ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

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10BT46

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Bioprocess Principles & Calculations

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following:
(i) Normality (ii) Parts / Million (iii) Henry's law (iv) Raoults law
(v) Molality **(05 Marks)**

b. Sodium chloride weighing 200 kg is mixed well with 600 kg potassium chloride. Find the composition of the mixture is weight percent and mole percent. **(07 Marks)**

c. When 2 grams of gas A is introduced into an evacuated flask at 298 K and pressure 101.325 KPa, if 3 gms of another gas B is then added to the same flask. The total pressure becomes 151.986 KPa assuming ideal behavior. Calculate the ratio of molecular weight as $M_A : M_B$ **(08 Marks)**

2 a. Fresh fruit juice 15% solids and 85% water by weight and is to be concentrated to contain 40% solids by weight. The by pass juice contains 15% solids, the solids leaving the evaporator contains 55%. Calculate and draw the block diagram.
(i) The fraction of juice that by passes the evaporator.
(ii) The concentrated juice produced per 100 kg of fresh fruit juices. **(10 Marks)**

b. Centrifuge is fed with a slurry containing 25% solids by weight and wet solids obtained after filtration are analyzed to contain 8% moisture by weight and filtrate is found to contain 200 ppm solids. If the centrifuge machine produces 100 kg per hour desired wet product and quantity of slurry to be handled is 5000 kg per batch.
Calculate (i) the time required for filteration of slurry.
(ii) Loss of solids in filterater per batch. **(10 Marks)**

3 a. Absorption system utilized for the absorption process of solute gas is 100 m^3/hr at 303 K at 101.325 KPa 15% of A by volume, Solvent containing 0.01 % of A by weight, Lean gas containing 1% by volume A and product solvent containing 1% A by weight. Calculate the mass flow rate of the solvent to the absorption tower (Assume molecular weight as 64) **(10 Marks)**

b. Dryer system handles 1000 kg/day of wet solids. Wet solids containing 50% solids and 50% water are fed to the first dryer. From the 1st dryer the product that comes out has 20% moisture. This is admitted to the 2nd from which the product carring out has 2% moisture. Calculate the % of original water that is removed in each dryer and final weight of the product. **(10 Marks)**

4 a. A combustion reactor is fed with butane and excess air combustion of butane and excess air combustion of butane is complete the composition of combustion gases on volume basis is given below:
$CO_2 - 9.39\%$, $H_2O - 11.73\%$, $O_2 - 4.7\%$, $N_2 - 74.18\%$
Find the percent excess air used and mole ratio of air to butane used. **(10 Marks)**

b. A feed containing 60 mole % A, 30 mole% b, 10 mole % inerts enters a reactor. The product leaving the reactor is found to contain 2 mole % A. Reacting taking place $2A + B \rightarrow C$. Find the % of original A getting converted to C. **(10 Marks)**

PART – B

5 a. A stream flowing at a rate of 15000 mol/hr containing 25 mole % N_2 and 75 mole % H_2 is to be heated from 298 K to 473 K. Calculate the heat that must be transferred using C_P° data given below:

$C_P^\circ = a + bT + cT^2 + dT^3$ KJ/kmol K **(10 Marks)**

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
N_2	29.5909	-5.41	13.1829	-4.968
H_2	28.6105	1.0194	-0.1476	0.769

b. Explain Hess's law of constant heat summation. **(05 Marks)**

c. If cooling tower water available at 298 K is used for heat duty, from 100 kg/W of methanol liquid at a temperature 303 K obtained by removing heat from saturated methanol vapour. Calculate the amount of heat to be removed.
Data boiling point T_B of Methanol = 337.8 K,
Latent heat of condensation of methanol = 1101.7 KJ/kg,
Specific heat of methanol = 2.7235 KJ/kgK. **(05 Marks)**

6 a. Explain the role of bioprocess engineer in the field of biotechnology. **(10 Marks)**

b. Explain with a neat sketch the manufacture of penicillin. **(10 Marks)**

7 a. The ultimate analysis of coal sample is given below: Carbon – 61.5%, H2 – 3.5%, S – 0.4%, Ash – 14.2%, Nitrogen – 1.8% and rest oxygen. Calculate :
(i) The theoretical oxygen requirement / unit wt of coal.
(ii) Theoretical drug air requirement / unit wt of coal.
(iii) Orsat analysis of flue gases when coal is burned with 90% excess dry air. **(10 Marks)**

b. A natural gas containing 85% methane and 15% ethane. Calculate the GHV of this fuel in KJ/kg from the standard heats of combustion of methane and ethane.

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$, $\Delta H_C^\circ = -802.62$ KJ/mol

$C_2H_6(g) + 3.5O_2 \rightarrow 2CO_2(g) + 3H_2O(g)$, $\Delta H_C^\circ = -1428.64$ KJ/mol

Latent heat of water at 298 K = 2442.5 KJ/kg **(10 Marks)**

8 a. Explain the importance of yield coefficient in the stoichiometry of biological processes giving at least 2 yield coefficient. **(08 Marks)**

b. Explain elemental balance for general bioprocess reaction. **(05 Marks)**

c. Explain biochemical equilibrium constant with significance. **(07 Marks)**

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