Code No: NR210803 **NR** **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. An evaporator is fed with 15000 kg/hr of a solution containing 10% NaCl, 15% NaOH and the rest water. In the operation some water is evaporated and NaCl gets precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and the rest water. Calculate
   (a) kg/hr of water evaporated.
   (b) kg/hr of salt precipitated.
   (c) kg/hr of thick liquor. [5+5+6]

2. (a) How does the heat of vaporization of a substance vary with its temperature and pressure?
   (b) The latent heat of vaporization of ethyl alcohol is experimentally found to be 204 cal per gram at its normal boiling point of 78^0C. Its critical temperature is 243^0C. Estimate the heat of vaporization at a temperature of 180^0C. [8+8]

3. (a) A gas mixture contains 0.274 kg mole of HCl, 0.337 kg mole of nitrogen and 0.089 kg mole of oxygen. Calculate
      i. The volume occupied by the mixture and
      ii. Its density in kg/m^3 at a pressure of 2000 mm Hg and temperature of 30^0C.
   (b) Write about the applications of ideal gas law. [8+8]

4. Write notes on
   (a) enthalpy-concentration charts
   (b) Partial molar enthalpy [8+8]

5. (a) What is the difference between the wet and dry bulb temperatures. Explain why the slope of the wet bulb lines are essentially the same as the slope of the adiabatic cooling lines for gaseous air and water mixtures.
   (b) A stream of gas at 30^0C, 760 mm Hg and 50% saturated with water vapor is passed through a drying tower where 90% of water is removed. Calculate the kg of water removed per 50 m^3 of entering gas.
   Saturation humidity, Hs = 0.027 kg water/kg dry air. [8+8]

6. A gas has the following composition by volume: CO_2 2.8%, $C_{2.7}H_{4.7}$ (unsaturated) 8.5%, O_2 0.7%, H_2 39.6%, CO 32.8%, $C_{1.1}H_{4.2}$ (paraffins) 10.2%, N_2 5.4%. Estimate

the theoretical amount of oxygen to be supplied for the complete combustion of 1 mole of the gas and also estimate the theoretical amount of air to be supplied as the source of oxygen. [16]

7. (a) In the decomposition of $KClO_3$,

$$2KClO_3 \text{ - - - - - } \rightarrow 2KCl + 3O_2,$$

   i. Calculate the amount of oxygen that evolves on decomposition of 12.9 gm of $KClO_3$.
   ii. Calculate the amount of $KClO_3$ for evolution of 5 gm of oxygen.

   (b) A solution of caustic soda in water contains 20% NaOH by weight at 333K. The density of the solution is 1.196 kg/L. Find the molarity, normality and molality of the solution. [4+4+8]

8. (a) State Raoult's law. What are its limitations?

   (b) Estimate the vapor phase composition at 60^0C in equilibrium with a liquid mixture containing 40 mole% benzene and 60 mole% toluene. Also calculate the composition of the liquid mixture, which boils at 90^0C and 101.32 kPa. Vapor pressure data is given as: [8+8]

Temp. ^{0}C	Vapor pressure of Benzene, kPa	Vaporpressure of toluene,kPa
60	51.3	18.7
90	135.05	54.4

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Code No: NR210803 **NR** **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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1. (a) How does the heat of vaporization of a substance vary with its temperature and pressure?
   (b) The latent heat of vaporization of ethyl alcohol is experimentally found to be 204 cal per gram at its normal boiling point of 78^0C. Its critical temperature is 243^0C. Estimate the heat of vaporization at a temperature of 180^0C. [8+8]

2. (a) A gas mixture contains 0.274 kg mole of HCl, 0.337 kg mole of nitrogen and 0.089 kg mole of oxygen. Calculate
      i. The volume occupied by the mixture and
      ii. Its density in kg/m^3 at a pressure of 2000 mm Hg and temperature of 30^0C.
   (b) Write about the applications of ideal gas law. [8+8]

3. An evaporator is fed with 15000 kg/hr of a solution containing 10% NaCl, 15% NaOH and the rest water. In the operation some water is evaporated and NaCl gets precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and the rest water. Calculate
   (a) kg/hr of water evaporated.
   (b) kg/hr of salt precipitated.
   (c) kg/hr of thick liquor. [5+5+6]

4. Write notes on
   (a) enthalpy-concentration charts
   (b) Partial molar enthalpy [8+8]

5. (a) What is the difference between the wet and dry bulb temperatures. Explain why the slope of the wet bulb lines are essentially the same as the slope of the adiabatic cooling lines for gaseous air and water mixtures.
   (b) A stream of gas at 30^0C, 760 mm Hg and 50% saturated with water vapor is passed through a drying tower where 90% of water is removed. Calculate the kg of water removed per 50 m^3 of entering gas.
   Saturation humidity, Hs = 0.027 kg water/kg dry air. [8+8]

6. (a) In the decomposition of $KClO_3$,

$$2KClO_3 \text{ - - - - - } \rightarrow 2KCl + 3O_2,$$

i. Calculate the amount of oxygen that evolves on decomposition of 12.9 gm of $KClO_3$.

ii. Calculate the amount of $KClO_3$ for evolution of 5 gm of oxygen.

