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CBCS SCHEME

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17BT44

Fourth Semester B.E. Degree Examination, June/July 2019
Bioprocess Principles and Calculations

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. A chemist is interested in preparing 500ml of 1 normal, 1 molar and 1 molal solution of H_2SO_4. Assuming the density of solution to be 1.075 g/cm^3, calculate the quantities of H_2SO_4 to be taken to prepare the solution. **(10 Marks)**

b. A natural gas has the following composition by volume, CH_4 = 82%, C_2H_6 = 12%, N_2 = 6%, Calculate: (i) Density of gas at 288K and 101.325 kPa (ii) Composition by weight % (iii) Average molecular weight. **(10 Marks)**

OR

2 a. An aqueous solution of K_2CO_3 is prepared by dissolving 43kg of K_2CO_3 in 100kg of water at 293K. Calculate molarity, normality and molality in solution. Density of solution is 1.3 kg/*l*. **(10 Marks)**

b. Define Daltons and Amagats law. **(04 Marks)**

c. What will be the % Na_2O content of lye containing 73% (by weight) caustic soda? **(06 Marks)**

Module-2

3 a. The feed containing 50% benzene and 50% toluene is fed to a distillation column at a rate of 5000 kg/hr. A top product contains 95% benzene and bottom product contains 92% toluene. All percentages are by weight. Calculate: i) the mass flow rates of top and bottom products and ii) percentage recovery of benzene. **(10 Marks)**

b. Soyabean seeds are extracted with hexane in batch extractor. The flaked seeds are found to contain 18.6% oil, 69% solid and 12.4% moisture (by weight). At the end of the extraction process cake (meal) is separated from hexane – oil mixture. The cake is analyzed to contain 0.8% oil, 87.7% solids and 11.5% moisture (by weight) find the percentage recovery of oil. **(10 Marks)**

OR

4 a. Crude oil is analyzed to contain 87% carbon 12.5% hydrogen and 0.5% Sulphur. Calculate the net calorific value of crude oil at 298 K.
Data: Gross calorific value of crude oil at 298K is 45071 kJ/kg oil. **(10 Marks)**

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

Module-3

5 a. In the production of sulphurtrioxide 100kmol of SO_2 and 100 kmol of O_2 are fed to a reactor. If the percent conversion of SO_2 is 80. Calculate the composition of the product stream on mole basis. **(10 Marks)**

b. A coke is known to contain 90% carbon and 10% non combustible ash (by weight)

i) How many moles of oxygen are theoretically required to burn 100kg of coke completely?

ii) If 50% excess air is supplied. Calculate the analysis. **(10 Marks)**

OR

6 a. A combustion chamber is fed with butane and excess air. Combustion of butane is complete. The composition of combustion of gases on volume basis is given below. CO_2 = 9.39%, H_2O = 11.73%, O2 = 4.70%, N_2 = 74.18%. Find % excess air used and mole ratio of air to butane used. **(10 Marks)**

b. Define the following: i) Yield ii) Selectivity iii) Limiting reactant iv) Excess reactant v) % excess. **(10 Marks)**

Module-4

7 a. A natural gas has the following composition on mole basis: CH_4 = 84%, C_2H_6 = 13%, N_2 = 3%. Calculate the heat to be added to heat 10 kmol of natural gas from 298K to 523K using the heat capacity data given below:

$CP^\circ = a + bT + cT^2 + dT^3$ kJ/kmol K

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CH_4	19.2494	52.1135	11.973	-11.3173
C_2H_6	5.4129	178.0872	-67.3749	8.7147
N_2	29.5909	-5.141	13.1829	-4.968

(10 Marks)

b. A natural gas has the following composition on mole basis. CH_4 = 84%, C_2H_6 = 13%, N_2 = 3%. Calculate: i) the heat added to heat 2 kmol of gas mixture from 311K to 533K ii) the heat to be added to heat 200kg of natural gas from 311k to 533k.

Data: C°_{pm} values in kJ/kmol/k

Gas	C°_{pm} (311-298K)	C°_{pm} (533-298k)
CH_4	36.0483	41.7800
C_2H_6	53.5240	67.4954
N_2	29.1317	29.3578

(10 Marks)

OR

8 a. Calculate the heat of formation of liquid ethyl acetate at 298K.

Data:

Standard heat of formation of $CO_2(g)$ = -393.51 kJ/mol

Standard heat of formation of $H_2O(l)$ = -285.83 kJ/mol

Standard heat of combustion of liquid ethylacetate $C_4H_8O_2 = \Delta H^\circ_C$ = -2230.91 kJ/mol

(10 Marks)

b. Obtain an empirical equation for calculating the heat of reaction at any temperature (T) in K for the reaction $CO(g) + 2H_2(g) \rightarrow CH_3OH$

Data: $\Delta H_R^\circ = -90.41$ kJ/mol

$CP^\circ = a + bT + cT^2 + dT^3$ (J/mol k)

Component	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO(g)	29.0277	-2.8165	11.6437	-4.7063
$H_2(g)$	28.6105	1.0194	-0.1476	0.769
$CH_3OH(g)$	21.137	70.843	25.86	-28.497

(10 Marks)

Module-5

9 a. Mention different unit operations involved in a typical bioprocess with a flow sheet. **(10 Marks)**

b. Define the following:
i) Maintenance coefficient
ii) Yield coefficient
iii) Specific growth rate
iv) Respiratory quotient
v) Proton oxygen ratio. **(10 Marks)**

OR

10 a. Assume that experimental measurements for a certain organism have shown that cells can convert 2/3 of substrate carbon to biomass
i) Calculate the stocheometric coefficients
$C_{16}H_{34} + aO_2 + bNH_3 \rightarrow c[C_{4.4}H_{7.3}N_{0.86}O_{1.2}] + dH_2O + eCO_2$
ii) Calculate yield coefficients Y_{x/O_2} and $Y_{x/s}$. **(12 Marks)**

b. Write a brief note on the historical developments of bioprocessing technology. **(08 Marks)**

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