B.TECH. Degree Examination, December 2020

Fifth Semester

BT18501 Bioprocess Engineering

(Regulation 2018)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. An inappropriate dilution rates (D) rate will result in
   a) Washout of cells
   b) The substrate concentration in the vessel gets accumulated
   c) Only a
   d) Both a and b
2. Surface aeration is specifically important for
   a) Heat sensitive bacteria
   b) Wild strains of yeast
   c) Animal cell
   d) none of above
3. _____ is a useful ratio for determining whether diffusion rates or reaction rates are more 'important'
   a) Effectiveness factor
   b) Renolds number
   c) Eddy constant
   d) Damköhler number
4. Which one of the following bioreactor configurations is the basis for a trickling biological filter?
   a) Stirred tank
   b) Packed bed
   c) Air lift
   d) Fluidized bed
5. The axial flow hydrofoil impellers have become increasingly popular. They have been shown to give superior performance. What is the reason for their popularity and superiority?
6. Give the Degree of reduction of Methanol (CH4O).
7. How can you overcome the diffusional mass transfer limitation in immobilized enzymes?
8. Compare structured and unstructured models.

PART B - (4 X16 = 64 marks)

09. (a) In a fed-batch culture operating with intermittent addition of glucose solution, values of the following parameters are given at time t = 2 h, when the system is at quasi-steady state. **(16)**

V =1000 ml

F = 200 ml/h

So = 100 g glucose/l

$\mu m = 0.3\ h^{-1}$

Ks = 0.1 g glucose/l

Y_m x/s = 0.5 gdw cells/g glucose

$X^t o$= 30 g

a. Find Vo (the initial volume of the culture).

b. Determine the concentration of growth-limiting substrate in the vessel at quasi-steady state.

c. Determine the concentration and total amount of biomass in the vessel at t = 2 h (at quasi-steady state).

d. If qp = 0.2 g product/g cells, Po = 0, determine the concentration of product in the vessel at t = 2 h.

(OR)

(b) A simple, batch fermentation of an aerobic bacterium growing on methanol gave the results shown in the table. Calculate: **(16)**

a) Maximum growth rate (u max)
b) Yield on substrate (Yx/s)
c) Mass doubling time
d) Saturation constant (Ks)
e) Specific growth rate (u net) at t = 10 h

Time (h)	X (g/1)	S (g/1)
0	0.2	9.23
2	0.211	9.21
4	0.305	9.07
8	0.98	8.03
10	1.77	6.8
12	3.2	4.6
14	5.6	0.92
16	6.15	0.077
18	6.2	0

10. (a) Compare four methods of determination of oxygen mass transfer coefficient. **(16)**

(OR)

(b) The dimensions and operating condition of a lab-scale fermentor are as follows: Volume = 1 L **(16)**

Diameter = 20 cm

Agitator speed = 600 rpm

Ratio of impeller diameter to fermentor diameter = 0.3

This fermentor needs to be scaled up to 8,000 L for a large scale industrial application. If the scale-up is based on constant impeller tip speed, the speed of the agitator in the larger reactor is rpm. Assume that the scale-up factor is the cube root of the ratio of fermentor volumes.

11. (a) The growth of baker's yeast on glucose may be simply described by the following equation: **(16)**

$C_6H_{12}O_6 + 3\ O_2 + 0.48\ NH_3 = 0.48\ C_6H_{10}NO_3 + 4.32\ H_2O + 3.12\ CO_2$

In a batch reactor of volume 10^5 L, the final desired yeast concentration is 50 gdw/L.

Using the above reaction stoichiometry:

a. Determine the total amount of oxygen required.

b. If the rate of growth at exponential phase is $r_x = 0.7$ gdw/L-h, determine the rate of oxygen consumption (g O_2/L-h).

c. Calculate the heat-removal requirements for the reactor

(OR)

(b) The growth of *S. cerevisiae* on glucose under anaerobic conditions can be described by the **(16)**

following overall reaction:

$C_6H_{12}O_6 + b\ NH_3 = 0.59\ CH_{1.74}N_{0.2}O_{0.45}$ (biomass) $+ 0.43\ C_3H_8O_3 + 1.54\ CO_2$

$+ 1.3\ C_2H_5OH + 0.036\ H_2O$

a. Determine the biomass yield coefficient $Y_{X/S}$.

b. Determine the product yield coefficients $Y_{EtOH/S}$, $Y_{CO2/S}$, $Y_{C3H8O3/S}$.

c. Determine the coefficient b.

12. (a) In detail elaborate experimental steps involved in determination of Monod constant. **(16)**

(OR)

(b) Describe different models for substrate and product inhibition. Also state the reason for selection of each model for describing a particular inhibitory reaction **(16)**