M.TECH. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
FIRST YEAR FIRST SEMESTER EXAM 2024

FERMENTER DESIGN, CONTROL AND OPTIMIZATION

Full Marks-100

(50 Marks for each Part)

Use separate answer script for each Part

Time: 3 hrs

Part – I

Group-A

Answer any one question   **1×5 = 5**

1. Write a short note on k_{La} measurement by dynamic method.
2. Prove that specific growth rate and dilution rate are same under steady state conditions in a CSTR.

Group-B

Answer any three questions   **3×15 =45**

3. (a) Briefly discuss the effect of different parameters on k_{La}.

   (b) 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 following data, determine the oxygen transfer coefficient 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+10 = 15

4. (a) What are the scaling criterion of fermentor?

   (b) Considered the scale-up of a fermentation from 10L to 10,000L vessel. The small fermenter has a height-to-diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500 rpm and three Ruston impellers are used. determine the dimensions of the large fermenter and agitator speed for (i) constant P/V; (ii) constant impeller tip speed, (iii) constant Reynolds number.   **5+10 = 15**

5. (a) Define power number, aeration number impeller Reynolds number.

   (b) Dimensions of a fermentor equipped with two sets of standard flat blade turbines and four baffle plates are:

   Fermenter diameter: 3m; Impeller diameter = 1.5m; Baffle plate width = 0.3m; Liquid depth = 5m. The viscosity and density of the broth are 1200 kg/m^3 and 0.02 kg/m.sec respectively. The rotational speed of the impeller is 60 rpm.

   Calculate: (i) Power requirement for ungassed system; (ii) power requirement for aerated system. (consider power number = 6 and aeration number = 6.9 ×10^{-2})   **5+10 = 15**

6. (a) Derive the expression for material balance of cell mass, substrate and product in a CSTR.

(b) Graphically present the correlation of cell mass concentration, substrate concentration and dilution rate. Define productivity. 9+6 = 15

MFTBE 1st Year 1st Semester Examination 2024
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Part – II
Answer any four questions (4 x 12.5 = 50)

1. What is the usual technique of sterilizing supply air for a lab-scale fermentation? Why do we require to maintain positive pressure during every stage of fermentation operation? What are the objectives of using 'sparger' in a fermenter? Name different types of sparger. What should be the recommended location of installation of a 'sparger' in a fermenter and why?　　　2.5 + 2.5+ +3+2+2.5

2. For 2.5L of fermentation medium, air is being supplied at the rate of 0.5vvm, find out the volumetric air flow rate in terms of L/hr. Mention the objectives of using agitator in a fermenter. Name and sketch different types of impeller. How oxygen transfer efficiency is related to impeller speed?

　　　3+ 2 + 5+ 2.5

3. Why 'condenser' is used in a fermenter? What is the objective of using baffles in a fermenter? What are 'thermistors'? What are the full form of 'PTC' and 'NTC'. Why do we require to maintain a good temperature control during fermentation. What do you mean by 'CIP' ?　　　2+ 2+ 2 +2+2.5 +2

4. Why 'foam control' is required in a fermentation system? How can we do that, explain with a neat sketch. Name one chemical anti-foam agent. Explain the mechanism of sensing oxygen supply for any one type of DO sensor.　　　2+4.5+ 1+ 5

5. What are the preferred acid and alkali for controlling pH of a fermentation medium ? What types of material are used to fabricate 'tubings' involved in pH control system of a fermenter? Explain 'set point and 'dead band' in connection to pH control in a fermenter. With reference to a neat sketch mention the geometric ratios of a stirred tank fermenter.　　　2 +2+3+ 5.5

6. What are the advantages and disadvantages of a stirred tank fermenter? With the help of a neat sketch explain the mechanism of action of an air-lift fermenter. Mention some applications of packed-bed fermenters.　　　5 + 5.5 + 2