall dimensions (with tentative electrical motor).

Drawings and Diagrams



Sources

Sulzer Pump Catalog

https://www.sulzer.com/en/products/pumps/pumps-by-type

Design Considerations

None

Data and Variables

Materials

-Sulzer Pump

Procedure & Calculations:

Summary

The pump is 12 x 12 x 20. Weight is about 2000 lbs

Analysis

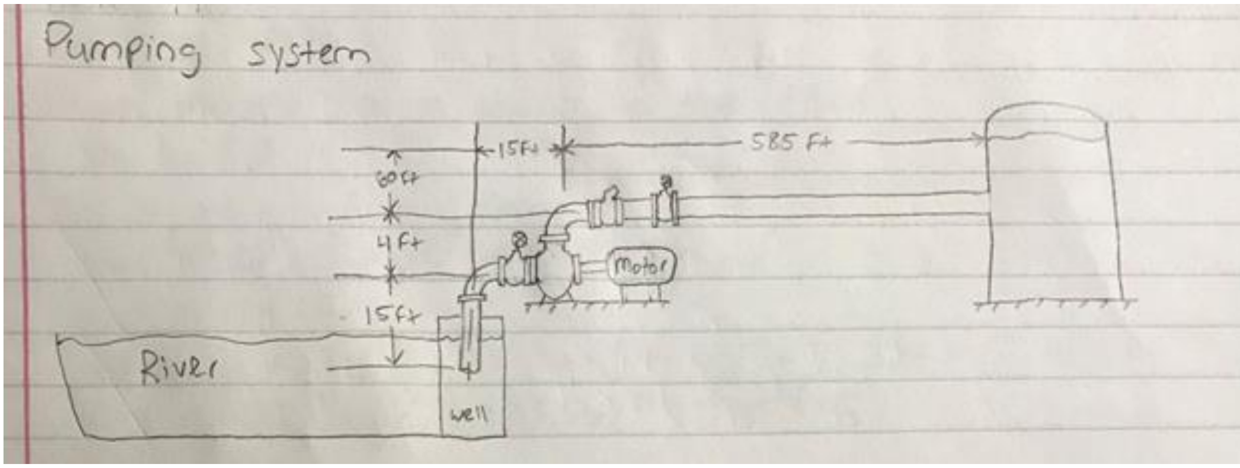
The group can select the type of pump we can use Sulzer pump catalog. We chose this pump because thought it would be sufficient for our system to have a pump of this size. The pumps are there to help the system flow better

