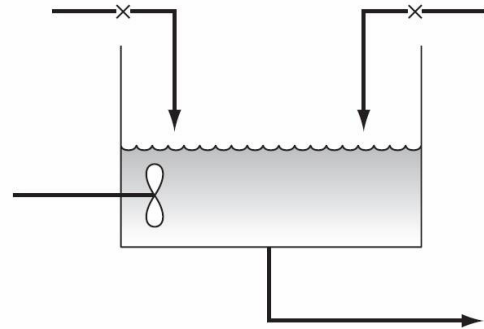


### PROBLEM SET 5

1) The mixing tank shown in the figure initially contains 50 kg of water at 25°C. Suddenly the two inlet valves and the single outlet valve are opened, so that two water streams, each with a flowrate of 5 kg/min, flow into the tank, and a single exit stream with a flowrate of 10 kg/min leaves the tank. The temperature of one inlet stream is 80°C and that of the other is 50°C. The tank is well mixed, so that the temperature of the outlet stream is always the same as the temperature of water in the tank.



- Assuming no heat loss from the tank to the surroundings, compute the steady-state temperature that will finally be obtained in the tank.
- Develop an expression for the temperature of the fluid in the tank at any time.
- Develop an expression for the temperature of the fluid in the tank at any time if the heat loss from the tank is  $\dot{Q} = B(T - T_o)$ , where

$$B = 0.4 \text{ kJ/s} \cdot ^\circ\text{C}$$

$$T_o = 25^\circ\text{C}, \text{ ambient temperature}$$

$$T = \text{temperature of water in the tank at any time.}$$

$$\text{Data: } c_{P, \text{water}} = 4.184 \text{ J/g} \cdot \text{K}$$

2) Our laboratory will use a 10-liter tankful of HFC-134a every week. Searching for suppliers, we came across two companies. The first company fills our tank for 100 TL, and returns it to us at 10 bars and 90°C. The second company fills it for 120 TL and returns it at 6 bars and 0°C. Regarding the cost charged per kilogram, which one of these companies should we buy HFC-134a from? Thermodynamic data on HFC-134a are available as a P-H diagram at the back of this sheet.

3) A high pressure line at the inlet to a chemical reactor contains almost pure methane at 200 bar and 30°C, according to instruments. However, an operator opens a small valve in the side of the line and claims that the recorded temperature must be wrong, since the gas coming out of the line feels cold. Resolve this problem if possible by appropriate thermodynamic analysis. Thermodynamic data on methane are available as a P-H diagram at the back of this sheet.

