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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: BIOPROCESS CALCULATIONS [BIO 2104]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.	The heat capacity of carbon dioxide gas is given by $C_P = 0.1978 + 1.059 * 10^{-4} T - 2.395 * 10^{-8} T^2$ Where C_P is in Btu/(lb ^oF) and T is in ^oF. Change the equation into the form in which C_P is given in kJ/(kmol K) and temperature is in K.	**5**
1B.	Discuss the different steps involved in Bioprocess development with a neat flow diagram.	**5**
2A.	In the production of a drug having a molecular weight of 192, the exit stream from the reactor flows at the rate of 10.3 L/min. The drug concentration is 41.2% (in water), and the specific gravity of the solution is 1.025. Calculate the concentration of the drug (in kg/L) in the exit stream, and the flow rate of the drug in k mol /min	**4**
2B.	Sodium chloride (Mol. Wt 58.5) weighing 600 kg is mixed with 200 kg potassium chloride (Mol. Wt 74.5). Find the composition of the mixture in (a) mass % (b) mole%	**3**
2C.	In a gas mixture consisting of hydrogen, nitrogen and carbon dioxide, the partial pressures are 25 kPa for hydrogen, 35 kPa for nitrogen and 140 kPa for CO_2. For 50 m^3 of the gas mixture at 400 K, determine the following: (a) The number of moles and mole fraction of hydrogen (b) The pure-component volume of hydrogen (c) The average molecular weight of the mixture	**3**
3A.	A triple effect evaporator is used to concentrate 1500 kg of aqueous solution from a concentration of 25 % solute to 75 % solute. Assuming equal amount vaporization in each effect, calculate the composition and weight of the solution entering the second and third evaporator	**7**

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3B.	The relationship between the pressure P and volume V of the air in a cylinder during the upstroke of a piston in an air compressor can be expressed as $P*V^K = C$ Where K and C are constants. During a compression test, the following data are taken: P (mm Hg): 760, 1140, 1520, 2280, 3040, 3800 V (Cm3): 48.3, 37.4, 31.3, 24.1, 20, 17.4 Determine the values of K and C that best fit the data. (Give both numerical values and units)	**3**
4A.	Chlorine is produced by the oxidation of hydrogen chloride gas with air $4\ HCl + O_2$ ----- > $2\ Cl_2 + 2\ H_2O$ The reaction is carried out at $1.2*10^5$ N/m^2 and 400 k. 50% excess oxygen is used and the reaction is only 80% complete. Calculate the following (a) The volume of air admitted per 100 m^3 of HCl if both air and HCl enter the reactor at 1 bar and 290 K. (b) The volume of gases leaving the reactor per 100 m^3 of HCl entering (c) The percentage composition by volume of the exit gas on a dry basis.	**6**
4B.	A distillation column is charged with aqueous solution of ethanol containing 35% ethanol by weight. The concentrated alcohol is withdrawn as the distillate containing 85% ethanol. The bottom product contains 5% ethanol. Determine the following: (a) The mass of distillate per 100 kg of feed. (b) The ratio of the mass of the distillate to mass of the residue.	**4**
5A.	Biological denitrification of nitrate containing waste waters can be described by the following overall reaction $NO_3^{-1} + a\ CH_3OH + H^+ \rightarrow b\ C_3H_7NO_2 + c\ N_2 + d\ CO_2 + e\ H_2O$ (a) Determine a, b, c, d and e, if $Y_{X/S}$ = 0.5 g X/g N. (b) Determine the degree of reduction of bacteria and methanol	**6**
5B.	Heat capacity data for gaseous SO_2 is given by the following equation: $C_P(\frac{k\ J}{kmol*K}) = 43.458 + 10.634*10^{-3}\ T - 5.945*\frac{10^5}{T^2}$ Calculate the heat needed to raise the temperature of 1 kmol pure Sulphur dioxide from 300 K to 1000 K	**4**