Code No: RR210803 **RR** **Set No. 2**

II B.Tech I Semester Examinations,November 2010
MATERIAL AND ENERGY BALANCE
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) If a solute forms a hydrate, how is the standard heat of solution of hydrates determined?
   (b) What is the heat of hydration?
   (c) Calculate the standard heat of solution of $CaCl_2.6H_2O$ to form a solution containing 10 moles of water per mole of $CaCl_2$.
   ΔH_f at 25°C and 1 atm are as follows: $CaCl_2$= -794960 J
   H_2O = -285840 J
   $CaCl_2.6H_2O$ = -2607259.6 J
   ΔH_s at 25^0C, for $CaCl_2$ (n_1 = 10) = -64852 J [5+5+6]

2. It is proposed to recover acetone, which is used as a solvent in an extraction process, by evaporation in to a stream of nitrogen. The nitrogen enters the evaporator at a temperature of 30^0C containing acetone such that its dew point is 10^0C. It leaves at a temperature of 25^0C with a dew point of 20^0C. The barometric pressure is constant at 750 mm Hg. Calculate
   (a) The vapor concentrations of the gases entering and leaving the evaporator, expressed in moles of vapor per mole of vapor free gas.
   (b) The moles of acetone evaporated per mole of vapor free gas passing through the evaporator.
   (c) The weight of acetone evaporated per 1000 m^3 of gases entering the evaporator.
   (d) The volume of gases leaving the evaporator per 1000 m^3 entering.
   Vapor pressure of acetone:
   116 mm Hg at 10^0C.
   185 mm Hg at 20 ^{0}C. [4×4]

3. (a) A dryer system handles 1000 kg/day of wet solids. The wet solids containing 50% solids and 50% water are fed to the first drier. From the first drier the product that comes out has 20% moisture. This is admitted to the second drier from which the product coming out has 2% moisture. Calculate
      i. the % of original water that is removed.
      ii. The final weight of the product.
   (b) Formaldehyde is produced from Methanol in a catalytic reactor by the reaction $CH_3OH \rightarrow HCHO + H_2$. If the conversion of methanol is 65% calculate the required feed rate of methanol if the production rate of formaldehyde is 1000 kg/hr. [8+8]

4. Calculate the heat that is available by coooling the flue gases having the following volumetric composition from 300^0 C to 25^0 C.
CO2 .. 10.32 ; CO ..0.37 ; O2 ..5.72
N2 .. 75.76 ; H2 O..7.83
Cp=a+b T + c T2 Cp in cal/gmol - k, T in K
a b x 10^3 C x 10^6

CO_2	6.339	10.140	-3.415
CO	6.350	1.811	-0.267
O_2	6.117	3.167	-1.005
N_2	6.457	1.389	-0.069
H_2O	7.136	2.640	0.046

[16]

5. (a) Write short notes on
   i. Critical properties.
   ii. Effect of temperature on vapor pressure.
   (b) What are reference substance plots? Discuss about equal-pressure. reference-substance plots and equal-temperature reference-substance plots giving examples. [8+8]

6. (a) Define the following:
   i. Partial pressure
   ii. Pure-component volume.
   (b) Prove that for an ideal gas mixture, the partial pressure of a component of the mixture is equal to the product of total pressure and the mole fraction of that component. [4+4+8]

7. Copperas (crude ferrous sulfate) is purified by dissolving it in water and recrystallizing it in a crystallizer. First copperas is dissolved in pure water to give a solution containing 28% $FeSO_4$ (by weight). The solution is cooled to 283K to give out the crystals of $FeSO_4.7H_2O$.The loss of water due to evaporation during the cooling operation is 5% on the basis of total solution, charged to the crystalliser. It is desired to yield 0.5 T of $FeSO_4.7H_2O$ crystals. The original copperas contains 96% $FeSO_4.7H_2O$ (by weight). Find the quantity of the copperas charged to the crystalliser. The solubility of $FeSO_4$ at 283K is 20.51 gm per 100 gm water. Assume the solubility of $FeSO_4$ at 283K is unaffected by impurities present in copperas. [16]

8. (a) Nitric acid and water forms a maximum boiling azeotrope containing 62.2 mole % water (boiling temperature is 130.6^0C). Find the composition of the azeotrope by weight %and mole % of TEA in the solution. Chemical formula of TEA is $N(CH_2CH_2OH)_3$.
   (b) The solubility of methyl bromide in methanol is 44 kg per 100 kg at 298K. Find the weight fraction and mole fraction of methanol in the saturated solution.Atomic weight of Bromine is 79.9. [8+8]

Code No: RR210803 **RR** **Set No. 2**

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Code No: RR210803 **RR** **Set No. 4**

II B.Tech I Semester Examinations,November 2010
MATERIAL AND ENERGY BALANCE
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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2. (a) Nitric acid and water forms a maximum boiling azeotrope containing 62.2 mole % water (boiling temperature is 130.6^0C). Find the composition of the azeotrope by weight %and mole % of TEA in the solution. Chemical formula of TEA is $N(CH_2CH_2OH)_3$.

   (b) The solubility of methyl bromide in methanol is 44 kg per 100 kg at 298K. Find the weight fraction and mole fraction of methanol in the saturated solution.Atomic weight of Bromine is 79.9. [8+8]

3. It is proposed to recover acetone, which is used as a solvent in an extraction process, by evaporation in to a stream of nitrogen. The nitrogen enters the evaporator at a temperature of 30^0C containing acetone such that its dew point is 10^0C. It leaves at a temperature of 25^0C with a dew point of 20^0C. The barometric pressure is constant at 750 mm Hg. Calculate

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   (b) The moles of acetone evaporated per mole of vapor free gas passing through the evaporator.

   (c) The weight of acetone evaporated per 1000 m^3 of gases entering the evaporator.

   (d) The volume of gases leaving the evaporator per 1000 m^3 entering.
   Vapor pressure of acetone:
   116 mm Hg at 10^0C.
   185 mm Hg at 20 ^{0}C. [4×4]

4. (a) If a solute forms a hydrate, how is the standard heat of solution of hydrates determined?

(b) What is the heat of hydration?

(c) Calculate the standard heat of solution of $CaCl_2.6H_2O$ to form a solution containing 10 moles of water per mole of $CaCl_2$.
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Cp=a+b T + c T2 Cp in cal/gmol - k, T in K

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CO_2	6.339	10.140	-3.415
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   (b) Prove that for an ideal gas mixture, the partial pressure of a component of the mixture is equal to the product of total pressure and the mole fraction of that component. [4+4+8]

8. (a) Write short notes on
   i. Critical properties.
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   (b) What are reference substance plots? Discuss about equal-pressure. reference-substance plots and equal-temperature reference-substance plots giving examples. [8+8]

Code No: RR210803 **RR** **Set No. 4**

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Code No: RR210803 **RR** **Set No. 1**

II B.Tech I Semester Examinations,November 2010
MATERIAL AND ENERGY BALANCE
Chemical Engineering

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

Answer any FIVE Questions
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Code No: RR210803 **RR** **Set No. 1**

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Code No: RR210803 **RR** **Set No. 3**

II B.Tech I Semester Examinations,November 2010
MATERIAL AND ENERGY BALANCE
Chemical Engineering

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