(b) A solution of caustic soda in water contains 20% NaOH by weight at 333K. The density of the solution is 1.196 kg/L. Find the molarity, normality and molality of the solution. [4+4+8]

7. A gas has the following composition by volume: CO_2 2.8%, $C_{2.7}H_{4.7}$ (unsaturated) 8.5%, O_2 0.7%, H_2 39.6%, CO 32.8%, $C_{1.1}H_{4.2}$ (paraffins) 10.2%, N_2 5.4%. Estimate the theoretical amount of oxygen to be supplied for the complete combustion of 1 mole of the gas and also estimate the theoretical amount of air to be supplied as the source of oxygen. [16]

8. (a) State Raoult's law. What are its limitations?

(b) Estimate the vapor phase composition at 60^0C in equilibrium with a liquid mixture containing 40 mole% benzene and 60 mole% toluene. Also calculate the composition of the liquid mixture, which boils at 90^0C and 101.32 kPa. Vapor pressure data is given as: [8+8]

Temp. ^{0}C	Vapor pressure of Benzene, kPa	Vaporpressure of toluene,kPa
60	51.3	18.7
90	135.05	54.4

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Code No: NR210803 **NR** **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
All Questions carry equal marks

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1. Write notes on
   (a) enthalpy-concentration charts
   (b) Partial molar enthalpy [8+8]

2. (a) What is the difference between the wet and dry bulb temperatures. Explain why the slope of the wet bulb lines are essentially the same as the slope of the adiabatic cooling lines for gaseous air and water mixtures.
   (b) A stream of gas at 30^0C, 760 mm Hg and 50% saturated with water vapor is passed through a drying tower where 90% of water is removed. Calculate the kg of water removed per 50 m^3 of entering gas.
   Saturation humidity, Hs = 0.027 kg water/kg dry air. [8+8]

3. (a) How does the heat of vaporization of a substance vary with its temperature and pressure?
   (b) The latent heat of vaporization of ethyl alcohol is experimentally found to be 204 cal per gram at its normal boiling point of 78^0C. Its critical temperature is 243^0C. Estimate the heat of vaporization at a temperature of 180^0C. [8+8]

4. A gas has the following composition by volume: CO_2 2.8%, $C_{2.7}H_{4.7}$ (unsaturated) 8.5%, O_2 0.7%, H_2 39.6%, CO 32.8%, $C_{1.1}H_{4.2}$ (paraffins) 10.2%, N_2 5.4%. Estimate the theoretical amount of oxygen to be supplied for the complete combustion of 1 mole of the gas and also estimate the theoretical amount of air to be supplied as the source of oxygen. [16]

5. (a) State Raoult's law. What are its limitations?
   (b) Estimate the vapor phase composition at 60^0C in equilibrium with a liquid mixture containing 40 mole% benzene and 60 mole% toluene. Also calculate the composition of the liquid mixture, which boils at 90^0C and 101.32 kPa. Vapor pressure data is given as: [8+8]

Temp. ^{0}C	Vapor pressure of Benzene, kPa	Vaporpressure of toluene,kPa
60	51.3	18.7
90	135.05	54.4

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ii. Calculate the amount of $KClO_3$ for evolution of 5 gm of oxygen.

(b) A solution of caustic soda in water contains 20% NaOH by weight at 333K. The density of the solution is 1.196 kg/L. Find the molarity, normality and molality of the solution. [4+4+8]

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(b) Write about the applications of ideal gas law. [8+8]

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(a) kg/hr of water evaporated.

(b) kg/hr of salt precipitated.

(c) kg/hr of thick liquor. [5+5+6]

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Code No: NR210803 **NR** **Set No. 3**

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) What is the difference between the wet and dry bulb temperatures. Explain why the slope of the wet bulb lines are essentially the same as the slope of the adiabatic cooling lines for gaseous air and water mixtures.
   (b) A stream of gas at 30^0C, 760 mm Hg and 50% saturated with water vapor is passed through a drying tower where 90% of water is removed. Calculate the kg of water removed per 50 m^3 of entering gas.
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2. (a) State Raoult's law. What are its limitations?
   (b) Estimate the vapor phase composition at 60^0C in equilibrium with a liquid mixture containing 40 mole% benzene and 60 mole% toluene. Also calculate the composition of the liquid mixture, which boils at 90^0C and 101.32 kPa. Vapor pressure data is given as: [8+8]

Temp. ^{0}C	Vapor pressure of Benzene, kPa	Vaporpressure of toluene,kPa
60	51.3	18.7
90	135.05	54.4

3. (a) In the decomposition of $KClO_3$,
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   i. Calculate the amount of oxygen that evolves on decomposition of 12.9 gm of $KClO_3$.
   ii. Calculate the amount of $KClO_3$ for evolution of 5 gm of oxygen.
   (b) A solution of caustic soda in water contains 20% NaOH by weight at 333K. The density of the solution is 1.196 kg/L. Find the molarity, normality and molality of the solution. [4+4+8]

4. A gas has the following composition by volume: CO_2 2.8%, $C_{2.7}H_{4.7}$ (unsaturated) 8.5%, O_2 0.7%, H_2 39.6%, CO 32.8%, $C_{1.1}H_{4.2}$ (paraffins) 10.2%, N_2 5.4%. Estimate the theoretical amount of oxygen to be supplied for the complete combustion of 1 mole of the gas and also estimate the theoretical amount of air to be supplied as the source of oxygen. [16]

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   (b) Partial molar enthalpy [8+8]

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