

## Solution for Problem T15

The specific enthalpy of kerosene is given as  $-1.77 \times 10^6$  J/kg. Converting it to molar enthalpy (with the "molecular mass" 13.95 g/mol of the fictitious kerosene, which is really a complex mixture),

$$\tilde{h}_{ker} = -2.469 \times 10^4 \text{ J/mol}$$

For the rest of the molar enthalpies, I used the tables in Van Wylen and Sonntag (Table A.11). At the inlet temperature of 600 K,

$$\tilde{h}_{O_2} = 9,247 \text{ J/mol} ; \quad \tilde{h}_{N_2}(600) = 8,891 \text{ J/mol}$$

and so the enthalpy per kg of reactants is

$$H_{in} = 2.088(-2.469 \times 10^4) + 7.072(9,247 + 3.76 \times 8891) = \underline{2.503 \times 10^5 \text{ J/kg}}$$

Since our best first estimate gave  $T = 1630$  K, we check enthalpy conservation at 1600 and 1800 K:

$$H_{out}(1600) = 2.088(-393,522 + 67,580) + 2.036(-241,827 + 52,844) + \\ + 3.367 \times 44,279 + 26.592 \times 41,903 = \underline{2.246 \times 10^5 \text{ J/kg}}$$

$$H_{out}(1800) = 2.088(-393,522 + 79,422) + 2.036(-241,827 + 62,609) + \\ + 3.367 \times 51,869 + 26.592 \times 48,982 = \underline{4.876 \times 10^5 \text{ J/kg}}$$

These values do bracket  $H_{in}$ . Interpolate linearly:

$$T = 1600 + \frac{1800 - 1600}{4.876 \times 10^5 - 2.246 \times 10^5} (2.503 \times 10^5 - 2.246 \times 10^5)$$

$$\boxed{T = 1620 \text{ K}}$$

which is fairly close to the value estimated using  $h = 43 \times 10^6$  J/kg and  $c_p = 1249$  J/kg/K. Using the straight  $c_p$  for air leads to a 20% overestimate of  $T$ .