Ref. No. : Ex/PG/FTBE/T/113A/2018

M.TECH. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING

FIRST YEAR FIRST SEMESTER – 2018

Subject: FERMENTER DESIGN, CONTROL AND OPTIMIZATION

Time: 3 hours **Full Marks :100**

Part-I

Use Separate Answer scripts for each Group

Answer any three questions **20×3 = 60**

1. (a) Present the relationship between specific growth rate, respiration, product formation and dissolve oxygen concentration.

   (b) What are the factors affecting the values of oxygen transfer coefficients?

   (c) Dimensions of a fermentor equipped with two sets of standard flat blade turbine and four baffle plates are:
   Fermentor diameter = 3m; impeller diameter = 1.5m; baffle plate width = 0.3m; liquid depth = 5m. The viscosity and density of the fermentation broth are 1200kg/m^3 and 0.02kg/m.sec. Rotational speed of the impellers and aeration rate are 60 rpm and 0.4 vvm respectively.
   Calculate (i) Power requirement for ungassed and under aeration condition
   (ii) Volumetric oxygen transfer coefficient
   (iii) Gas hold up
   Given: power no = 6; power required under aerated / ungassed = 0.65; at $(P/V)^{0.4}vs^{0.5}$ value 18 - gas hold up is 21%. 3+7+10=20

2. (a) Mention the cardinal design rules of fermentor.
   (b) What are the selection criteria of material of construction of fermentor?
   © Briefly describe the aseptic sealing and aseptic operation of fermentor. 6+4+10 = 20

3. (a) What are the different physical and chemical sensors conventionally attached with the fermentor?
   (b) Write short note on pH and temperature sensor.
   © What are the potential sensors may be attached with fermentors? 5+10+5 = 20

4. (a) A microbial fermentation broth contains 10^8 microorganisms /ml of representative diameter 2 $\times 10^{-4}$ cm. Molecular diffusivity of oxygen in broth is 10^{-5} cm^2/sec and dissolve oxygen concentration is 6ppm. Calculate the volumetric oxygen transfer rate under given condition.
   (b) Write the different resistances act during air supply in fermentation broth.
   © Describe the relationship between critical dissolve oxygen concentration and microbial growth.
   5+8+7 =20

5. (a) Briefly describe volumetric oxygen transfer coefficient in bubble aeration with mechanical agitation.
   (b) Briefly describe the physical and enzymatic considerations of air supply in fermentation broth.
   10+10 =20

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M.TECH (F.T.B.E) EXAMINATION, 2018

(1st Year -1st Semester)

Fermenter design , optimization and control

Time: 3 hrs. Full Marks : 100

Part-II [Answer any two questions, Marks 20 x 2= 40]

1. A batch fermenter was operated for the production of alcohol from glucose using yeast. The rate of glucose conversion is measured and the data are presented in the table below. Find the time taken in the batch fermenter when the concentration falls down to 12 $kgmol/m^3$. Assume C_{A0}= 70 $kgmol/m^3$. (20)

Concentration (C_A) $kgmol/m^3$	68	54.6	33.0	20.0	12.2	7.4	4.5	2.7
Rate of reaction ($-r_A$) $kgmol/m^3.h$	2.82	4.71	4.31	3.74	3.16	2.46	1.91	1.40

2. (a) For a CSTR, show Volume of reactor , $V = (F_{A0}.X_A) / (-r_A)$
   (b) Derive a relation between time required for a certain amount of conversion to take place (t) and rate of reaction ($-r_A$) for a batch reactor
   (c) Write the general material balance equation for a rector.
   (d) Define the terms : i) conversion, ii) yield , iii) selectivity associated with biochemical reactions.

(7+6+1+6)

3. (a) For the conversion of glucose to ethanol during molasses fermentation the following data were obtained: For 1 mol of glucose fed in the reactor, 0.1mol of glucose reacted to produce 0.2 mol of ethanol. Based on the data comment on the values of conversion, yield and selectivity in this case.
   (b) For the production of alcohol from glucose using yeast, the following data are obtained : When the concentration of glucose falls down to 12 $kgmol/m^3$, $(-1/r_A) = 0.315$. If the process occurs in a CSTR , find the space time and volume of the fermenter . Assume that the volumetric flow rate is 5.5×10^{-3} m^3/h and C_{A0}= 70 $kgmol/m^3$. (5+15)