Code No: 07A30802 **R07** **Set No. 2**

II B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS CALCULATIONS
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 solution pressure? Explain.
   (b) A solution of sodium nitrate in water contains 1 kg of $NaNO_3$ per 10 kg of water. Calculate the amount of ice formed in cooling 1000 kg of this solution to a temperature of -15^0C. Concentration of saturated solution at -15^0C is given by 6.2 kmol of $NaNO_3$ per 1000 kg of water. [4+12]

2. A large chamber contains dry N_2 at 27 ^{0}C and 101.3 kPa. water is injected in to the chamber. After saturation of the N_2 with water vapor, the temperature in the chamber is 27 ^{0}C:
   (a) What is the pressure inside the chamber after saturation?
   (b) How many moles of H_2O per mole of N_2 are present in the saturated mixture? [8+8]

3. Ammonia is made by the reaction between hydrogen and N_2 according to the reaction

   $N_2+3H_2 \rightarrow 2\ NH_3$

   If the reaction is carried out at 50 bar and 600 K, What volumes of nitrogen and H_2 at these conditions are theoretically required for producing 1000 kg of ammonia and what will be the volume of NH_3 produced at the reactor conditions. [16]

4. Dry air at 295K and 100 kPa is bubbled through benzene. If the saturated air leaves at 300K and 100 kPa; how many kilograms of benzene are evaporated per 100m^3 of entering air. The vapour pressure of benzene (kPa.) is given by: [16]

   $1nP^* = 13.885 - \frac{2788.51}{T-52.36}$

5. Calculate the amount of heat needed to raise the temperature of 1 mol of a gaseous mixture containing 79% N_2 and 21% O_2 by volume from 200 to 1200^{0}C.
   C_p for $N_2 = 6.457 + 1.389 \times 10^{-3}\ T - 0.069 \times 10^{-6}\ T^2$
   C_p for $O_2 = 6.117 + 3.167 \times 10^{-3}\ T - 1.005 \times 10^{-6}\ T^2$
   Here C_p is in Cal/(mol.K) and T is in K. [16]

6. (a) A solution has a gravity of 100^0 Twaddell. Calculate its specific gravity and its gravity in degrees Baume.
   (b) An oil has a specific gravity at 60^0 / 60^{0}F of 0.790. Calculate its gravity in degrees API and degrees Baume. [8+8]

7. Molten sulfur at 140^0C is burnt with 30% excess air at 120^0C in a sulfur burner producing sulfur dioxide. Calculate the adiabatic reaction temperature using the following data:
   Standard heat of reaction = −70.96 kcal/mol
   Mean heat capacities in cal/mol.K :
   S(l) = 7.4
   SO_2(g) = 12.15
   O_2(g) = 7.14
   N_2(g) = 7.51
   Air = 7.00 [16]

8. (a) To prepare a solution of 50% sulfuric acid, a dilute waste acid containing 25% H_2SO_4 is combined with a concentrated acid containing 90% H_2SO_4. How many kg of the concentrated acid must be purchased for each 100 kg of dilute waste acid?

   (b) A mixed acid containing 65% H_2SO_4, 20% HNO_3 and 15% H_2O is to be made by blending the following:

      i. A spent acid containing 10% HNO_3, 60% H_2SO_4 and 30% H_2O.

      ii. A concentrated nitric acid containing 92% HNO_3 and 8% H_2O.

      iii. A concentrated sulfuric acid containing 95% H_2SO_4 and 5% H_2O.

      All percentages are on weight basis. How many kg of each acid must be used to obtain 1700 kg of the mixed acid? [8+8]

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Code No: 07A30802 **R07** **Set No. 4**

II B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS CALCULATIONS
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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   (b) A mixed acid containing 65% H_2SO_4, 20% HNO_3 and 15% H_2O is to be made by blending the following:
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      ii. A concentrated nitric acid containing 92% HNO_3 and 8% H_2O.
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4. (a) A solution has a gravity of 100^0 Twaddell. Calculate its specific gravity and its gravity in degrees Baume.
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   If the reaction is carried out at 50 bar and 600 K, What volumes of nitrogen and H_2 at these conditions are theoretically required for producing 1000 kg of ammonia and what will be the volume of NH_3 produced at the reactor conditions. [16]

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Code No: 07A30802 **R07** **Set No. 1**

II B.Tech I Semester Examinations,MAY 2011
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Chemical Engineering

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2. Ammonia is made by the reaction between hydrogen and N_2 according to the reaction
   N_2+3H_2 → 2 NH_3
   If the reaction is carried out at 50 bar and 600 K, What volumes of nitrogen and H_2 at these conditions are theoretically required for producing 1000 kg of ammonia and what will be the volume of NH_3 produced at the reactor conditions. [16]

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Code No: 07A30802 **R07** **Set No. 3**

II B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS CALCULATIONS
Chemical Engineering

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