Department of Energy Science and Engineering
IIT Bombay

EN 222: Fluid Mechanics and Heat Transfer

Graded tutorial sheet
13/02/2025

1. A pump is attached to the end of the smooth pipe to pump water into the reservoir. What pressure (gage) must the pump produce? Please refer to the figure for the data. Assumptions: $\alpha_1 = \alpha_2 = 1$; $v_{avg,2}$=0

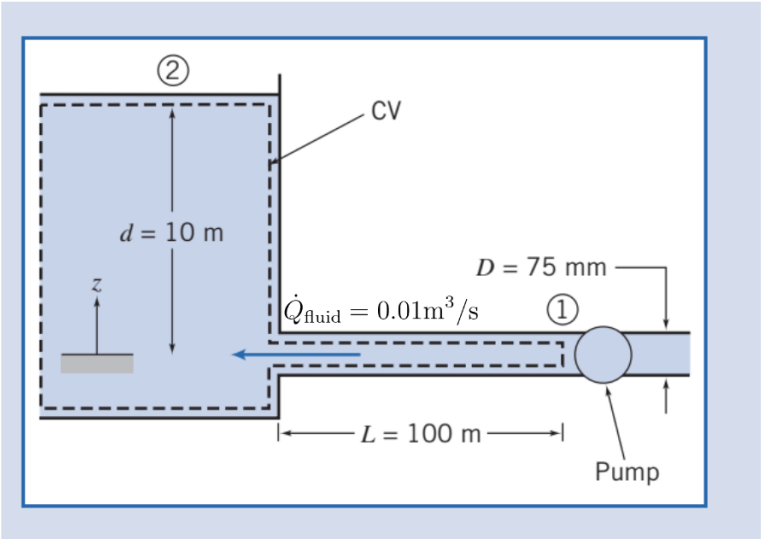

Figure 1: Problem 1

2. In a water scarce city, citizens were allowed to attach a calibrated, circular, tubular bronze nozzle to the supply tank. Some took undue advantage by attaching a diffuser. (Why do you think it was an undue advantage? Assume the static head available from the main is zo = 1.5 m and the nozzle exit diameter is D = 25 mm. (The discharge is to atmospheric pressure.) Determine the increase in flow rate when a diffuser with $N/R_1 = 3.0$ and AR = 2.0 is attached to the end of the nozzle.

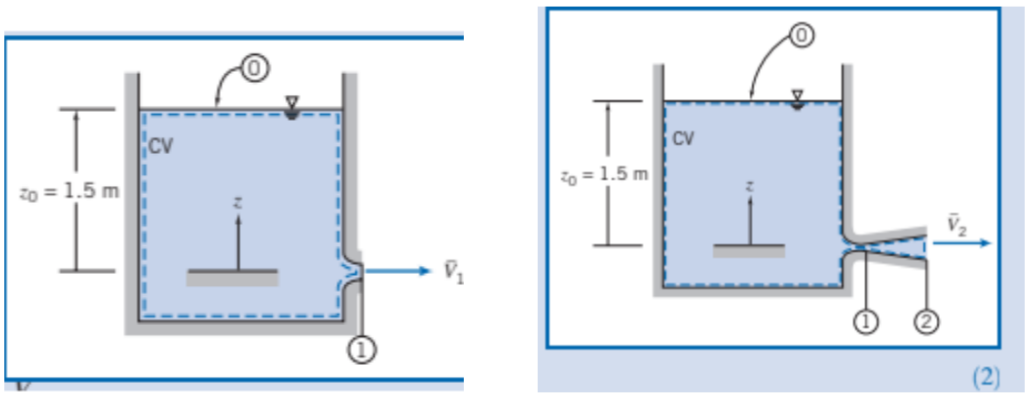

Figure 2: Problem 2

3. A 3 m long copper pipe with 40 mm i.d., was used for tests to determine the entrance losses for flow from a large reservoir to pipe. Determine the loss coefficient for a square edged entrance. Please refer to the figure for the data. Assumptions: $\alpha_1 = \alpha_2 = 1$; $v_{avg,1}$=0

