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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, DEC 2015/ JAN16

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.	If dibromopentane (DBP) has a specific gravity of 1.57, what is its density in g/cm^3 & lbm/ft^3, (Take density of water 1g/cm^3)	**2**
1B.	In biological systems, enzymes are used to accelerate the rates of certain biological reactions. Glucoamylase is an enzyme that aids in the conversion of starch to glucose. Experiments show that 1 µg mol of glucoamylase in a 4% starch solution results in a production rate of glucose of 0.6 µg mol/(mL. min). Determine the production rate of glucose for this system in the units of lb mol/(ft^3 .day)?	**4**
1C.	250 kg wet ammonium sulfate containing 50 kg moisture is sent to a dryer in order to remove 90 % of the moisture in the feed. Calculate the weight % of moisture on a wet basis and dry basis at the entrance and exit of the dryer.	**4**
2A.	The flow rate of a gas mixture consisting of 60% ethane, 25% hydrogen and 15% carbon dioxide is found to be 200 m3/h at 300 K and 1.2 bar. All % are in mole basis. (a) Determine the composition of the gas in weight percent (b) Express the composition in mol/L (c) What is the flow rate in kg/h	**6**
2B.	Determine the molar volume of gaseous methane at 300 K and 600 bar by the following methods: (a) Using the vander Waals equation given that a = 0.2285 $\frac{N*m^4}{mol^2}$; b = 4.27*10^{-5} m^3/mol (b) Using the Redlich-Kwong equation given that T_C = 191.1 K and P_C = 46.4 bar.	**4**

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3A. A 100 kg mixture of 27.8% acetone and 72.2 % of chloroform by mass is to be extracted with a mixed solvent at 298 K. The mixed solvent of an unknown composition is known to contain water and acetic acid. The mixture of the original and mixed solvent is shaken well, allowed to attain equilibrium, and separated into two layers. The composition of the two layers are given below

Composition of Immiscible layers:

Layer	Composition, mass%			
	Acetone	Chloroform	Water	Acetic cid
Upper	7.5	3.5	57.84	31.16
Lower	20.3	67.3	2.8	9.6

Find

(a) The quantities of the two layer

(b) The mass ration of the mixed solvent to the feed mixture

(c) The composition of the mixed solvent in Wt %

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3B. A solution of 65 g of $MgSO_4$ per 100 g of water cooled from 353 K to 323 K. During the process 9% water gets evaporated. For 100 Kg of original feed solution calculate the amount of $MgSO_4.7H_20$ crystals obtained and the quantity of mother liquor left. At 323 K the mass fraction of $MgSO_4$ should be 0.3. (MW of $MgSO_4.7H_2O$ – 246)

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4A. Two thermocouples (temperature measurement devices) are tested by inserting their probes in boiling water, recording the readings, removing and drying the probes, and then doing it again. The results of five measurements are as follows:

Thermocouple A (^oC)	72.4	73.1	72.6	72.8	73
Thermocouple B (^oC)	97.3	101.4	98.7	103.1	100.4

(a) For each set of temperature readings, calculate the sample mean, and the sample standard deviation.

(b) Which thermocouple readings exhibit the higher degree of scatter? Which thermocouple is more accurate?

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4B. Formaldehyde is produced by the gas phase oxidation of methanol with air over a catalyst

$$CH_3OH + \frac{1}{2}O_2 \text{ ------ > } HCHO + H_2O$$

100 m3 of methanol vapor at $1.013*10^5$ N/m^2 and 550 K is to be treated. If 10% excess air is supplied and the reaction is only 80% complete, calculate

(a) The composition of the product gas

(b) The volume of product gases at $1.5*10^5$ N/m^2 and 800 K.

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<td>5A.</td>
<td>A natural gas has the following composition on mole basis:
CH_4 = 84%, C_2H_6 = 13% and N_2 = 3%
Calculate the amount of heat required to heat 10 kmol of natural gas from 298 K to 523 K using heat capacity data given below
$C_p = a + bT + cT^2 + dT^3$, kJ/ (kmol K)
<table>
<tr><th>Gas</th><th>a</th><th>b×10^3</th><th>c×10^6</th><th>d×10^9</th></tr>
<tr><td>CH_4</td><td>19.2494</td><td>52.1135</td><td>11.973</td><td>-11.3173</td></tr>
<tr><td>C_2H_6</td><td>5.4129</td><td>178.0872</td><td>-67.3749</td><td>8.7147</td></tr>
<tr><td>N_2</td><td>29.5909</td><td>-5.141</td><td>13.1829</td><td>-4.968</td></tr>
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<td>5</td>
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<tr>
<td>5B.</td>
<td>Production of single-cell protein from hexadecane is described by the following reaction
$C_{16}H_{34} + aO_2 + bNH_3 \longrightarrow cCH_{1.66}O_{0.27}N_{0.20} + dCO_2 + eH_2O$
Where $CH_{1.66}O_{0.27}N_{0.20}$ represents the biomass. If RQ=0.43, Determine the stoichiometric coefficients of the reaction</td>
<td>5</td>
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