Homework 11

Ch En 374 – Fluid Mechanics

Due date: 4 Dec. 2019

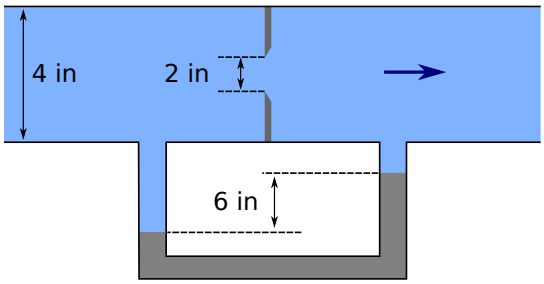
Survey Question

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 31 – Pipe Networks]. Two pipes of identical length and material are connected in parallel. The diameter of pipe A is twice the diameter of pipe B. Assuming the friction factor to be the same in both cases and disregarding minor losses, determine the ratio of the flow rate in the two pipes.

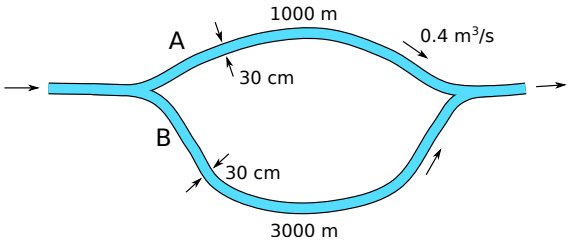
2. [Lecture 32 – Valves and Flow Meters]. An orifice with a 2-in diameter opening is used to measure the mass flow rate of water at 60°F ($\rho = 62.36\,\text{lbm}\cdot\text{ft}^{-3}$ and $\mu = 7.536\times10^{-4}\,\text{lbm}\cdot\text{ft}^{-1}\cdot\text{s}^{-1}$) through a horizontal 4-in diameter pipe. A mercury manometer ($\rho_{\text{Hg}} = 846.3\,\text{lbm}\cdot\text{ft}^{-3}$) is used to measure the pressure difference across the orifice. If the differential height of the manometer is read to be 6 in, determine the volumetric flow rate of water through the pipe, the average velocity, and the head loss caused by the orifice meter.



3. [Lecture 32 – Valves and Flow Meters]. A Pitot-static probe is mounted in a 2.5-cm inner diameter pipe at a location where the local velocity is approximately equal to the average velocity. The oil in the pipe has density $\rho = 860\,\text{kg/m}^3$ and viscosity $\mu = 0.0103\,\text{kg/(m}\cdot\text{s)}$. The pressure difference is measured to be 95.8 Pa. Calculate the volumetric flow rate through the pipe in cubic meters per second.

Challenge Problems

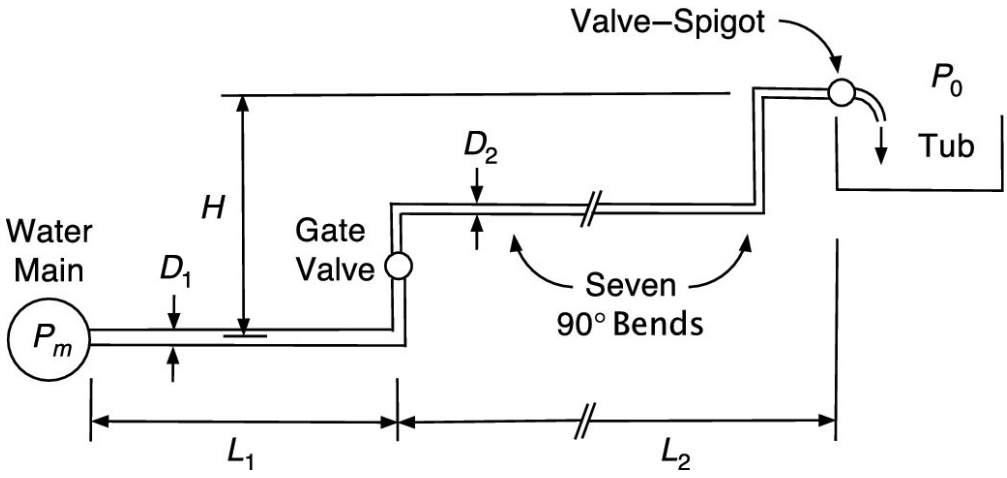
4. A certain part of cast iron piping of a water distribution system involves a parallel section. Both parallel pipes have a diameter of 30 cm and the flow is fully turbulent. One of the branches (pipe A) is 1000 m long while the other branch (pipe B) is 3000 m long. If the flow rate through pipe A is $0.4\,\text{m}^3/\text{s}$, determine the flow rate through the pipe B. Disregard minor losses.



5. A piping diagram for a household bathtub is shown below. The pipe leading from the underground water main to the house is a pipe of diameter D_1 and total length L_1, with one 90° bend. Inside the house are pipe segments of diameter D_2 and total length L_2. The interior pipe leading to the tub has seven 90° bends and an open gate valve. There is a total rise H from water main to tub spigot. The main and atmospheric pressures are P_m and P_0, respectively.

   All of the pipe is copper. The 3/4-inch exterior pipe has a length $L_1 = 20\,\text{m}$ and actual diameter $D_1 = 1.9\,\text{cm}$. The 1/2-inch interior pipe has a length $L_2 = 16\,\text{m}$ and actual diameter $D_2 = 1.4\,\text{cm}$.

   Use Python to plot the system demand curve $h_{L,\text{tot}}$ versus $Q \in [0.1, 0.35]$ L/s for valve-spigot values of $K_{\text{tub}} = \{0, 100, 200\}$. What happens to the value of Q at constant $h_{L,\text{tot}}$ as K_{tub} increases? What is physically happening here that makes K_{tub} increase?


Valve–Spigot
P_0
Tub
D_2
H
Water
Main
D_1
Gate
Valve
Seven
90° Bends
P_m
L_1
L_2