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## Problem Set 3

### Problem 2.24

A stream of warm water is produced in a steady-flow mixing process by combining  $1.0 \text{ kg s}^{-1}$  of cool water at  $25 \text{ degC}$  with  $0.8 \text{ kg s}^{-1}$  of hot water at  $75 \text{ deg C}$ . During mixing, heat is lost to the surroundings at a rate of  $30 \text{ kJ s}^{-1}$ . What is the temperature of the warm water stream? Assume the specific heat of water is constant at  $4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ .

### Problem 2.28

Nitrogen flows at steady state through a horizontal, insulated pipe with inside diameter of 1.5 (in). A pressure drop results from flow through a partially opened valve. Just upstream from the valve the pressure is 100 (psia), the temperature is 120 (degF), and the average velocity is  $20 \text{ (ft)(s)}^{-1}$ . If the pressure just downstream from the valve is 20 (psia), what is the temperature? Assume for nitrogen that  $PV/T$  is constant,  $C_v = (5/2)R$ , and  $C_p = (7/2)R$ . (Values of  $R$  are given in App. A.)

### Problem 2.40

One kilogram of air is heated reversibly at constant pressure from an initial state of 300 K and 1 bar until its volume triples. Calculate  $W$ ,  $Q$ ,  $\Delta U$ , and  $\Delta H$  for the process. Assume for air that  $(PV/T) = 83.14 \text{ (bar)(cm)}^3 \text{ (mol)}^{-1} \text{ (K)}^{-1}$  and  $C_p = 29 \text{ (J)(mol)}^{-1} \text{ (K)}^{-1}$ . Report your answers in kJ.

### Problem 2.38

Carbon dioxide gas enters a water-cooled compressor at conditions  $P_1 = 15 \text{ (psia)}$  and  $T_1 = 50 \text{ (degF)}$ , and is discharged at conditions  $P_2 = 520 \text{ (psia)}$  and  $T_2 = 200 \text{ (degF)}$ . The entering  $\text{CO}_2$  flows through a 4-inch-diameter pipe with a velocity of  $20 \text{ (ft)(s)}^{-1}$ , and is discharged through a 1-inch-diameter pipe. The shaft work supplied to the compressor is  $5,360 \text{ (Btu)(lb mol)}^{-1}$ . What is the heat-transfer rate from the compressor in  $\text{(Btu)(hr)}^{-1}$ ?

Additional Information:

$$H_1 = 307 \text{ (Btu)(lb}_m\text{)}^{-1} \text{ and } V_1 = 9.25 \text{ (ft)}^3 \text{ (lb}_m\text{)}^{-1}$$

$$H_2 = 330 \text{ (Btu)(lb}_m\text{)}^{-1} \text{ and } V_2 = 0.28 \text{ (ft)}^3 \text{ (lb}_m\text{)}^{-1}$$