Test 2 Reflection

This test demonstrated my work toward 3 of the course objectives. “Apply the principles of conservation of energy (Bernoulli’s equation) and mass to fluid flow systems.” My work on both problems demonstrated this. Both problems required that I apply Bernoulli’s equation one or more times to solve for the unknowns in the problem. Since question one was a parallel system, it required that I apply Bernoulli's equation twice, once for each branch of the system, to solve for the total flow exiting the system of gutters. I needed to apply it again in order to find the pressure at the exit of the tee. Although problem 2 was a series system, I still needed to apply Bernoulli’s equation twice because I had 2 unknowns, the flow rate required for the water exiting the fountain to reach the one-meter specified height and to solve for the pump head which I used to calculate the power delivered to the system. “Compute friction losses in pipes for a variety of configurations (series, parallel, network, etc.).” The 2 problems on this test required that calculate the friction losses in the pipe and a variety of fittings such as elbows, tees, and valves.

On problem 2, I made a mistake that severely impacted the pump head I calculated. When finding the losses in the annulus, I substituted in flow rate divided by area for the velocity into the equation for losses in a pipe, f*(L/D)*(V^2/2g), as we always have. This made the equation that I used for the losses in the annulus equal to f*(L/D)*(8*Q^2/π^2*D^4*g. In the part of the equation for length divided by diameter, I used the correct diameter which was obtained from the hydraulic radius. That part was correct. However, since I substituted in flow rate divided by area, the diameter that I used to find the area was incorrect. Since the annulus isn’t just a circular pipe, but a circle inside a circle, the diameter calculated from the hydraulic radius will not yield the same area as the actual cross-sectional area of the pipe. The area of the annulus was 0.004 meters^2 and the diameter of the annulus found through hydraulic radius is 0.03 meters. If you calculate the area using diameter from hydraulic radius like I did, the area you would get is 7.06x10^-4 which is smaller than the area of the annulus. This resulted in the velocity calculated in the equation to be 25.04 m/s, which is a massive difference from the 4.43 m/s velocity that I had calculated that was the velocity needed for the water exiting the annulus for the water to reach the 1-meter specified height. There are 2 ways that I should have handled this, the simplest way would have been to calculate the losses in the annulus by simply using the velocity instead of substituting in flow rate over area, but as I said before we have been taught to use flow rates and this is one special case that I made a mistake on and overlooked. The other way I could have avoided this was still use the flow rate, but not break down the area into π/4*D^2. That would have given me Q^2/A^2 instead, which would have allowed me to use the flow rate I had calculated but also using the correct area of the annulus. The advice I would give myself would be to practice problems solving for losses with non-circular pipes. I hadn't done any before this test which is most likely why I made this mistake.

PROBLEM 1)

Correct application of 2 Bernoulli's + Conservation of mass?	3/12
Were all minor losses handled?	2/12
Have the equations worked out with numbers?	1/12
Was there an iterative procedure to solve system of eqs?	3/12
Was the velocity criterion checked?	1/12
Are the results correct?	2/12
TOTAL	12/12

PROBLEM 2)

Used Bernoulli's to determine velocity to then compute Q?	2/12
Was the pipe sized using velocity criterion?	2/12
Was the pump head computed from Bernoulli's eq?	1/12
Were ALL energy losses included?	3/12
Was the annulus energy loss handled with hydraulic diam?	1/12
Was the pump power computed?	1/12
Are the results correct?	0/12
TOTAL	10/12

FINAL GRADE:

(90/2)*(12/12 + 10/12) = 82.5

I believe that one of my strengths was my ability to use Bernoulli's equation for different configurations. I felt strongly about my ability to apply the equation several times to both problems. On number one, I showed my ability to use Bernoulli's equation on a parallel system to solve for flow rate. On number two, I was confident in using Bernoulli's equation to find the velocity of the water needed to reach the required height. I felt strongly in my ability to apply the equation again to solve for the pump head. I also think that I have a strength in calculating losses in pipe and many different fittings. However, it is quite obvious that I have a weakness in calculating the loss in a pipe that in not circular. This is an area that I should practice more.

