PROBLEM 6.4

FIND: Determine the change in specific entropy, in Btu/lb·°R.

(a) Water. $p_1 = 1000$ lbf/in², $T_1 = 800°F$, $p_2 = 1000$ lbf/in², $T_2 = 100°F$.

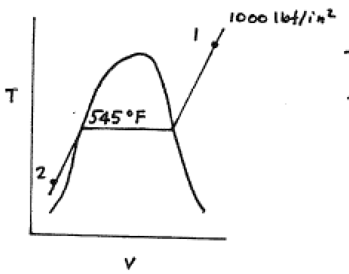

Table A-4E. $s_1 = 1.5665$ Btu/lb·°R

Table A-5E. $s_2 = 0.12901$ Btu/lb·°R

$s_2 - s_1 = -1.43749$ Btu/lb·°R ← (a)

(b) R-134a. $h_1 = 47.91$ Btu/lb, $T_1 = -40°F$, saturated vapor at $p_2 = 40$ lbf/in².

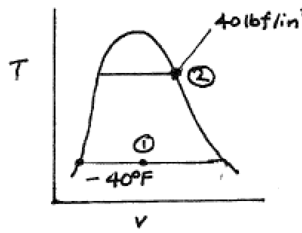

Table A-10E at −40°F: $h_f = 0$, $h_{fg} = 95.82$ Btu/lb

$\therefore \quad x_1 = \frac{47.91 - 0}{95.82} = 0.5$

And $s_1 = s_f + x_1(s_g - s_f) = 0 + 0.5(0.2283 - 0) = 0.11415$ Btu/lb·°R.

Table A-11E, $s_2 = 0.2197$ Btu/lb·°R. Then

$s_2 - s_1 = 0.2197 - 0.11415 = 0.1056$ Btu/lb·°R ← (b)

(c) Air as an ideal gas. $T_1 = 40°F$, $p_1 = 2$ atm, $T_2 = 420°F$, $p_2 = 1$ atm.

With Eq. 6.20a and $s°$ data from Table A-22E at 500°R and 880°R

$$s_2 - s_1 = s°(T_2) - s°(T_1) - \frac{\bar{R}}{M} \ln \frac{p_2}{p_1}$$

$$= (0.71886 - 0.58233)\left(\frac{\text{Btu}}{\text{lb}\cdot°\text{R}}\right) - \left(\frac{1.986}{28.97}\ \frac{\text{Btu}}{\text{lb}\cdot°\text{R}}\right) \ln \frac{1}{2}$$

$$= 0.18405 \text{ Btu/lb}\cdot°\text{R}$$ ← (c)

(d) Carbon dioxide as an ideal gas. $T_1 = 820°F$, $p_1 = 1$ atm, $T_2 = 77°F$, $p_2 = 3$ atm.

With Eq. 6.20b and $\bar{s}°$ data from Table A-23E at 1280°R and 537°R

$$\bar{s}_2 - \bar{s}_1 = \bar{s}°(T_2) - \bar{s}°(T_1) - \bar{R} \ln \frac{p_2}{p_1}$$

$$= (51.032 - 60.044)\left(\frac{\text{Btu}}{\text{lbmol}\cdot°\text{R}}\right) - \left(1.986\ \frac{\text{Btu}}{\text{lbmol}\cdot°\text{R}}\right) \ln \frac{3}{1}$$

$$= -11.1938 \ \frac{\text{Btu}}{\text{lbmol}\cdot°\text{R}}$$

Then, with the molecular weight of CO_2 from Table A-1E

$$s_2 - s_1 = \frac{\bar{s}_2 - \bar{s}_1}{M}$$

$$= \frac{-11.1938 \ \frac{\text{Btu}}{\text{lbmol}\cdot°\text{R}}}{44.01 \ \text{lb/lbmol}}$$

$$= -0.25435 \text{ Btu/lb}\cdot°\text{R}$$ ← (d)