

Question 9: A 200 cm (height) by 75 cm (diameter) cylindrical tank initially contains 500L of water at 20C. At 8:00 a.m., a 1.0 cm diameter orifice at the bottom of the tank is opened. Simultaneously, ethanol begins to flow into the tank at 12 L/min. The liquid is well-mixed, and the orifice flow coefficient is 0.58.

Find:

- i) The time that the concentration of ethanol in the tank reaches 50%.
- ii) The volume of liquid in the tank at the time found in part i.

Additional Information:

linear velocity (v) of a liquid flowing out of a tank through an orifice is given by:

$$v = C\sqrt{2gh}$$

where C = orifice flow coefficient
 g = gravitational acceleration constant (e.g., 981 cm/s²)
 h = height of the liquid in the tank.

Pre-problem Thoughts:

1. What are the components?
2. What are the subsystems?
3. What are the streams?
4. What type of balance should be performed?
5. Steady-state vs. unsteady-state and reactive vs unreactive.
6. What is going on in this problem?