Applications of Bernoulli Equation

There are several applications of Bernoulli equation and will be discussed in the problems of this chapter.

Important notes before solving problems:

✓ Three equations should be in mind:

- Bernoulli equation.
- Continuity Equation.
- Up down method (Ch.2)

✓ When the fluid is flowing from section (1) to section (2), some losses of energy will occur between sections (1) and (2), so we include a **coefficient of discharge (C_d)** to get the actual discharge:

$Q_{actual} = C_d \times Q_{Theoritical}$

$Q_{Theoritical} = \text{the calculated discharge} = Av$

This will be clarified in problems later.

✓ Pump is a machine that consuming electricity power to produce a head of water.

✓ Turbine is a machine that consuming energy from water to produce power elevtricity.

✓ **If we want to calculate the power:**

$\text{Power} = \rho QgH \quad (\text{Watt})$

$746\ \text{Watt} = 1\ \text{horse power}$

Power consumed by pump = ρQgh_p

Power generated by turbine = ρQgh_t

If we need the power supplied by any object (machine, reservoir, jet, etc…) just calculate the total head and apply in power equation above.

We can also calculate the efficiency of pump or turbine or any system:

$$\eta = \frac{\text{Power}_{out}}{\text{Power}_{in}}$$

For pump:

$\text{Power}_{out} = \rho Qgh_p \qquad \text{Power}_{in} = \text{electricity power}$

For turbine:

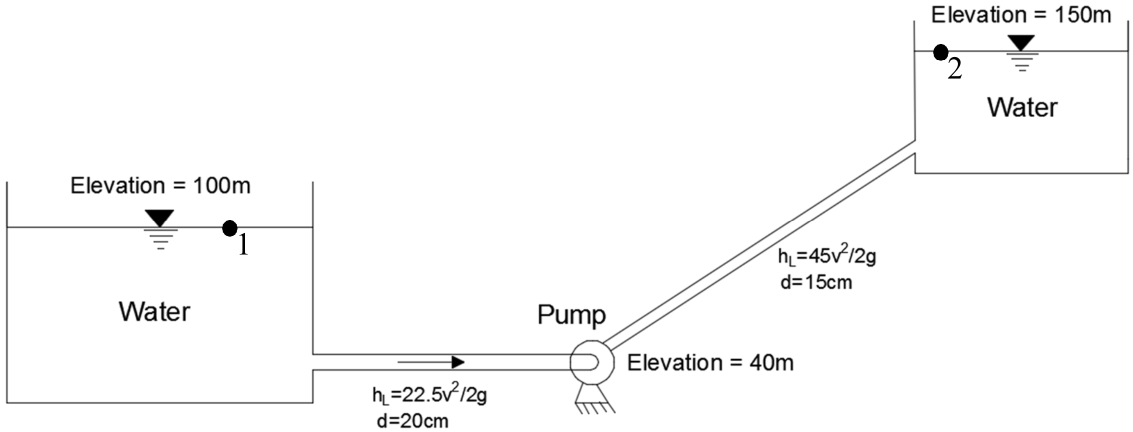
$\text{Power}_{out} = \text{electricity power} \qquad \text{Power}_{in} = \rho Qgh_t$

Problems

1.

What is the head that must be supplied by the pump to the water to pump 0.4 m^3/s from the lower to the upper reservoir ?

Hint: [The head loss in the pipes is given in the figure as a function of water velocity].



Solution

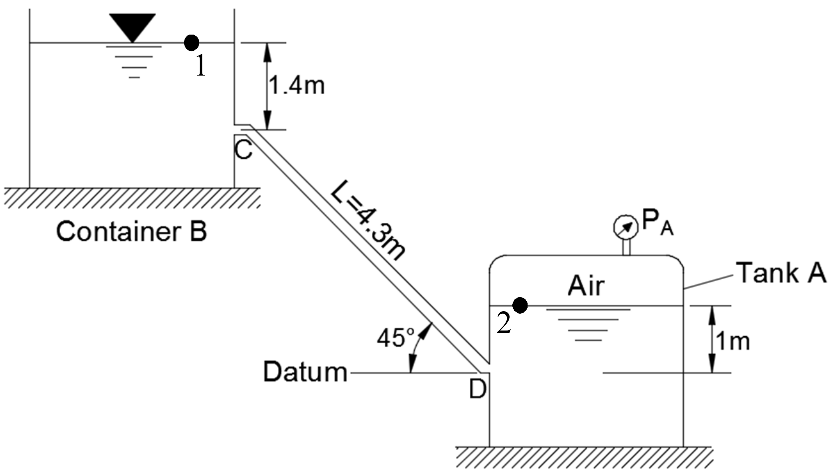
2.

