Test 2 Reflection
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MET 330 Fluid Mechanics
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Learning Objectives

The Unit 2 Test focused on 3 learning objectives:

- Explain the fluid dynamics in pipes and fittings
- Apply the principles of conservation of energy (Bernoulli's equation) and mass to fluid flow systems
- Compute the friction losses in pipes for a variety of configurations (series, parallel, network, etc.)

Both problems on the test covered all three learning objectives. Knowledge about flow and friction in a series of pipes was necessary to solve the problems using Bernoulli's equation.

Grading

Problem 1:

For this problem utilizing the supplied grading rubric, I would grade it as an 8/12. Two Bernoulli's equations were used, one for each branch of the system, the minor losses were included in those equations and applied with the correct K values, all the equations were worked out and simplified into numerical values, and the velocity criterion was checked, accounting for 7 of the 12 points. I failed to use an iterative process to determine my velocity values, and therefore my answer was also off by about 5%. Due to it being a small error, I only subtracted one of the 2 points for that section, and there is no pressure at the exit of the tee supplied in the test answer document, so I am unsure about the accuracy of that answer. Checking my answer of 32.72 kPa with a quickly calculated answer using the supplied velocities in the test answer gives an error of about 10%.

The mistake I made was treating the top of the gutter system as a parallel system and using equivalent head loss to simplify the system. By doing so, I was artificially able to create an extra equivalency alongside the conservation of mass equation, and it allowed me to solve the system of equations without an iterative process, which was incorrect. Though the answers I found are a reasonable approximation, they are not fully accurate and would almost certainly have larger errors in more complex systems if applied in the same way.

If I were to attempt this problem again, I would be more concerned that the iterative process was not used, especially as it was not needed in the second problem either. It was a big focus of the unit and not using it on the test should have raised some more questions for me. Because this problem gave a way to determine the friction factor and because the pipes all had the same dimensions, I thought finding a way to a solution without an iterative process made sense as there were less variables than many of the examples given in the lectures had, which often did not supply the pipe diameter or the friction factor. I had a very difficult time finding examples in the book or the lecture that exhibited similar behavior to this system. Once I applied the parallel technique, I ran with it.

Problem 2:

This problem also receives an 8/12 based on the rubric. The pipes I chose were based on the velocity I calculated using the diagrams available in the lectures and the book, the pump head was calculated using Bernoulli's equation, the energy losses were all accounted for, and the annulus was solved using the length equivalent found with the hydraulic radius, and the pump power was computed. Those points added up to 8 of the 12 points. I did not use Bernoulli's equation to determine the velocity of the water at the exit of the annulus, and therefore, my results are not correct. Another apparent error I made was using different diameters for my suction and discharge lines from the pump. Adding that feature created a much more complicated Bernoulli's equation when attempting to solve for pump head, and the added features appear to have created a much larger pump head requirement for the system. I also incorrectly applied Bernoulli's to the pump head, calculating for the power necessary to propel the water the entire 2.8m from the level of the pump to the top of the water height.

For the first error, I applied the kinetic energy equation to the water. When I first laid out Bernoulli's equation for this system, I did not cancel out the friction losses, and therefore could not isolate the pump head and the heights the way the answer sheet does. The error I made was selecting points that did not allow me to utilize Bernoulli's effectively. I chose A as the top of the water in the tank, and therefore my application of Bernoulli's needed to take the energy losses into account. To establish a velocity for the system, I used the kinetic and potential energy relationship as it supplied a necessary velocity to lift water to a specific height. Using that equation gave a value nearly twice that found with the Bernoulli's equation on the answer sheet, and this created issues for determining the rest of the values in the system making for a pump power nearly ten times that given in the test answer. This was exacerbated when using two different pipe diameters for the suction and discharge lines. Because the chart supplied gave two sizes and the book specifies that the suction line should be larger than the discharge line, I applied this principle to this problem. That meant that the system had a different velocity before and after the pump, which meant different friction factors, and this created a much longer and more complicated process when solving for the pump power.

In attempting this problem again, I would have asked the professor for some clarification on how to start. I used methods for selecting points that coincided with methods we had used on the examples and in the lectures, not realizing the best way to approach this problem was to neglect the system entirely and focus only on the annulus exit. This overcomplicated my approach greatly and lead to gigantic errors in my answers. For the pipe selection, I am not sure how I would have approached that differently. The book and the supplied graphs both specify that suction and discharge pipes should have different diameters, and the fluid mechanics lab using a centrifugal pump is also setup in that way. Even though it made the process more complicated, had I been using the correct velocity the pump power would have been closer to the answer provided.

Based on the scores above, my final grade for this test would be 60/90. I had major errors for both problems that stemmed from taking an incorrect approach to the problems. I went through all the chapter examples when working on both problems and had a tough time finding examples that were close enough to apply to these situations. The parallel system I applied to Problem 1 was imperfect and was based on similar problems in the book, but they did not include multiple sources of flow the way that problem did. Communication with my professor after the fact helped me find an example that used a similar principle during a portion of a problem assigned for homework. For Problem 2, not realizing Bernoulli's could be simply applied to the annulus exit and the top of the water travel created a more complicated situation than was necessary. and I used methods I had used in other classes to try and find an initial velocity for the system. Because of that error and using two differently sized pipes, my answer for this problem was wrong by a large margin.

Discussion

The main issues I had with this test revolved around not understanding how to apply the tools I had learned in this unit to these specific situations. Though we had covered many examples, and the book provided even more guided solutions, the specifics of these problems confused me, and my overall understanding of the material was not good enough to apply them in a new way.

I began this test the day after it was assigned and laid out both problems before starting any of the actual calculations. I thought approaching it in this manner would save some time by allowing me to deal with the engineering problems involved separately from the math necessary to solve the problems. In doing so I overcomplicated them. The separate pipe diameter issue I had on the second problem could be attributed to over analyzing the problem while trying to set up the procedure for the solution.

Conceptually, all the friction factors and the various uses of the Bernoulli's equation are new engineering tools I have acquired during this unit, though the application of those tools clearly leaves something to be desired. They have myriad real world uses, and both problems on the test illustrate simple everyday systems that must be engineered using these concepts. Any plumbing system would require knowledge of friction losses and the use of Bernoulli's equation to find the parameters of the desired system. Whether designing fountain systems or hydraulic or pneumatic assemblies, the ability to determine a system's necessary parameters accurately is important for designing any system that relies on fluid to function.

After this unit, I have a better understanding of how flexible Bernoulli's equation is, and how complicated a system can be even after eliminating many factors from it. It is also clear that it has more value than I gave it credit for on this test, as it was able to greatly simplify both problems by being applied correctly and creatively.

I spent about 7 hours on this test, approximately 5 in my initial run through and another 2 in editing and adjusting calculations. I completed it on Friday and checked my work on Sunday when I found some basic calculation errors in Problem 2. Had I not fixed those issues, not only would my answers have been wrong, but my basic calculations would have been flawed as well. I also spent extra time calculating the impact of two different pipe sizes, a step that was not necessary.