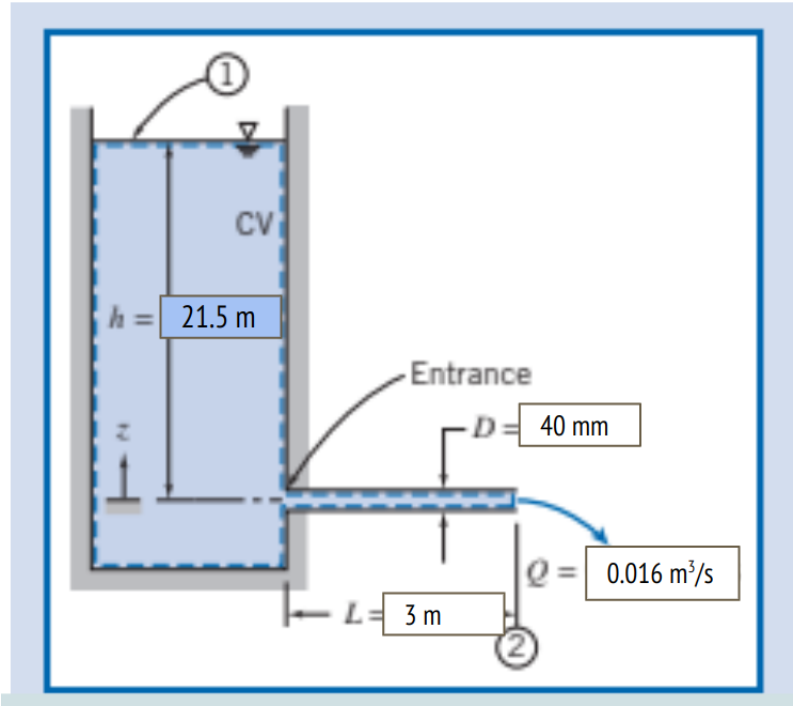

Figure 3: Problem 3

4. Water is pumped at the rate of 0.075 m^3/s from a reservoir 20 m above a pump to a free discharge 35 m above the pump. The pressure on the intake side of the pump is 150 kPa and the pressure on the discharge side is 450 kPa. All pipes are commercial steel of 15 cm diameter. Determine (a) the head supplied by the pump and (b) the total head loss between the pump and point of free discharge.

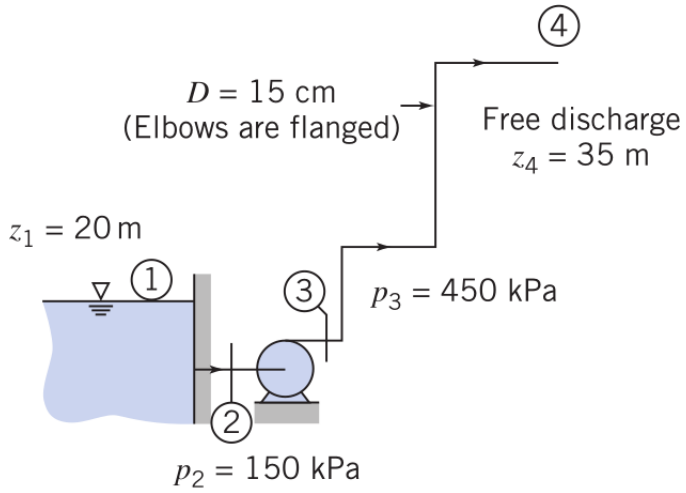

Figure 4: Problem 4

5. Water flows in a horizontal constant-area pipe; the pipe diameter is 75 mm and the average flow speed is 5 m/s. At the pipe inlet, the gage pressure is 275 kPa, and the outlet is at atmospheric pressure. Determine the head loss in the pipe. If the pipe is now aligned so that the outlet is 15 m above the inlet, what will the inlet pressure need to be to maintain the same flow rate? If the pipe is now aligned so that the outlet is 15 m below the inlet, what will the inlet pressure need to be to maintain the same flow rate? Finally, how much lower than the inlet must the outlet be so that the same flow rate is maintained if both ends of the pipe are at atmospheric pressure (i.e., gravity feed)?

6. In engineering science, there are often analogies to be made between disparate phenomena. For example, the applied pressure difference, Δp, and corresponding volume flow rate, Q, in a tube can be compared to the applied DC voltage, V, across and current, I, through an electrical resistor, respectively. By analogy, find a formula for the "resistance" of laminar flow of fluid of viscosity, μ, in a tube length of L and diameter D, corresponding to electrical resistance, R. For a tube 250 mm long with inside diameter 7.5 mm, find the maximum flow rate and pressure difference for which this analogy will hold for (a) kerosene and (b) castor oil (both at 40°C). When the flow exceeds this maximum, why does the analogy fail?