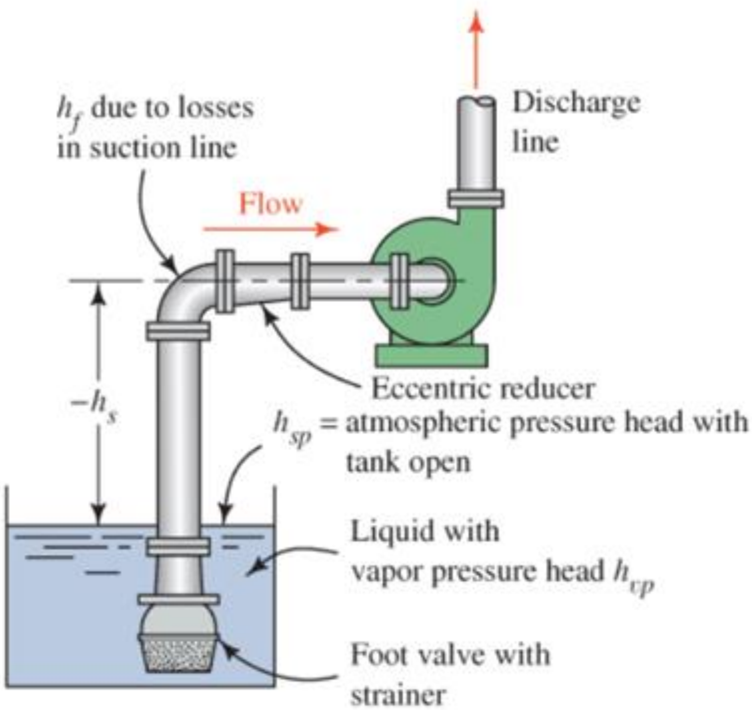
Task 21: Available NPSH

Purpose

Evaluate the NPSH available for the design

Drawings and Diagrams





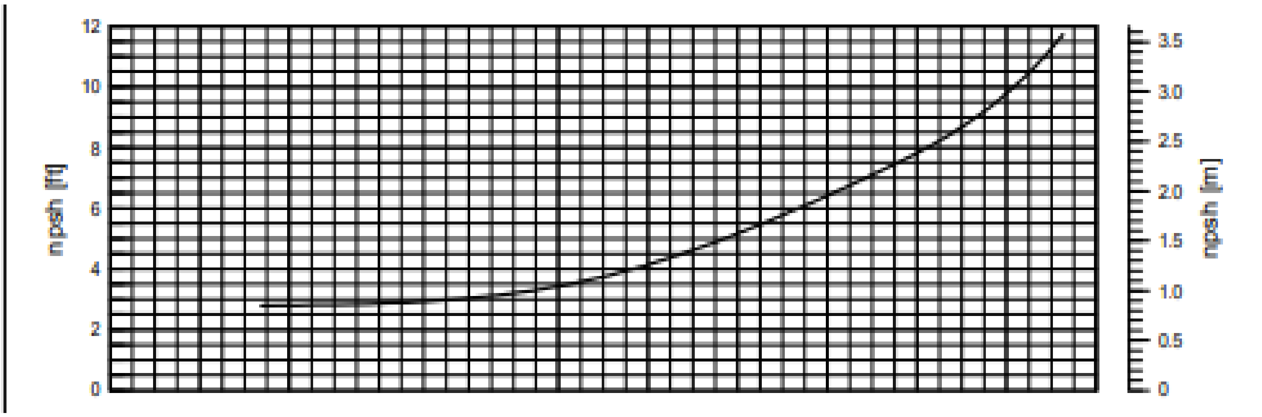
Based on the equation of Net Positive suction Head (NPSH) suggest four ways to decrease the cavitation performance of a centrifugal pump.

$$NPSH = V_{eye}^2 \frac{1}{2g} + \frac{P_{eye} - P_v}{\rho g};$$

where, V_{eye}- average velocity at the eye of the pump;

P_{eye}- static pressure at the eye of the pump;

P_v- vapor pressure;



Sources

Mott, R, Untener, J.A., "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

Sulzer Pump Catalog

https://www.engineeringtoolbox.com/cavitation-d_407.html

Design Considerations

Incompressible fluid

Isothermal process

Steady State

Data and Variables

Tank gage pressure = 584.64 lb/ft^2

Atmospheric pressure = 2116.22 lb/ft^2

H L = 70.224

Procedure

The NPSH can be found by adding up the static pressure head, elevation difference, head losses, and vapor pressure head. Head loss and elevation difference are known. Static pressure head can be calculated by adding the atmospheric pressure and tank gage pressure. The vapor pressure head can be found in table 13.2 in the book.

Calculations

Task 21

NPSH

$h_{sp} = P_{abs}/\gamma \rightarrow P_{abs} = atm + \text{Tank gage pressure}$

$P_{abs} = 2116.22\ lb/ft^2 - 584.64\ lb/ft^2$

$= 1531.58\ lb/ft^2$

$h_{sp} = 1531.58\ lb/ft^2 / 62.2\ lb/ft^3 = 24.62\ ft$

$h_s = 60\ ft$

$h_L = 70.224\ ft$

$h_{vp} = 3.25\ ft$ @ $80°F$

$NPSH_A = h_{sp} + h_s - h_L - h_{vp}$

$= 24.62 ft + 60 ft - 70.224 ft + 3.25 ft$

$= 11.146 ft$

$NPSH_A > 1.10\ NPSH_R$

$NPSH_R < NPSH_A / 1.10$

$NPSH_R = 11.146\ ft / 1.10 = 10.13\ ft$

The results indicate that any pump that requires 5.89 m or less for NPSH is acceptable.

The installation of the pump must be so that the suction pipe is face the river. The pump must be supported on a base plate which is then bolts to a concrete slab.

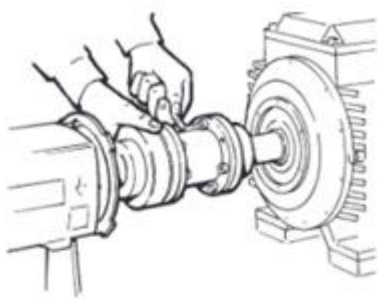


Fig. 1
Removal of coupling spacer to provide withdrawal gap.

