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SE-8254

B. E. III (Sem. V) Examination

April / May – 2011

Chemical Engg. Thermo. - II

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - 3 (Sem. 5)**

Name of the Subject :

☛ **Chemical Engg. Thermo. - 2**

☛Subject Code No. : **8 2 5 4** ☛Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) Assume suitable data wherever necessary and clearly mention them.

(3) Figures to the right indicate full marks.

(4) Attempt all questions.

(5) Use graph and steam tables wherever required.

1 (a) Answer the following : **5×2=10**

(1) Define chemical potential and write fundamental property relation for an open system. **2**

(2) The fugacity coefficient is the ratio of _____ and _____ in pure species. **2**

(3) Write the full form of NRTL and UNIQUAC and state its application. **2**

(4) Write the equations for property change of mixing in terms of Gibbs energy, entropy, volume and enthalpy. **2**

(5) State the Gibbs theorem for parital molar property. **2**

(b) Answer the following : **10**

(1) Assuming 2-propanol and 1-propanol form an ideal solution, prepare t-x-y diagram at 760 bar pressure. The antoire constants for the system are given below :

	A	B	C
2-propanol -	8.8729	2010.330	252.636
1-propanol	8.37845	1788.020	227.438

(2) Define Poynting factor and state its application. **2**

2 Attempt any two : **16**

(a) Derive equations of enthalpy and entropy for an ideal gas mixture.

(b) The need arises in a laboratory for 2000 cm^3 of an anitifreeze consisting of a 30 mole % solution of methanol in water. What volumes of pure methanol and of pure water at 25°C must be mixed to form the 2000 cm^3 of antifreeze, also at 20°C ? Partial molar volumes for methanol and water in a 30 mole % methanol solution at 25°C are :

Methanol(1) $\overline{V_1}$ =38.632 cm^3/mol

Water(2) = $\overline{V_2}$ =17.765 cm^3/mol

For the pure species at 25°C

Methanol(1) : V_1 =40.727 cm^3/mol

Water(2) : V_2 =18.068 cm^3/mol.

(c) The system acetone (1) / acetonitrile (2) / nitromethane (3) at 80°C and 100 kPa has the overall composition, $Z_1 = 0.45$, $Z_2 = 0.35$, $Z_3 = 0.20$. Assuming that Raoult's law is appropriate to this system, determine L, V, (x_i) and (y_i). The vapour pressures of the pure species at 80°C are $P_1^{sat} = 195.75$, $P_2^{sat} = 97.84$, $P_3^{sat} = 50.32$ kPa.

3 Attempt any **two** : **14**

(1) Discuss p-xy and T-xy diagram for vapour liquid equilibrium. **7**

(2) Explain any three models for excess Gibbs energy. **7**

(3) Derive the equation for fundamental property relation for an open system. **7**

4 (a) Answer the following : **1×8=8**

(1) What is UCST and LCST ?

(2) Mention the relation for the mole fraction of species related to progress of variable for multiple chemical reation.

(3) What is the effect of temperature on equilibrium constant for an exothermic reaction ?

(4) Write down phase rule for non-reacting system.

(5) Define chemical reaction equilibrium.

(6) Write down law of mass action.

(7) Designate the stability criteria in terms of activity coefficient.

(8) What is the unit of equilibrium constant.

(b) The equilibrium constant K_c for the water-gas shift reaction : **1×8=8**

$$CO_{2(g)} + H_{2(g)} \longrightarrow CO_{(g)} + H_2O_{(g)}$$

at 298.15 K is 8.685×10^{-6}. Estimate the value of K_a at 1000 K assuming that ΔH^o is constant in the temperature range 298.15 K to 1000 K.

ΔH_f^o for $CO_{2(g)}$ = -393.978 kJ/mol

$CO_{(g)}$ = -110.532 kJ/mol

$H_2O_{(g)}$ = -241.997 kJ/mol.

5 Attempt any two : **8×2=16**

(a) Determine the number of degrees of freedom F for each of the following systems.

(i) A system of two miscible non-reacting species which exists as an azeotrope in vapor/liquid equilibrium.

(ii) A system prepared by partially decomposing $CaCO_3$ into an evaluated space.

(iii) A system prepared by partially decomposing NH_4Cl into an evacuated space.

(b) In the synthesis of methanol from $CO_{(g)}$ and $H_{2(g)}$ at 500K and 5 bar, Estimate the degree of conversion of $CO_{(g)}$ if the reactor is fed with a mixture of $CO_{(g)}$, $H_{2(g)}$ and $CH_3OH_{(g)}$ in the mole ratio 1:2:0.02. $K_a=4.973 \times 10^{-3}$.

(c) Describe the effect of operating conditions on degree of conversion at equilibrium.

6 Attempt any three : **6×3=18**

(a) Describe p-x-y diagram for partically miscible system at constant temperature.

(b) Relation of equilibrium to composition in case-phase 4 liquid phase reaction.

(c) Application of equlibrium criteria to chemical reactions.

(d) Evaluate equlibrium constant in terms of standard Gibbs free energy.
