13.62 Determine the lower heating value, in kJ per kmol of fuel and in kJ per kg of fuel, at 25°C, 1 atm for

(a) gaseous ethane \((C_2H_6)\).
(b) liquid ethanol \((C_2H_5OH)\).
(c) gaseous propane \((C_3H_8)\).
(d) liquid octane \((C_8H_{18})\).

13.65 Liquid octane \((C_8H_{18})\) at 25°C, 1 atm enters an insulated reactor operating at steady state and burns with 90% of theoretical air at 25°C, 1 atm to form products consisting of \(\text{CO}_2\), \(\text{CO}\), \(\text{H}_2\text{O}\), and \(\text{N}_2\) only. Determine the temperature of the exiting products, in K. Compare with the results of Example 13.8 and comment.

13.74 Methane \((\text{CH}_4)\) at 77°F enters the combustor of a gas turbine power plant operating at steady state and burns completely with air entering at 400°F. The temperature of the products of combustion flowing from the combustor to the turbine depends on the percent excess air for combustion. Plot the percent excess air versus combustion product temperatures ranging from 1400 to 1800°F. There is no significant heat transfer between the combustor and its surroundings, and kinetic and potential energy effects can be ignored.
13.84 Liquid ethanol ($\text{C}_2\text{H}_5\text{OH}$) at 25°C, 1 atm enters a reactor operating at steady state and burns completely with 130% of theoretical air entering in a separate stream at 25°C, 1 atm. Combustion products exit at 227°C, 1 atm. Heat transfer from the reactor takes place at an average surface temperature of 127°C. Determine

(a) the rate of entropy production within the reactor, in kJ/K per kmol of fuel,

(b) the rate of exergy destruction within the reactor, in kJ per kmol of fuel. Kinetic and potential energy effects are negligible. Let $T_0 = 25^\circ$C.

14.2 Calculate the equilibrium constant, expressed as $\log_{10}K$, for $\text{CO}_2 \rightleftharpoons \text{CO} + \frac{1}{2}\text{O}_2$ at (a) 500 K, (b) 1800°F. Compare with values from Table A-27.

14.8 Consider the reactions

1. $\text{CO} + \text{H}_2\text{O} \rightleftharpoons \text{H}_2 + \text{CO}_2$
2. $2\text{CO}_2 \rightleftharpoons 2\text{CO} + \text{O}_2$
3. $2\text{H}_2\text{O} \rightleftharpoons 2\text{H}_2 + \text{O}_2$

Show that $K_1 = (K_3/K_2)^{1/2}$. 