A pipe of a diameter 6 mm connects tank A and open container B as shown in figure below. The liquid having a specific weight of 9780 N/m^3 and a viscosity of 0.0008 kg/m.s.

The pressure P_A=34.5 kPa and the head loss from pipe CD is $h_L = 25\frac{v^2}{2g}$

a) Which direction will the water flow and what is the flow rate?

b) Is the flow in pipe CD laminar or turbulent?

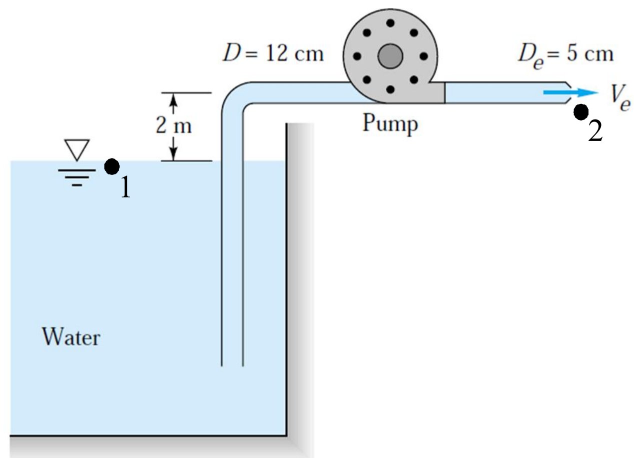


Solution

3.

When the pump shown in figure below draws 0.06 m^3/s of water from the reservoir, the total friction head loss is 5 m. The flow discharges through a nozzle to the atmosphere. Estimate the pump power in kW delivered to the water.

Solution



4.

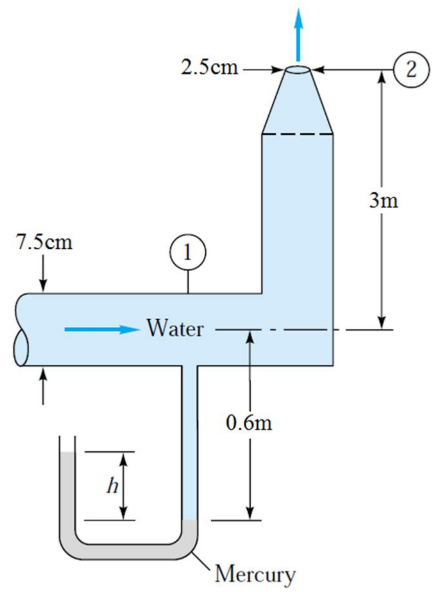
For the water system shown, the velocity at section (1) is v_1=0.6m/s.

Calculate the mercury manometer reading, h.

Notes:

- Losses are neglected.
- Section 2 is opened to atmosphere.
- $\rho_{mercury} = 13600\ kg/m^3$, $\rho_{water} = 1000\ kg/m^3$

Solution

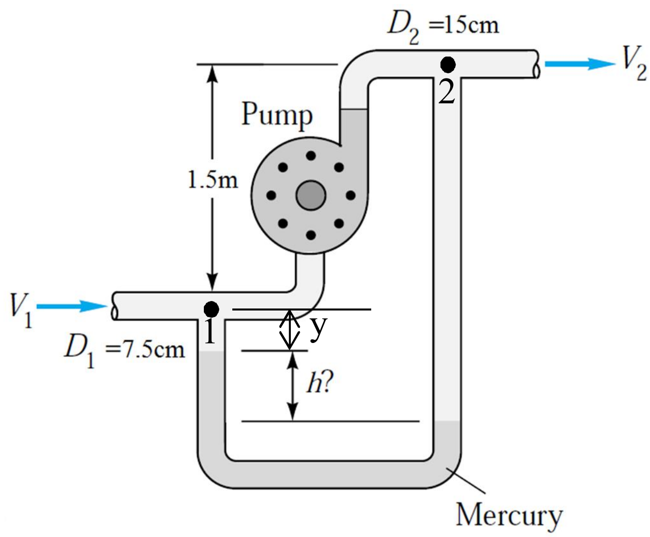


5.

