Chemical Process Calculation (CH 1103, RM Part)
Tutorial Problem Sheet – 01E
Problem Sheet

***The problem Number in the Parenthesis Refers to Problem Number in the Exercise of Himmelblau's Book, 8th Edition**

4. (9.2.14) Calculate the heat transfer to the atmosphere per second from a circular pipe, 5 cm in diameter and 100 m long, carrying steam at an average temperature of 120°C if the surroundings are at 20°C. The heat transfer can be estimated from the relation

$$\mathbf{Q = hA\Delta T}$$

Where

h = 5 J/(s)(m^2)(°C)
A is the surface area of the pipe
ΔT is the temperature difference between the surface of the pipe and ambient conditions.

9. (9.2.23) For the systems defined below, state whether Q, W, ΔH, and ΔU are 0, >0, or <0, and compare their relative values if not equal to 0:

a. An egg (the system) is placed into boiling water.

b. Gas (the system), initially at equilibrium with its surroundings, is compressed rapidly by a piston in an insulated non-conducting cylinder by an insulated non-conducting piston; give your answer for two cases:

(1) Before reaching a new equilibrium state.
(2) After reaching a new equilibrium state.

c. A Dewar flask of coffee (the system) is shaken.

14. (9.2.30) What is the enthalpy change for acetylene when heated from 37.8°C to 93.3°C?

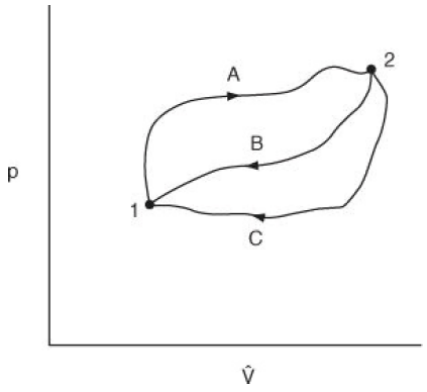
19. (9.2.35) Equal quantities by weight of water at +50°C and of ice at –40°C are mixed together. What will be the final temperature of the mixture?

24. (9.2.46) Use the steam tables to calculate the enthalpy change (in joules) of 2 kgmol of steam when heated from 400 K and 100 kPa to 900 K and 100 kPa. Repeat using the table in the text for the enthalpies of combustion gases. Repeat using the heat capacity for steam. Compare your answers. Which is more accurate?

29. (9.2.52) Wet steam flows in a pipe at a pressure of 700 kPa. To check the quality, the wet steam is expanded adiabatically to a pressure of 100 kPa in a separate pipe. A thermocouple inserted into the pipe indicates that the expanded steam has a temperature of 125°C. What was the quality of the wet steam in the pipe prior to expansion?

34. (9.3.11) Two states, 1 and 2, are marked in Figure P9.3.11. Path A is taken from 1 to 2. Two alternative return paths from 2 to 1 are shown: B and C. Two different cycles can now be made up, each going from point 1 to point 2, and then returning to point 1. One cycle is made up from path A and path B, and the other from path A and path C. Are the following equations correct for the cycle 1 to 2 and return?

$$Q_A + Q_B = W_A + W_B;\ Q_A + Q_C = W_A + W_C$$



39. (9.3.17) Write the simplified energy balance for the following processes:

a) A fluid flows steadily through a poorly designed coil in which it is heated from170°F to 250°F. The pressure at the coil inlet is 120 psia, and at the coil outlet is 70psia. The coil is of uniform cross section, and the fluid enters with a velocity of 2ft/s.

b) A fluid is allowed to flow through a cracked (slightly opened) valve from region where its pressure is 200 psia and 670°F to a region where its pressure is 40 psia, the whole operation being adiabatic. List each assumption or decision by number. You do not have to solve the problems.

44. (9.3.26) Four kilograms of superheated steam at 700 kPa and 500 K are cooled in a tank to 400 K. Calculate the heat transfer involved.

49. (9.3.35) A liquid that can be treated as water is being well mixed by a stirrer in a 1 m^3 vessel. The stirrer introduces 300 W of power into the vessel. The heat transfer from the tank to the surroundings is proportional to the temperature difference between the vessel and the surroundings (which are at 20°C). The flow rate of liquid in and out of the tank is 1 kg/min. If the temperature of the inlet liquid is 40°C, what is the temperature of the outlet liquid? The proportionality constant for the heat transfer is 100 W/°C.

54. (9.3.40) A large piston in a cylinder does 12,500 (ft)(lbf) of work in compressing 3 ft^3 of air to 25 psia. Five pounds of water in a jacket surrounding the cylinder increased in temperature by2.3°F during the process. What was the change in the internal energy of the air?

$$C_{p,\,water} = 8.0\ \frac{\text{Btu}}{(\text{lb mol})(^\circ\text{F})}$$

59. (9.3.48) A proposal to store Cl_2 as a liquid at atmospheric pressure was recently in the news. The operation is shown in Figure P9.3.48.

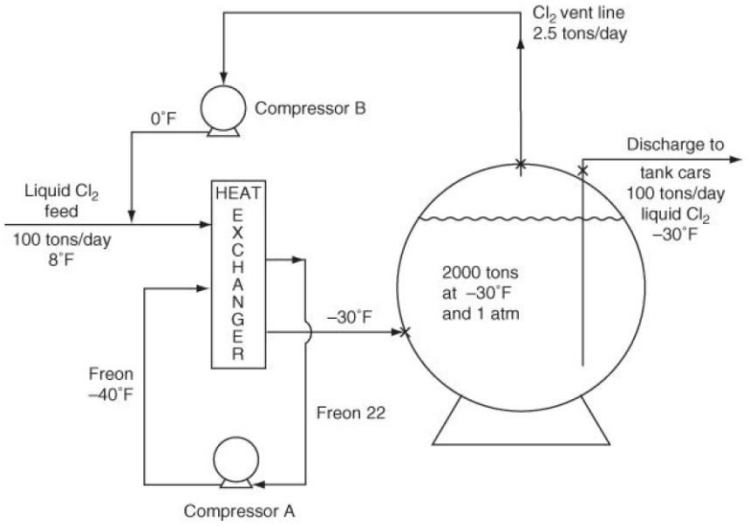


Figure P9.3.48

The normal boiling point of Cl_2 is –30°F. Vapor formed in the storage tank exits through the vent and is compressed to liquid at 0°F and returned to the feed. The vaporization rate is 2.5 tons/day when the sphere is filled to its capacity and the surrounding air temperature is80°F.If the compressors are driven by electric motors and are about 30% efficient, what is the horsepower input required to make this process successful? Assume lines and heat exchangers are well insulated. Use 8.1 Btu/(lbmol) (°F) for the heat capacity of liquid Cl_2. $\Delta H_{vaporization}$= 123.67 Btu/lb Cl_2.