S.E - III Sem - Chem.

9/12/15

Process Calculations

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SE/III/CBGS/CHEM./PC

Q.P.No.: **5226**

(3 Hours) [Total Marks : 80

N.B.:- 1) Question no. 1 is compulsory.
2) Attempt any 03 questions out of remaining 05 questions.
3) Figures to the right indicate marks.

1. a) Two litres of NH_3 at 30°C and 20.265 kPa is neutralized by 135 ml of solution of H_2SO_4. Find the normality of the acid. 5

b) The ground nut seeds containing 45 % oil and 45 % solids are fed to expeller, the cake coming out of expeller is found to contain 80 % solids and 5 % oil. Find the percentage recovery of oil. 5

c) A sample of petrol contains 15% H_2 and 85% C by weight. Calculate the amount of air required for the complete combustion of 1 kg of petrol. Find the composition of the dry products on volume basis if 15 % excess air is supplied. 5

d) Define (i) Dry bulb temperature (ii) Absolute humidity 5

2. a) 5000 Kg of KCl are present in a saturated solution at 80°C. The solution is cooled to 20°C in an open tank. The solubilities of KCl at 80°C and 20°C are 55 and 35 parts per 100 parts of water. i) Assuming water equal to 3% by weight of solution is lost by evaporation, calculate the weight of crystals obtained. ii) Calculate the yield of crystals neglecting loss of water by evaporation; KCl crystallizes without any water of crystals. 10

b) Make the following conversions: i) Pressure of 2 atm to mm Hg ii) 127 lb/ft^3 to g/cm^3 iii) 499 g of $CuSO_4.5H_2O$ into moles iv) 3M K_2SO_4 to g/l v) 4.8 mg/ml $CaCl_2$ to normality. 10

3 a) The dilute acid containing 25% H_2SO_4 is concentrated by commercial grade sulphuric acid containing 98% H_2SO_4 to obtain desired acid containing 65% H_2SO_4. Find out the quantities of the acids required to make 1000 kg desired acid. 10

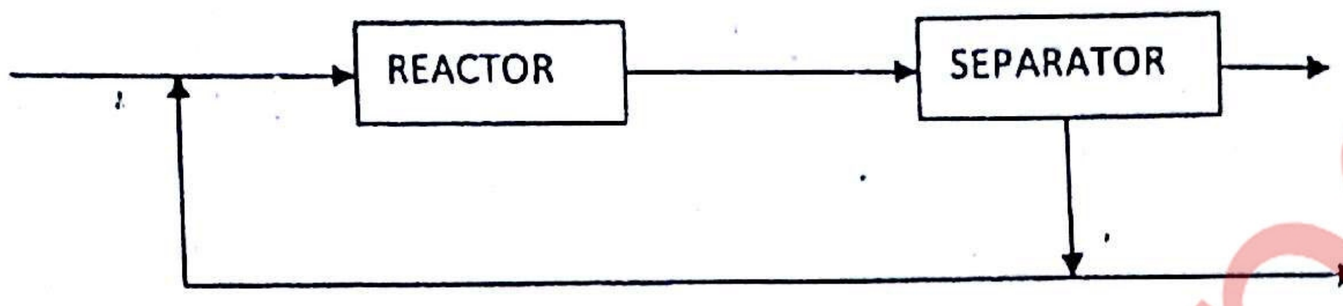
b) A feed to a continuous fractionating column analyses by wt. 50% benzene and 50% tolune. The analysis of the distillate shows 95 wt% benzene and 8 wt.% benzene as found in the bottom product. Calculate the amount of distillate and bottom product per 5000 kg of feed per hour. Also calculate % recovery of benzene. 10

4. a) Wood containing 40 % moisture is dried to 5 % moisture. What mass of water in kilogram is evaporated per kg of dry wood? 10

b) A sample of coal is found to contain 67.2 % carbon and 22.3 % ash (wt. basis). The refuse obtained at the end of combustion is analyzed to contain 7.1 % carbon and the rest ash. Compute the % of the original carbon remaining unburnt in the refuse. 10

5 a) For the reaction A → B, the process flow diagram is shown in following figure. The fresh feed of A contains 0.6% ofinerts by volume. Sixty five percentage conversion of A per pass is obtained. The concentration of inerts going into the reactor at point 1 must be held at 2.5% by volume. All streams are ideal gases and the process is steady-state. 10

(I) How many moles need to be recycled per mole of total feed to the reactor at point 1?
(II)How many moles to be purged?
(III) What is the overall conversion of A?



b) Calculate the heat that must be removed in cooling 32 kg of oxygen from 488 K (215°C) to 313 K (40°C) using Cp data. 10

$$C_p^\circ = a + bT + cT^2 + dT^3 \quad (kJ/kmol\text{-}K)$$

gas	a	b x 10^3	c x 10^6	d x 10^9
O_2	26.0257	11.7551	-2.3426	-0.5623

6 a) Calculate the theoretical flame temperature of a gas containing 20 % CO and 80 % N_2 when burned with 100 % excess air, both air and gas initially being at 25°C. 10

H_{298}° = -67,636 cal. T is in K and C_p in cal/(gmol-K) in following eqs.

For $CO_2 C_p = 6.339 + 0.01014\ T - 3.416 \times 10^{-6}\ T^2$

For $O_2 C_p = 6.117 + 0.003167\ T - 1.005 \times 10^{-6}\ T^2$

For $N_2 C_p = 6.457 + 0.001389\ T - 0.069 \times 10^{-6}\ T^2$

b) Calculate the standard heat of reaction of the following reaction 10

$$2FeS_2(s) + 11/2\ O_2(g) \longrightarrow Fe_2O_3(s) + 4SO_2(g)$$

Compound	$\triangle H_f^\circ$ (kJ/gmol) at 25°C
$FeS_2(s)$	-178.02
$Fe_2O_3(s)$	-822.70
$SO_2(g)$	-296.81
