Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech

PCCH 4203

Special Examination – 2012

CHEMICAL PROCESS AND CALCULATION

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

   (a) How many molecules are present in 700 gm of K_2CO_3 ?

   (b) Determine the volume of oxygen obtained under standard conditions, by the decomposition of 100 kg of potassium chlorate.

   (c) What are valency and equivalent weight ?

   (d) A body weighs 1 kg in air, 0.9 kg in water, and 0.8 kg in a liquid. Find the specific gravity of the liquid.

   (e) Define normality and molarity.

   (f) Explain yield and selectivity with example.

   (g) An automobile tyre is inflated to a pressure of 190 kPa at 273 K. If the pressure inside the tyre is not to exceed 250 kPa, what is the maximum temperature the tyre may be heated ?

   (h) What are wet bulb temperature and humid heat ?

   (i) Write Hess's law.

   (j) Differentiate between heat of solution and heat of mixing.

2. In the vapour-phase hydration of ethylene to ethanol, diethyl ether is obtained as a by-product.

   $$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

   $$2C_2H_4 + H_2O \rightarrow (C_2H_5)_2OH$$

   A feed mixture consisting of 60% ethylene, 3% inerts, and rest water is sent to a reactor. The products analyzed to contain 54% ethylene, 14% ethanol, 2% ether,

26% water, and rest inerts. Calculate: (i) conversion of ethylene and (ii) yield of ethanol and ether based on ethylene. 10

3. Natural gas is piped from the well at 300 K and 400 kPa. The gas is found to contain 93 % methane, 4 % ethane, and rest nitrogen. Calculate : (i) partial pressure of nitrogen, (ii) pure component volume of ethane in 10 m^3 of the gas, (iii) density at standard conditions in kg/m^3, and (iv) average molecular weight of the gas. 10

4. An aqueous solution of Na_2CO_3 contains 15 % carbonate by weight. 80 % of the carbonate is recovered as $Na_2CO_3.10H_2O$ by evaporation of water and subsequent cooling to 273 K. The solubility of Na_2CO_3 at 278 K is 9 % (weight). On the basis of 100 kg of solution treated, determine the quantity of crystals formed and the amount of water evaporated. 10

5. (a) Using humidity chart find the dew point, % RH and H for a mixture of air-water vapour system having DB = 35°C and WB = 26°C. 4

   (b) 10,000 kg/h of solution containing 20 % methanol is continuously fed to a distillation column. Distillate is found to contain 98 % methanol and waste solution from column carries 1 % methanol. All percentages are by wt %. Calculate the mass flow rate of distillate and product and the percent loss of methanol. 6

6. In a sulphuric acid plant, pyrites containing 50 % (weight) sulphur is burnt to give SO_2 which is subsequently converted to SO_3 in a converter. The analysis of the burner gas shows 9% SO_2 and 7% O_2. The cinder is analysed and it is found that it contains 3% sulphur as SO_3. Assuming that all the sulphur in the feed is burnt, calculate the weight of pyrites burnt per 100 kmol SO_3-free burner gas. 10

7. (a) Calculate the heat of reaction for the esterification of ethyl alcohol with acetic acid if the standard heats of combustion are: ethyl alcohol (l), - 1367 kJ/mol; acetic acid (l), - 872 kJ/mol; and ethyl acetate (l), - 2275 kJ/mol. 5

   (b) Discuss on the effect of temperature on heat of reaction. 5

8. Write short notes on any ***two*** : 5×2

   (a) Van der Waal's theory

   (b) Effect of temperature on heat capacity

   (c) Adiabatic flame temperature

   (d) Humidity chart.
