10.213 Chemical Engineering Thermodynamics
Spring 2002

Problem Set E
Due Friday, March 15, 2002 in lecture

Problem 17
Consider the air conditioning of a house through use of solar energy. At a particular location, the flux of solar radiation allows a large tank of water to be maintained at 205 °C. During a particular time interval, heat in the amount of 1,000 kJ must be extracted from the house to maintain its temperature at 20 °C when the surrounding temperature is 32 °C. Treating the tank of water, the house, and the surroundings as heat reservoirs, determine the minimum amount of heat that must be extracted from the tank of water by any device to accomplish the required cooling of the house. No other sources of energy are available.

Problem 18
a) A rigid, nonconducting vessel is divided in half by a rigid partition. Initially, one side of the vessel contains steam at 3.4 MPa and 275 °C, and the other side is evacuated. The partition is removed, and the steam expands adiabatically to fill the vessel. What are the final temperature and pressure of the steam?
b) Superheated methane (SVN6, Fig G.1) at 1000 psia and 500 °F expands isentropically to 50 psia. What are the enthalpy and temperature changes for the gas?
c) Superheated methane (SVN6, Fig G.1) at 1000 psia and 500 °F expands isenthalpically to 50 psia. What is the temperature change for the gas? Comment on the reversibility of this process.

Problem 19
A stream of ethane gas at 200 °C and 25 bar expands isentropically to 2 bar. Determine the temperature of the expanded gas and the work produced if the properties of the ethane are calculated by:
a) Equations for an ideal gas
b) Appropriate generalized correlations
c) http://webbook.nist.gov/chemistry/fluid/ (to within 0.5 °C).

If the gas was expanded isenthalpically to 2 bar, determine the temperature of the expanded gas if the properties of the ethane are calculated by:
d) Appropriate generalized correlations
Note: Problem 19d is for practice (do not hand in). Turn in 17, 18, 19a-c and 19e.
e) http://webbook.nist.gov/chemistry/fluid/ (to within 0.5 °C).

Note: to see numerical data for entropy on the nist website, use the "View Table" feature and set the headings to the desired parameters.

Additional Practice Problem (not to be handed in)

Practice Problem P7
Superheated steam at 700 kPa and 280 °C flowing at a rate of 50 kg/s is mixed with liquid water at 40 °C to produce steam at 700 kPa and 200 °C. Assuming adiabatic operation, at what rate is water supplied to the mixer? What is the rate of entropic gain or loss for the process? What is the irreversible feature of the process?