Ref. No. : Ex/FTBE/T/414/2019

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
FOURTH YEAR, FIRST SEMESTER-2019

Subject: BIOCHEMICAL ENGINEERING II

Time: 3 hrs **Full Marks: 100**

Use separate answer scripts for each group

Part-I **50 marks**

GROUP-A

Answer any one question **10×1 = 10**

1. Write short note on bioreactor for mamalian cell culture and membrane bioreactor.

2. Briefly describe the applications of bioreactor in food processing and biochemical engineering sector. Write short note on bioreactor for solid state fermentation process.

5+5 = 10

GROUP-B

Answer any two questions **20×2 = 40**

3. (a) Whar are the basic components of air-lift fermentors? Explain different interaction between geomatric and fluid dynamic variables in air lift fermentor.

(b) What are the different types of gas seperator in air lift fermentor?

(c) Write short note on packed bed reactor. 12+4+4 = 20

4. (a) Derive the material balance equations in CSTR in series.

(b) Define maximum productivity. Derive expression for maximum productivity of cell mass and product. 10+10 = 20

5. (a) What are the different types of photo bioreactor? Explain different types of

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FOURTH YEAR FIRST SEMESTER EXAM 2019
Biochemical Engineering II

Time: 3 hrs. Full Marks : 100

Part – II

(Answer question no. 1 and any two from the rest questions; 10 + 20 x 2 = 50)

1. Answer any five questions (5 x 2 =10)
   (a) Write the relation between impeller tip velocity and its rpm
   (b) (P_g / P) is less than 1 : explain
   (c) What is the relation between the aeration power requirement and the no of impellers?
   (d) Draw the profile of N_P against the $N_{Re,m}$ for a particular type of impeller
   (e) Draw the profile of Q_{O2} vs. dissolved oxygen concentration C_L.
   (f) What is 'k_La'? Write the relation between 'k_La' and 'Q_{O2}' at steady state condition.

2. A fermenter is to be used for a specific fermentation where the viscousity and the density of the broth are 1250 kg/m^3 and 0.02 kg/m-sec, respectively. Speed of impeller and aeration rate are 60 rpm and 0.5 vvm, respectively.
   Calculate (i) Power requirement for ungassed system (ii) Power requirement when the vessel is aerated and (iii) hold up of gas bubbles in the medium.
   Other data:
   Dimensions of the fermenter equipped with two sets of standard flat blade turbines and four baffle plates are : vessel diameter = 3m; impeller diameter = 1.5 m, baffle plate width = 0.3m; liquid depth = 5m; (P_g /P) =10N_a and [(P / V) $^{0.4}$ x $v_s^{0.5}$]1.5 =H_o, where P_g and P are power requirement for gassed and ungassed system, respectively (HP) , V is the volume of the liquid (m^3) , N_a is aeration no. , v_s is linear velocity of air based on the empty cross sectional area of tank (m/hr) and H_o (%) is gas hold up. Also given that at turbulent regime N_P for flat bed turbine is 6. (20)

3. (a) Assuming power requirement per unit volume to be the scale up factor (basis) find the ratios of the following parameters in two different scales. Assume small scale fermenter to be of 50 liter volume and the large scale one of 6,250 liter capacity. The parameters to be considered are : P , P/ V , n , D_i , F, F/ V , nD_i and $nDi^2\rho/\mu$. The terms bear normal meaning.

   (b) With the help of neat sketch mention the geometrical design ratios recommended for the fabrication of fermenting vessels with different types of impellers. (12 + 8)

4. A bacterial fermentation is going on in a fermenting vessel . The required information about the fermentation is given below:
   The capacity of the vessel is 30 liter, H_L = 1.2 D_t ; D_i=D_t/3 ; (F/V) = 2.2 vvm and there are 2 sets of flat blade type of impellers inside the vessel.

However, the production is to be transferred to a large scale fermenter of capacity 45,000 liter and therefore, you are supposed to estimate (F/V) and (v_s) for this larger fermenter.
Actual working volume of each of the fermenter is 60% of the geometrical volume of each tank. All the physical properties of the broth are similar with those of pure water at room temperature. Also assume, $(F/V) \alpha \ 1/H_L^{2/3}$ (20)

5. (i) With proper sketch, show the oxygen transport path originating from a bubble and termination at a microbial cell suspended in a fermentation medium . Also mention the resistances encountered. Mention the factors on which respiration rate coefficient (Q_{O2}) of a microbe depends .

(ii) A strain of *Azotobacter vinelandii* is cultured in a 15 m^3 stirred fermenter for alginate production . Under current operating condition , k_La is 0.15 s^{-1}. The solubility of oxygen in the broth is approximately, 6 x 10^{-3} kg m^{-3}.

(a) The specific rate of oxygen uptake is 12.5mmol g^{-1} h^{-1}. What is the maximum cell concentration supported by oxygen transfer in the fermenter ?

(b) The microbe suffers growth inhibition after copper sulphate is accidentally added to the fermentation broth just after the start of the culture. This causes a reduction in the oxygen uptake rate to 3 mmol g^{-1} h^{-1}. What maximum cell concentration can now be supported by oxygen transfer in the fermenter ? 4 + (10 + 6)

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