Kerosine flows through the pump shown in figure below at 0.065 m^3/s. Head losses between 1 and 2 are 2.4 m, and the pump delivers 8 hp to the flow.

What should the mercury manometer reading h be?

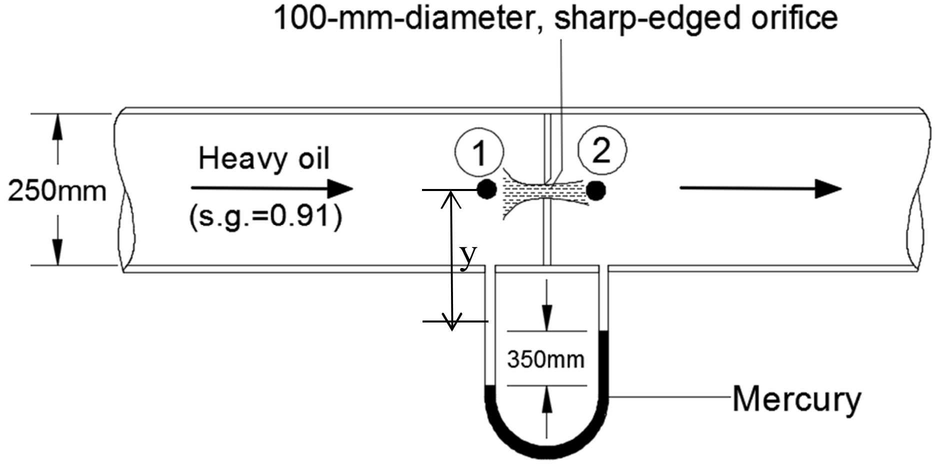
- $\rho_{mercury} = 13600\ kg/m^3$, $\rho_{kerosine} = 804\ kg/m^3$



Solution

6.

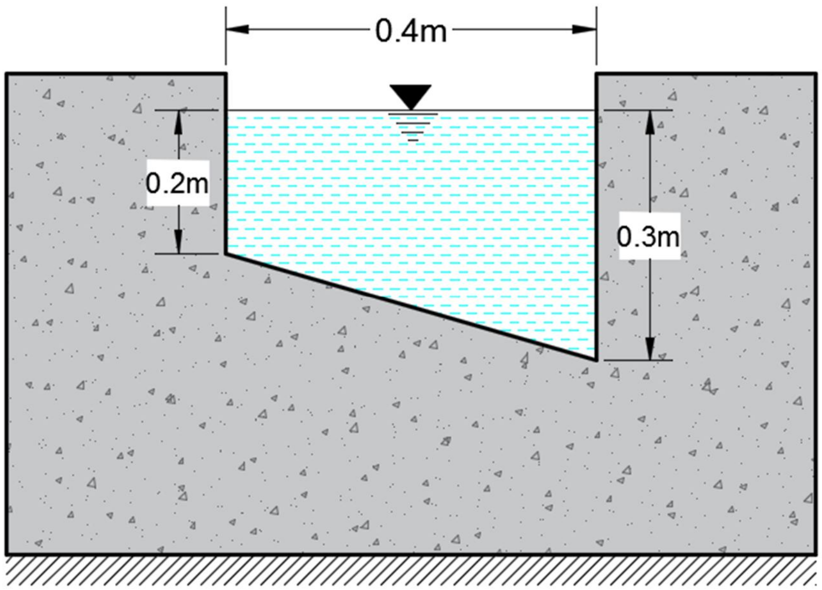
Oil flows through a pipe as shown in figure below. If the coefficient of discharge (C_d) for the orifice in the pipe is 0.63. **Calculate** the discharge of oil in the pipe.



Solution

7.

A weir of cross section shown below is used to measure the flow rate. **Calculate** this value of flow rate (Q).



Solution