

Tutorial Sheet - Application of Bernoulli's Equation

Take: $\rho_{\text{water}} = 10^3 \text{ kg/m}^3$; $\rho_{\text{mercury}} = 13.6 \times 10^3 \text{ kg/m}^3$; $\rho_{\text{air}} = 1.2 \text{ kg/m}^3$

1. A pitot tube is used to measure the velocity of an incompressible fluid in steady flow. If the static pressure in the flow is atmospheric and the tube is connected to a mercury manometer with a difference in levels of 100 mm, the other arm of the manometer being open to atmosphere, calculate the velocity of the flow if the fluid density is 1.2 kg/m^3 .
(149 m/s)
2. Calculate the volume flow rate through a horizontal Venturi meter of inlet to throat diameter ratio 2:1, given that the throat diameter is 50 mm. The pressure difference between the inlet and throat is recorded on a mercury manometer as a 60 mm difference in levels. The discharge coefficient, C_d , of the meter is 0.95. The flow rate should be calculated when (i) water flows through the meter, and (ii) air flows.
($7.42 \times 10^{-3} \text{ m}^3/\text{s}$; $0.223 \text{ m}^3/\text{s}$)
3. Water is drawn from a reservoir by a pump and is delivered at the rate of $0.1 \text{ m}^3/\text{s}$ to a point 30 m vertically above the reservoir through a pipe 0.2 m in diameter, where it is discharged to atmosphere. If the total losses in the system amount to 20 times velocity head in the pipe, determine the power required to drive the pump which is 66% efficient. What would contribute to the loss?
(60 kW)
4. The pressure at inlet to a water turbine is recorded on a gauge as 100 kPa at a point where the pipe is 0.3 m diameter. The flow through the turbine is $0.2 \text{ m}^3/\text{s}$. The turbine discharges at atmospheric pressure through a pipe 0.8 m diameter, the exit velocity being lost. The discharge point is 1 m below the inlet. Determine the output power from the 60% efficient turbine.
(13.6 kW)
5. Oil of relative density 0.85 flows upwards through a vertical Venturi meter fitted in a 225 mm diameter pipe line. The diameter of the throat is 75 mm and the throat is 150 mm above the inlet.

Pressure connections are taken from the inlet and throat of the meter to the lower and upper ends of a vertical cylinder in which a piston with an area of 1950 mm^2 is free to move. A load can be applied to the piston by placing masses on a piston rod passing through the cylinder.

Calculate the discharge through the meter if a load of 13.65 kg, including the piston, is required to maintain the piston in equilibrium. Neglect frictional losses.

($0.057 \text{ m}^3/\text{s}$)