T.E / V / CBGS / Chem / CET-II

Chemical Engineering Thermodynamics - II

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Q.P.Code No.: **5708**

(3 Hours) [Total Marks :80

Note: 1. Question No. one is compulsory.
2. Attempt any three out of remaining five questions.
3. In all four questions to be attempted.
4. Figures in brackets on right hand side indicate full marks.
5. Assume suitable data if needed and justify the same.

Q1a. Write short notes on Thermodynamic equilibrium. (05)
b. Write short notes on Gibbs Duhem Equation. (05)
c. Explain Vandervaal's equation. (05)
d. Expalin properties of refrigerants. (05)

Q2a. For binary solution the activity coefficient of component1 is $\ln\gamma_1 = Ax_2^2$, where A is constant. x_2 is mole fraction of component 2. Obtain an expression for activity coefficient of component 2 in the same solution. (07)
b. What are azeotropes? What is the effect of pressure on the azeotropic composition? (06)
c. Derive the relationship between the mole fraction of the components taking part in the reaction and the extent of the reaction. (07)

Q3a. Show that the fugacity of a gas obeying the Vanderwaal's equation of state is given by:

$$\ln f = \frac{b}{v-b} - \frac{2a}{RTV} + \ln\frac{RT}{V-b}$$ (10)

b. Describe the procedure to find the partial molar properties using the graphical method. (10)

Q4a. A gas mixture containing 25% CO, 55% H_2 and 20% inert gas is to be used for methanol synthesis. The gases issue from the catalyst chamber in chemical equilibrium with respect to the reaction: $CO_{(g)} + 2H_{2(g)} \rightarrow CH_3OH_{(g)}$ at pressure of 300 bar and temperature of 625K. Assume that the equilibrium mixture forms an ideal solution and k_p and k_φ are 4.9×10^{-5} and 0.35 respectively. What is the percent conversion of CO? (10)
b. For a binary system of components A and B the activity coefficient are given by the relation $\ln\gamma_1 = 0.9761x_B^2$. The vapor phase data in bars are given by

$$\ln p_A^0 = 9.7321 - \frac{2866.6}{t+217.88} \quad ; \quad \ln p_B^0 = 12.0586 - \frac{3667.7}{t+226.18}$$

t is in ^{0}C. Does this system form an azeotrope at 71.7^{0}C? If so at what composition? (10)

07/12/15

T.E/V/CBAS/Chem/C

Q5a. A vapour compression refrigeration unit using Freon-12 operates between 151kpa and 746.6kpa. The fluid leaving the evaporator is saturated vapour and leaves the condenser at 303k. Calculate: (i) Refrigeration effect. (ii) Power required. (iii) COP. (iv) mass flow of refrigerant for refrigeration capacity of 4 Tons of refrigeration. Properties of Freon-12:

P_s kpa	T_s ^{0}k	V_s m^3/kg	H_L kJ/ kg	H_V kJ/ kg	Entropy kJ/ kg^{0}k
151	253	0.1093	17.81	179.63	0.7123
746.6	303	0.0236	64.77	201.10	0.6903

(12)

b. What is standard heat of reaction and derive an expression for effect of temperature on standard heat of reaction?

(08)

Q6. Attempt the following questions :

a. Explain vapour absorption refrigeration cycle with neat sketch.

(10)

b. Explain various methods to determine thermodynamic critical properties with appropriate equations.

(10)