Problem 4-4

3

1

2

Water

The diameters of the ports in the accompanying figures are 10 cm, 5 cm, and 1 cm at port 1, 2, and 3 respectively. At a given instant, water enters the tank at port 1 with a velocity of 2 m/s and leaves through port 2 with a velocity of 1 m/s. Assuming air in insoluble in water, determine(a) the mass flow rate of water in kg/s at the inlet (b) at the exit and (c) the rate at which water accumulates in the tank in kg/s. (d) Determine the mass flow rate of air in kg/s coming out of port 3. (e) Determine the velocity of air in m/s at port 3.

Solution Balance the mass-flow equations for an unsteady system.

Assumptions Density of water and air to remain constant at 1000 kg/3 and 1 kg/m3 respectively, the water and air do no mix.

Analysis Since the water and air do not mix, we can find the mass flow for the water. This can then be converted into volume flow. Since the volume of the tank is constant, the volume flow of the water must equal the volume flow of the air.

Since the volume of the tank is constant, this must also be the rate that air is expelled:

Given