Homework 10

Ch En 374 – Fluid Mechanics

Due date: Tuesday, 26 Nov. 2019

To ensure you get full credit, don't forget to explicitly cite your source for any loss coefficients that you use (e.g. Deen or the handout from Cengel and Cimbala) where relevant.

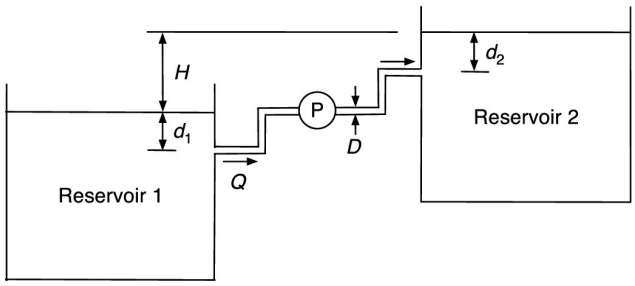
Survey Question

Please report how long it took you to complete this assignment (in hours) in the "Notes" section when you turn your assignment in on Learning Suite.

Practice Problems

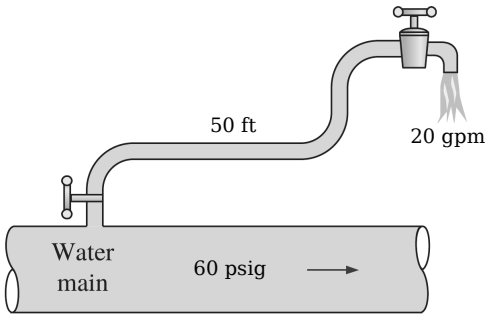
1. [Lecture 29 – Major and Minor Losses]. Water is to be withdrawn from a 3-m-high water reservoir by drilling a 1.5-cm-diameter hole at the bottom surface. Assuming plug flow, determine the flow rate of water through the hole if the entrance of the hole is sharp-edged.

2. [Lecture 30 – Single Pipelines]. Suppose that water is to be pumped upward at a volumetric flow rate Q from one reservoir to another, as in the figure below. The difference in the water levels is nearly constant at H. The connection is a steel pipe of diameter D and total length L that has four 90° bends. The depths at its inlet and outlet are d_1 and d_2, respectively. Find the pump power (in kW) that would be required if $Q = 0.13\,\mathrm{m}^3/s$, $H = 10\,\mathrm{m}$, $D = 0.40\,\mathrm{m}$, $L = 1000\,\mathrm{m}$, $d_1 = 5\,\mathrm{m}$, $d_2 = 4\,\mathrm{m}$.

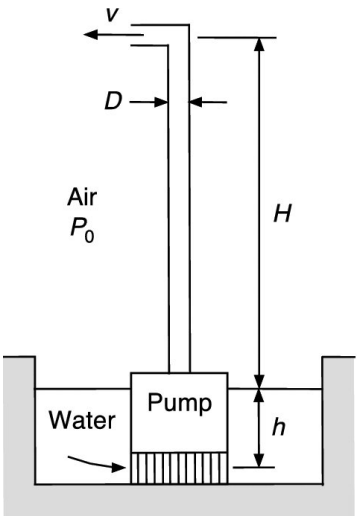


Challenge Problems

3. A water fountain is to be installed at a remote location by attaching a cast iron pipe directly to a water main through which water is flowing at 60 psig. The entrance to the pipe is sharp-edged, and the 50-ft-long piping system involves three 90° miter bends without vanes, a fully open gate valve, and an angle valve with a loss coefficient of 5 when fully open. If the system is to provide water at a rate of 20 gal/min and the elevation difference between the pipe and the fountain is negligible, determine the minimum diameter of the piping system.



4. Suppose that you start an internship at a local water district this summer, and they have a broken pipe leaking into a well at a rate of about 5 gallons per minute. For a variety of business and technical reasons, they can't shut off all of the water near the well to stop the leak. The well is about 250 feet deep and has about 25 feet of water in it. Your manager has a strong suspicion that the leak is below the surface of the water. They are looking for a cheap and easy solution to get (and keep) enough water out to identify and repair the broken pipe, and your manager decides that it would be a good project for you, the new intern, to work on. She suggests that you might be able to use a spare 1/4-hp sump pump that they have for the task. For your information, a typical installation of a sump pump is shown in the figure to the right.



Use the engineering design process we talked about in class to do the following:

(a) Write a brief paragraph of analysis and synthesis defining the problem you are trying to solve, describing possible solutions and discussing how you might go about generating one of those solutions. Your paragraph should provide a clear direction that you can propose to your manager for what you will do to meet her needs.

(a) Determine whether or not you can get enough water out of the well using the spare sump pump to do the job. Your final answer is a "yes" or a "no", but you should have numerical calculations to justify your answer. Also note that I have specifically left the problem underdetermined; You will have to make assumptions. Clearly describe any assumptions that you are making, and justify them by describing your reasoning or citing a source.

(b) Write a paragraph speculating about how she might evaluate your work at the end of the week. Dicuss technical factors and non-technical factors. Specifically, comment on *all* of the following: (i) public health, (ii) public safety, (iii) public welfare, (iv) global factors, (v) cultural factors, (vi) social factors, (vii) environmental factors, (viii) economic factors. If a category is not applicable state why.

This problem is vague on purpose. If you follow the design process, put in significant effort, and document your work, you will get full credit for the problem.