However, I believe that I have learned a valuable lesson from this mistake and will be much more careful when handling situations like this in the future.

Whenever I encountered something that I was unsure of such as the temperature of the water or what type of elbows to use, I always ask questions. One issue that I ran into on number two was calculating the loss in the annulus. I had not calculated the area, wetted perimeter, diameter, or losses in a non-circular pipe before this test. The way I troubleshooted this was to go to the textbook to find how to do it. This worked well for everything but finding the loss in the pipe.

I work on each question one at a time. I don't worry about what the next question is so that I can focus on the question I am solving. The process for each question goes like this: First, I read the entire question to get an idea of what the question is asking me to do. I also look at the supplied drawing to get a better idea. Next, I write down what the purpose of the problem is so that I know what I need to find and create my own drawing with labels. I also write the design considerations. Next, I write down the data supplied from the question and drawing and go to the textbook to get any variables I need such as pipe roughness, internal diameter of pipe, specific weight, and kinematic viscosity. I analyzed the problem to determine all sources of loss in the system, major and minor. Next, I proceed with the procedure and calculations where I use Bernoulli's equation, eliminate everything I know from the points of interest, and add the losses. After this, I find things like the friction factor, flow rate, and velocities. With all the data and variables I needed, I could solve the problem. After I solve it, I go back and check my procedure and calculations a couple of times. Then, I write the summary of what I have found, the materials, and write an analysis of what I have found. I go back and read the question once more to ensure that I have solved everything the question asked for. I repeat this process for the second question.

I have learned how to apply Bernoulli's equation to many different system configurations like series, parallel, and branching systems. I have learned how to use Bernoulli's equation to allow me to calculate many different things like flow rate, pipe diameter, pressure or pressure difference, velocity, and pump head. I have learned how fluids act in pipes and fittings. I have learned how to calculate Reynolds's number, relative roughness, and friction factor. I also learned how to find the friction factor using the Moody chart. Using the friction factor, I learned how to find the losses in pipe and fittings. I learned how to find pump power using pump head and finding the required electrical power for a pump with a certain efficiency.

An engineer would use these concepts if they were designing a piping system for many different fluids. An example that comes to my mind which I know of firsthand is the piping for ethylene glycol. At the metal finisher work for, we have a chiller that cools the glycol and returns it to a storage tank. From here the glycol is pumped from the storage tank to the heat exchanger where it removes heat from the sulfuric acid used I the anodizing process. If an engineer were designing a new system, they would use Bernoulli's equation to find the losses in the system, determine pipe diameter, and pump head. They would also use Bernoulli's equation for the side circulating the acid between the process tank and heat exchanger. An engineer would need to look at the heat that needs to be removed from the tank and determine the flow rate required to design the rest of the system.

I definitely believe that what I have learned will help me in my future. If I were tasked with the job of designing a pipe system for a fluid such water, oil or glycol and were provided a required flow rate or other criteria, I would need Bernoulli's equation to design the system. This is good because I would be interested in doing something like this. I would be a large task, but I think it would be an interesting thing to do. Piping systems are used in nearly every industry which shows its importance for me to be able to understand how to design one. For example, if I were asked to design a piping system for water to supply a process and select a pump, I would need to look at the required flow rate and choose a diameter, calculate losses, pump head, and selecta pump large enough to provide proper amount of flow. I have not been able to apply these concepts in my other classes or work, but again, I could foresee myself needing it.

As I stated previously, I believe that I have improved the most in being able to use Bernoulli's equation on many different system configurations.

I worked on the test over the course of 3 days, but total work time was approximately 18-20 hours. This is mostly due to the fact that I was trying to take my time and not make mistakes. I tried to start early enough that I wouldn't run out of time.