Problem Set 3

Problem 2.24

A stream of warm water is produced in a steady-flow mixing process by combining 1.0 kg s^{-1} of cool water at 25 °C with 0.8 kg s^{-1} of hot water at 75 °C. During mixing, heat is lost to the surroundings at a rate of 30 kJ s^{-1}. What is the temperature of the warm water stream? Assume the specific heat of water is constant at 4.18 kJ kg^{-1} 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 (°F), and the average velocity is 20 (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, Cv=(5/2)R, and Cp=(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, ΔU, and ΔH for the process. Assume for air that (PV/T)=83.14 (bar)$(cm)^3(mol)^{-1}(K)^{-1}$ and Cp=29(J)$(mol)^{-1}(K)^{-1}$. Report your answers in kJ.

Problem 2.38

Carbon dioxide gas enters a water-cooled compressor at conditions P_1 = 15 (psia) and T_1 = 50 °, and is discharged at conditions P_2 = 520 (psia) and T_2 = 200 °F. The entering CO_2 flows through a 4-inch-diameter pipe with a velocity of 20 (ft) $(s)^{-1}$, and is discharged through a 1-inch-diameter pipe. The shaft work supplied to the compressor is 5,360 (Btu) $(lb\ mol)^{-1}$. What is the heat-transfer rate from the compressor in (Btu) $(hr)^{-1}$?

Additional Information:
H_1 = 307 (Btu) $(lb_m)^{-1}$ and V_1 = 9.25 $(ft)^3$ $(lb_m)^{-1}$
H_2 = 330 (Btu) $(lb_m)^{-1}$ and V_2 = 0.28 $(ft)^3$ $(lb_m)^{-1}$