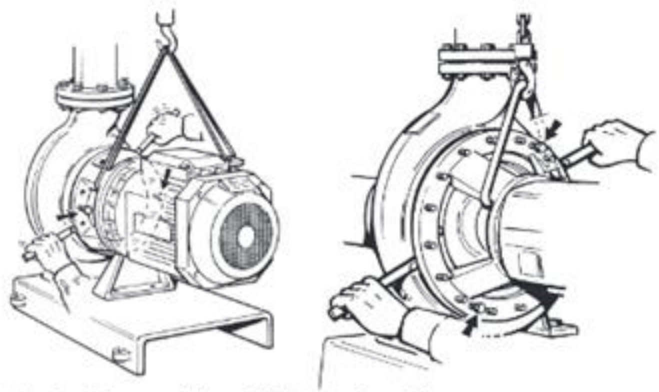


Fig. 2a Close-coupled and 2b Bearing Assembly
To remove the rotor unit, insert jacking screws in the tapped holes as the arrows show or use levers. For Close-coupled version lift the rotor unit as in 2a. For Bearing Assemblies use a sling according to 2b.

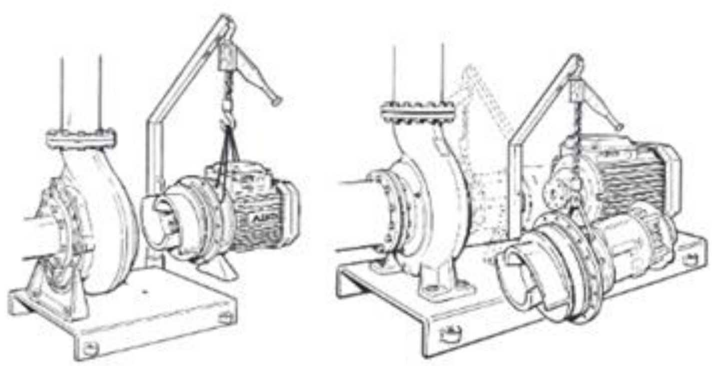


Fig. 3a Close-coupled and 3b Bearing Assembly
By using an ABS lifting arm one man can lift out the rotor from the casing.

The suction line pay a major role in the system and must be designed to ensure an adequate net positive suction head. The system in which we design uses the suction lift method because the pump must draw liquid from below. The centrifugal pump must be artificially primed by filling the suction line with fluid. Since the suction is located inside of a well built alongside the river, it must be filtered to avoid the suction of unwanted particles. To do this, a strainer should be installed at the inlet on the suction pipe. The pipe alignment should avoid the formation of air bubbles in the system. Air bubbles or air pockets could cause the pump to lose suction.

Summary

The results indicate that any pump that requires 10.13 ft or less for NPSH is acceptable.

Materials

None

Analysis

Net Positive Suction Head is margin of pressure over vapor pressure at the pump suction nozzle. It’s the difference between the suction pressure and vapor pressure. the equations used to describe what can be acceptable to use in our system.

Task 22: Bill of material

Purpose

This is for everything that has been included in this project. Materials are listed in this section such as the pumps

Sources

Mott, R, Untener, J.A., “Applied Fluid Mechanics,” 7th edition, Pearson Education Inc (2015)

Sulzer Pump Catalog

Materials

- Stainless Steel Tank
- Rest Supports
- Flowmeter
- 12x12x20 Sulzer Pump
- Electromagnetic flowmeter (WMx101)

Task 23: Description of system/Final Remarks

Purpose

Summarize the system presented in the report

Summary

This system can provide the four logs needed to travel across from the facility to the river. We made adjustments to the system that were necessary that accommodated for cost, efficiency, and longevity. We made sure the system had the necessary material in order to combat wear and tear over time. The material we used was steel, as it can last in water without deteriorating. We made sure the system can steadily supply water in case of a power outage. We used a cost efficient pump that will help the fluid flow.

Appendix

Reflection

This report has taught us a process of creating a system in Fluid mechanics class.

