53 (FPT 712) FMTC

2016

FERMENTATION TECHNOLOGY

Paper : FPT 712

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions from **seven**.*

1. *(i)* What is Stoichiometry ? Explain with a microbial growth equation.

   (ii) What is Respiratory quotient and Theoretical oxygen demand ?

   (iii) How "Del Factor' for medium sterilization is estimated ?

   (iv) For Del Factor Calculation, why final microbial load can not be considered zero ?

(v) Write microbial cell growth kinetic equation. What is doubling time ? What is Monod equation ? Define all terms.

3+3+6+2+6=20

2. (i) What is batch fermentation ?

(ii) What is CSTR ? Do material balance for biomass, substrate and product in a Continuous Stirred Tank Reactor (CSTR) and calculate steady state biomass, substrate and product concentration ?

(iii) What does Dilution Rate $\left(h^{-1}\right)$ signify in CSTR ?

(iv) How Plug Flow Reactor has operational similarity with Batch and CSTR ?

(v) What does "Maintenance Coefficient" signify in microbial growth ?

3+8+2+4+3=20

3. (i) What is Fed batch culture ? Why it is required ?

(ii) Do substrate balance around a differential section in a Plug Flow Reactor under steady state and derive equation to calculate Reactor length and Residence time for substrate conversion ?

(iii) Why agitation is required in suspension microbial culture ?

(iv) How O_2 is transferred to microbial cell in stirred suspension culture ?

(v) Write Fick's 1st and 2nd law of diffusion and discuss.

4+7+2+3+4=20

4. (i) How volumetric oxygen transfer coefficient $(K_L a)$ can be improved ?

(ii) What does NRe signify ?

(iii) What is unit for Diffusion coefficient and Mass transfer coefficient ?

(iv) How $(K_L a)$ can be determined in a microbial culture under dynamic condition ?

(v) How fermentor is scaled up based on equal power input/unit volume ?

(vi) How mixing can be improved in CSTR ?

2+2+2+5+5+4=20

5. (i) What do the following terms signify ? Km, V_{max}, effectiveness Factor, Damkohler number, Thiele modulus.

(ii) Write short notes on : ***(Any three)***

Filtration

Centrifugation

Absorption

Ultrafiltration

Chromatographic Separation

8+12=20

6. (i) Discuss fermentative production of the following products, specifically mention microbial strain, culture condition, nutrient medium etc. ***(Any Four)***

Citric Acid

Lactic Acid

α Amylase

β-galactosidase

Ascorbic Acid

(ii) Yeast was cultured in a CSTR under aerobic condition. The nutrient medium flow rate was varied and the steady state concentration of cells and glucose was measured in fermenter. The glucose concentration in inlet medium was $100 g/L$. The volume of fermenter content was $500 ml$. Inlet medium was sterile.

Flow Rate (ml/hr)	**Cell Concentration** (g/L)	**Substrate Concentration** (g/L)
31	5·97	0·5
50	5·94	1·0
71	5·88	2·0
91	5·76	4·0
200	0	100

Find rate equation for cell growth. What should be the range of the flow rate to prevent washout of the cells ?

10+10=20

7. (i) Find out the ratio of substrate concentration. When the velocity of enzyme reaction is 90% of V_{Max} and 10% of V_{Max}.

(ii) What fraction of V_{Max} is observed at substrate concentration = $4Km$.

(iii) Suppose a microorganism obeys Monod equation :

$$\frac{dcx}{dt} = \frac{\mu_{Max}[S][x]}{K_s + [S]}$$

where $\mu_{Max} = 0{\cdot}7\ hr^{-1}$, $K_s = 5g/L$. The cell yield $(Y_{x/s})$ is 0·65. The microorganism is cultured in one fermenter. The flow rate and the substrate concentration of the inlet stream are $500L/hr$ and $85g/L$ respectively. The substrate concentration of outlet stream is $5g/L$.

What will be the size of the fermenter ? What is the cell concentration of the outlet stream ?

(iv) For production of penicillin ($C_{16}H_{18}O_4N_2S$, Mol wt = 334·4) using Penicillium mould, where glucose ($C_{16}H_{12}O_6$, Mol wt. = 180) is substrate and phenylacetic acid ($C_8H_8O_2$, Mol wt = 136·2) is precursor. The

stoichiometric equation for the synthesis is

$$1{\cdot}67\ C_6H_{12}O_6 + 2NH_3 + 0{\cdot}5O_2 + H_2SO_4 + C_6H_8O_2 \rightarrow C_{16}H_{18}O_4N_2S + 2CO_2 + 9H_2O$$

Hence, 6% glucose is used for penicillin synthesis and rest is used for cell growth and maintenance. The above fermentation is carried out in a $100L$ batch fermenter. The initial glucose and phenylacetic acid concentration in nutrient medium are $50g/L$ and $4g/L$ respectively. After the fermentation is over, the residual glucose concentration is $5{\cdot}5g/L$. Justify / Prove that glucose is the limiting substrate in this fermentations.

6+2+6+6=20