Code No: RR220802 **Set No.1**

II B.Tech. II Semester Regular Examinations, April/May -2005
CHEMICAL ENGINEERING THERMODYNAMICS-I
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Define and explain the following:
   (a) Closed System
   (b) Control Volume
   (c) Isolated System
   (d) Open System.
2. Derive the governing equation for the adiabatic process.
3. Consider an adiabatic vessel divided into 2 chambers. One chamber contains dry saturated steam of mass 4 kg at a pressure of 2.5 bar while the other chamber contains 8 kg of steam, 0.9 quality at 4 bar. Now the partition between the chambers is removed and the steam is mixed thoroughly and reaches thermal equilibrium. Calculate the entropy change, steam quality and final pressure.
4. (a) Discuss law of corresponding states of two parameters. What is pitzer modification and why?
   (b) The saturation pressure of water at 180^0C is 1.0027 Mpa. Calculate the acentric factor of water. The critical temperature and pressure of water are 647.3 and 221.2 bar respectively.
5. (a) Write different causes of irreversibility. Why cooling of hot coffee is an irreversible process.
   (b) Discuss different difficulties in producing ideal heat engine.
6. What is the change in entropy of 0.5kgmol of an ideal gas which is initially at 50^0C and $10x10^5 N/m^2$ pressure and is expanded irreversibly to 1 x 10^5 N/m^2 and 22^0C. The molar heat capacity at constant pressure is $30KJ/kg^0C$.
7. Describe the operation of Adsorption Refrigerator by means of a neat sketch in detail with proper labeling.
8. (a) Mention the applications of liquefied gases and discuss the principles to achieve them.
   (b) A Carnot refrigerator is operating between two reservoirs at temperature 25^0C and 35^0C. Determine COP of the refrigerator.

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1. (a) Illustrate the meaning of point function and path function.
   (b) Explain the following:
      i. Flow work
      ii. Specific heat of Gas
      iii. Enthalpy
2. (a) Discuss flow work and heat content of a system.
   (b) Differentiate between the flow work and non-flow work by drawing a PV diagram.
3. (a) Define specific heat, internal energy and enthalpy of an ideal gas.
   (b) Obtain an expression for the entropy change of an ideal gas.
4. (a) What is the physical significance of the compressibility factor? Explain.
   (b) Determine the specific volume of superheated steam at 2 bar and 150^0C using,
      i. The steam tables
      ii. The ideal-gas equation of state, and
      iii. The generalized compressibility chart.

   What is the error involved in (ii) and (iii)?
5. Using clauses inequality. Show that the change of entropy in a process is related to the heat interaction as $ds \geq \frac{dQ}{T}$.
6. Derive are Maxwells equation from fundamental property relation. What are their importance?
7. (a) What are important characteristics of refrigerants. Write the chemical name of R-11 and R-12.
   (b) Compare real refrigeration cycle with carnot refrigeration cycle on T-S diagram. Why dry compression is preferred over wet compression? Why superheating and subcooling are essential? Show these on P-H diagram. All diagram should be labeled properly.
8. (a) Define ton of refrigeration. Show superheating and subcooling on P-H diagram.

(b) A Car engine with a power output of 65hp has a thermal efficiency of 24%. Determine the fuel consumption rate of this air, if a fuel has a heating value of 19000 Bta/lbm (i.e., this much energy is released for each lbm of fuel burned.

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Code No: RR220802 **Set No.3**

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Time: 3 hours **Max Marks: 80**

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1. (a) Compare the closed system with open system.
   (b) Define the following and explain
      i. State
      ii. Process
      iii. Property
      iv. Cycle.
2. Derive the expression of the first law of the study state, steady flow process.
3. A rigid vessel contains a mixture of saturated steam and water at 550 K. The volume of the vessel is 50 liters. If the liquid mass is 10 kg, determine the total mass, enthalpy, entropy and internal energy of the mixture.
4. What pressure is generated in atmosphere. When 1 lb-mol of methane is stored in a volume of 2 cuft. At 122^0F, based upon
   (a) ideal gas equation
   (b) Redlich-kwong equation.

   R = 10.73 Psia ft^3/ lb.mol R

   a = 454 atm. ft^6; b = 0.4781 ft^3.
5. (a) Prove for universe Δ DS ≥ 0.
   (b) With the help of
      i. find the criteria for eq^m in terms of Δ S.
6. Prove
   (a) $v = \left(\frac{\partial H}{\partial P.}\right)_T + \left(\frac{\partial V}{\partial T}\right)_P$
   (b) $C_V = \left(\frac{\partial U}{\partial T}\right)_V$
   (c) $= \left(\frac{\partial H}{\partial P}\right)_T = 0$
   (d) $Tds = C_P dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$

   .
7. Discuss the factor to be considered for the choice of a refrigerant and given your recommendations. Discuss subcooling and super heating. Show them on P-H diagram.

8. (a) Explain absorption compression refrigeration working and derive the relation for the COP.

   (b) It is proposed to use a reversed Carnot cycle for cooling and heating. The work supplied to the unit is 10kW. If the COP = 3.5 for cooling, determine the ratio of temperatures of the reservoirs between which the device is working, the rate of refrigeration and the COP for heating.

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1. A cold storage is to be maintained at -5^0 spended C with the surroundings are at 35^0C. The heat leakage from the surroundings into the cold storage is estimated to the 29KW. The actual COP of the refrigeration plant is 1/3rd of an ideal plant working between the same temperature. Find the power required to drive the plant.

2. (a) What is the difference the continuity equation and the Bernoulis equation.
   (b) One kg of water 30^0C and 100 kpa is continuously heated in the atmosphere till it is completely evaporated. Determine the heat and work interactions. Data: At 30^0C: Sp. Vol. of water = 0.001004 m^3/kg Sp. Vol. of water vapour=1.6949 m^3/kg Heat content of vapour and water liquid are 2675.47 and 125.6 kJ/kg. Respectively.

3. Write short notes on the following:
   (a) Polytropic process.
   (b) Ideal gas law application to equations of state.
   (c) Laws of corresponding states and acentric factor.

4. Determine the molar volume of n-butane at 510k and 25 bar by each of the following:
   (a) The ideal gas equation
   (b) The generalized compressibility factor correlation.

   Data: $T_C = 425K, P_C = 38bar, Z^o = 0.865$. Acentric factor can be neglected.

5. Prove $\oint \frac{dQ}{T} \leq 0$. How it lead to entropy.

6. (a) Using Maxwell's equation. Prove $\Delta S\, C_P\, 1n\frac{T_2}{T_1}$.
   (b) Determine the increase in entropy of solid magnesium when the temperature is increased from 300 K to 800 K at atmosphere pressure. The heat capacity is given as $C_P = 26.04 + 5.58610^{-3} + 28.47610^4 T^{-2}$.

7. Give a schematic diagram of an absorption refrigeration unit propose a relation for thermal Efficiency. Discuss, in brief, two absorption refrigeration on unit used in industry.

8. A Carnot engine is couple to a Carnot refrigerator so that all the work produced by the engine is used by the refrigerator in extraction of heat from a heat reservoir at 0^0C at the rate of 50kJ s^{-1}. The source of energy for the carnot engine is a heat reservoir at 25^0C. If both the devices discard heat to the surroundings at 25^0C, how much heat does the engine absorb from its heat source reservoir?

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