Reflection for Engineers

Zach Hollifield - Reflection

- What I have learned is very important to my professional career. As engineers, we must learn to design and work around challenges and this class has made me as a student think critically.
- When designing everyday systems, fluids always have a role within the system. I will be using the information from this class whether it is designing future projects or providing other engineers with the proper information.
- In a job interview, I would say that my determination in finding the solution and completing the assignments to the best of my abilities helped me contribute to the project. Most of the problems in class were real world situations which made solving them a process of thinking critically and applying knowledge learned from lecture.
- My strengths for the project was that I was always available to help my teammates. I also tried my best to look over their work and give feedback when needed. I kept the material for the project organized. Whether it was my task or homework, my handwriting was always neat and my drawing work detailed and label which was beneficial to my teammates in case the needed data or information from my work and it was easy for them to read my work.
- My weaknesses for the project included lack of time management and preparedness. I addressed my weakness by setting aside time to work on class assignments and always giving myself extra time to comprehend the material. My classmates help me address quick questions regarding problems I had before and after the lecture.
- The technical strengths in the project included determination, motivation, and communications. My teammates and I were always available to discuss problems and work together to ensure that we would all complete the course. The course focused around teamwork and relying on teammates to complete the given task. We communicated well from the start of the semester to the end. Weaknesses in the project were uncertainty in some of the task whether they were right or wrong. My teammates and I worked collectively on agreeing on what we thought was the correct way when solving task.
- If I was to start the class over again, the advice I would suggest myself would be to stay on top of assignments, lectures, and course material. Study the material until you are comfortable with and if not then do not be afraid to ask questions to the professor. The test are overwhelming at first glance but it is important to pull the problems apart and think about them. Do not try and find example problems and waste your time. You will find that the solutions. Pay attention during lecture. Information the professor teaches

will be on the test and you will benefit on the test and projects you can apply the lecture material to the assignments.

Aaron Jackson- Reflection

- **I believe what I have learned in this class is definitely important for my career. This class has taught us the value of staying on your toes and being able to overcome obstacles.**
- **Everything learned in this class can be used anywhere in life. The class taught more than just about fluids. This class has fine tuned essential life skills such as critical thinking, overcoming adversity, and time management. This class will certainly help projects later on in life. Not only that, it will help in the industry and being able to problem solve.**
- **I would explain how my attention to detail, persistent and organization skills has contributed to the project. Additionally, I would explain how easy I am to work with**
- **I would say my weaknesses were time management. I addressed this by making time when I needed to and getting other assignments and extra-curricular activities done early to allow myself more time.**
- **The technical strengths were communication and persistence. My partners were readily available most of the time to answer questions and answered in a very timely manner. As far as weaknesses, there was confusion on how to do some of the assignments. Also, there was some confusion on how to organize the project.**
- **If I were to start the class over, I would emphasize to myself to manage my time better from the start instead of later. I would also urge myself to get more help from the professor as he was always readily available. Additionally, I would use the resources the professor provided to us to a greater extent. The same ideas apply if I were to start the project over. I would take care as much as I can as early as possible for the project.**

Nathanael Yapnayon - Reflection

- **This project genuinely helped me understand what I am getting into with career as an engineer. This class is a lot more realistic in terms of how we work in the field of engineering. I am only a minoring in mechanical engineering. I can appreciate how much technical effort into the pipes and pumps. Fluids can provide more technical difficulties depending on what system is being made. Trying to figure small those small details by calculations is interesting. These were real world situations that were a lot more practical**
- **I had better insight on what the industry has to offer. My idea of this type of engineering made me realize how competitive the industry can be. There's a good cause going on with different organizations. The ideas present over the semester made me think about what I should be doing with my major in the future.**
- **I do think this class was difficult but was worth going through it. I learned how to adapt to my situations and try my best to provide any type of content that was needed for this class.**

- **Communication and confidence is definitely a weakness for me. I should have done more to communicate better of what we needed to do. I have a hard time organizing myself when other things are affecting my life. I have sympathy for my teammates because both are just trying to balance their other classes while focusing on other things in their lives.**
- **Communication is something that I do struggle with when comes to team assignments. I am always open to criticism. I'm open to talk about things rather than just demanding others or force people what to do. I don't give up too easily. Even though am at the end of the road, I do give my best even if it's not enough.**
- **If I were to retake this class, I would try to do better organizing my priorities. This project would have been approached differently. I am open to push myself to ask more questions in class. Do not worry. Just do your best.**