V SEMESTER B.TECH. EXTERNAL EXAMINATIONS NOV 2019

SUBJECT: BIOPROCESS ENGINEERING [BIO 3102]

Date of Exam: **18/11/2019** Time of Exam: **2.00 PM – 5.00 PM** Max. Marks: **50**

Instructions to Candidates:

- Answer ALL the questions & missing data may be suitable assumed

1A.	Following data have been obtained for an initial enzyme concentration of 0.00875 g/L for an enzyme catalysed reaction:	**5**

S, g/L	20	10	6.7	5	4
V, g/L.min	0.67	0.51	0.41	0.34	0.29

Find K_m, V_{max} and K_2 using Hanes-Woolf plot.

1B.	α-amylase is being investigated as an additive to textile industry for starch thinning effects in making textile. The Michaelis constant for α-amylase se is 10 mM. At 60ºC, α-amylase is subject to deactivation with a half-life of 16 min. Starch hydrolysis is carried out in a well-mixed batch reactor. The initial starch concentration is 90 gmol /m^3. At the beginning of the reaction the rate of hydrolysis is 0.14 mmol/L.s. How long does it take for the enzyme to hydrolyze 80% of the starch present?	**5**
2A.	A 15 m^3 chemostat is operated with dilution rate 0.1 h^{-1}. A continuous sterilizer with steam injection and flash cooling delivers sterilized medium to the fermentor. Medium in the holding section of the sterilizer is maintained at 130ºC. The concentration of contaminants in the raw medium is 10^5/mL, an acceptable contamination risk is one organism every 3 months. The Arrhenius constant and activation energy for thermal death are estimated to be 7.5 x 10^{39} h^{-1} and 288.5 kJ/gmol respectively. The sterilizer pipe inner diameter is 12 cm. At 130ºC the liquid density is 1000 kg/m^3 and viscosity is 3 kg/m.h. i. Assuming perfect plug flow determine the length of the holding section. ii. What length is required if axial dispersion effects are taken into account?	**5**
2B.	Elucidate the effect of increasing linear air velocity on K and X_{90} of a filtration system with mathematical steps and also list the assumptions made.	**5**
3A.	Consider the growth of a microorganism in batch culture. When the substrate concentration is high, the cell density doubles every 1.0 h, the observed substrate yield coefficient is 0.6 g DCW/g, and substrate consumption is allocated towards biosynthesis (50%), maintenance (20%), as well as product formation (30%). The product formation is strictly growth-associated. The batch reactor is inoculated with 0.01 g DCW/L and 20 g/L substrate. Estimate: i. The maximum cell density (after lag phase). ii. Refer to part (a), and estimate the time (after lag time) required achieving it.	**5**

	iii. Refer to part (a) and (b), and determine the value of the maintenance coefficient (g substrate/g DCW.h) DCW = dry cell weight	
3B.	Differentiate between Exponential growth model and Logistic Model.	**2**
3C.	Define the following: i. Endogenous metabolism ii. Maintenance coefficient iii. $Y_{x/O2}$	**3**
4A.	In cultivation of baker's yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately. Increase in dissolved oxygen (DO) concentration upon addition of lethal agents is followed with the aid of a DO analyser and a recorder. Using the following data, determine the oxygen transfer coefficient (k_La) for the reactor. Saturation DO concentration is C* = 9 mg/L. Time (min): 1, 2, 2.5, 3, 4, 5 DO (mg/L): 1, 3, 4, 5, 6.5, 7.2	**5**
4B.	What is the significance of K_La in gas-liquid mass transfer? Elucidate the method for measuring k_La based on oxygen balance technique.	**5**
5A.	The first order reaction A ---→ B takes place in a spherical catalyst pellet. The effectiveness factor due to diffusion limitations in the catalyst pores is 0.80. When the same reaction is carried out in a catalyst pellet whose diameter is four times larger, how much larger is the total rate of reaction?	**4**
5B.	An industrial effluent stream is treated biologically by using a reactor containing immobilized cells in porous particles. Variation of rate of substrate removal with particle size is given in the following table. i. What are the effectiveness factors for D_p = 4 mm and D_p = 7 mm? Bead dia, D_p mm: 1, 2, 3, 4, 5, 7, 10 Rate, V (mg/L.h): 300, 300, 250, 200, 150, 100, 50 ii. The following data were obtained for D_p = 4 mm at different substrate concentrations. Assuming no liquid film resistance, determine the V_m and K_s for the microbial system. $[S_o]$, (mg/L): 100, 250, 500, 1000, 2000 Rate, V (mg/L.h): 85, 200, 360, 630, 1000	**6**

4A data:

Time (min)	1	2	2.5	3	4	5
DO (mg/L)	1	3	4	5	6.5	7.2

5B (i) data:

Bead dia, D_p mm	1	2	3	4	5	7	10
Rate, V (mg/L.h)	300	300	250	200	150	100	50

5B (ii) data:

$[S_o]$, (mg/L)	100	250	500	1000	2000
Rate, V (mg/L.h)	85	200	360	630	1000