KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

Marks Scored:

Level : B.Tech.
Year : II

Course : BIOT 209
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date 10.12.2023

SECTION "A"

Mark [X] the most appropriate answer. **[20 Q. × 0.5 = 10 marks]**

1. A process with input of material to the system but not output is called
   [ ] Batch Process [ ] Semi batch Process
   [ ] Fed batch Process [ ] Continuous Process

2. The amount of energy accumulation(ΔE) for a steady state system during a process
   [ ] Increases [ ] Decreases [ ] Aways zero [ ] Non zero Constant

3. The concept of material balance is based upon
   [ ] Conservation of mass [ ] Conservation of energy
   [ ] Conservation of momentum [ ] Conservation of volume

4. At steady state, when reaction does not occur, the appropriate mass balance equation is
   [ ] Mass in + Mass generated = Mass out + Mass consumed
   [ ] Mass in = Mass out
   [ ] Mass in + Mass generated -Mass out + Mass consumed = Mass accumulated
   [ ] Mass generated = Mass consumed

5. Generation equation of cell growth is
   [ ] $C_wH_xO_yN_z + O_2 + H_gO_hN_i \rightarrow cC_\alpha H_\beta ON + CO_2 + H_2O$
   [ ] $cC_wH_xO_yN_z + O_2 + dH_gO_hN_i \rightarrow eC_\alpha H_\beta ON + CO_2 + H_2O$
   [ ] $aC_wH_xO_yN_z + bO_2 + cH_gO_hN_i \rightarrow dC_\alpha H_\beta ON + eCO_2 + fH_2O$
   [ ] $C_wH_xO_yN_z + aO_2 + bH_gO_hN_i \rightarrow cCH_\alpha O_\beta N_\delta + dCO_2 + eH_2O$

6. The value of Standard heat of reaction of H_2O is
   [ ] 0 kJ [ ] 10 kJ [ ] 15 kJ [ ] 20 kJ

7. In a stirred tank reactor, the equipment used for mixing is
   [ ] Agitator [ ] Impeller [ ] Baffles [ ] Sparger

8. Which formula can be used as a general formula for cell biomass when composition analysis is not available
   [ ] $CH_{1.8}O_{0.5}N_{0.2}$ [ ] $CH_{2.8}O_{0.5}N_{0.2}$ [ ] $CH_{1.8}O_{0.9}N_{0.2}$ [ ] $CH_{1.8}O_{0.5}N_{0.5}$

9. The number of available electrons for glucose is
[ ] 12 [ ] 20 [ ] 24 [ ] 32

10. Maximum theoretical biomass yield for methane is
[ ] 0.4 [ ] 1.6 [ ] 2.9 [ ] 3.2

11. The reaction equation for aerobic production of acetic acid from ethanol is: $C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$. The theoretical yield of acetic acid from ethanol is
[ ] 0.6 [ ] 1.3 [ ] 2.5 [ ] 4.01

12. Oxygen demand of a typical bacteria without growth is approximately
[ ] 1 [ ] 2 [ ] 4 [ ] 6

13. Production of single-cell protein from hexadecane is described by the following reaction equation: $C_{16}H_{34} + 12.48\ O_2 + 2.13\ NH_3 \rightarrow 10.64\ CH_{1.66}\ O_{0.27}\ N_{0.20} + 5.37\ CO_2 + 11.6\ H_2O$. The biomass yield from the substrate is
[ ] 0.3 [ ] 0.5 [ ] 0.7 [ ] 0.9

14. The unit of specific growth rate is
[ ] h^{-1} [ ] gh^{-1} [ ] gh^{-2} [ ] h

15. Industrial-scale stirred vessels with working volumes between 1 and 100 m^3 have mixing time in the range of
[ ] 10 -40 seconds [ ] 5 – 15 seconds
[ ] 20 – 100 seconds [ ] 30 -120 seconds

16. Heat of reaction (ΔH_{rxn}) for fully aerobic metabolism is approximately
[ ] – 130 kJ $gmol^{-1}$ O_2 consumed [ ] – 230 kJ $gmol^{-1}$ O_2 consumed
[ ] – 460 kJ $gmol^{-1}$ O_2 consumed [ ] – 550 kJ $gmol^{-1}$ O_2 consumed

17. Which of the following is a slowest step in an ideal mixing process?
[ ] Distribution [ ] Diffusion [ ] Dispersion [ ] Decomposition

18. For the growth equation " $C_wH_xO_yN_z + aO_2 + bH_gO_hN_i \rightarrow CH\alpha O_\beta N_\delta + d\ CO_2 + e\ H_2O$" , the coefficient used for the estimation of biomass yield is
[ ] a [ ] b [ ] c [ ] d

19. The standard heat of combustion for yeast is approximately
[ ] -23.2 kJ g^{-1} [ ] -20.4 kJ g^{-1} [ ] -21.2 kJ g^{-1} [ ] -19.2 kJ g^{-1}

20. What is the width of baffle in terms of the tank diameter?
[ ] 1/5- 1/10 * tank diameter [ ] 1/10-1/12 * tank diameter
[ ] 1/12-1/15 * tank diameter [ ] 1/5-1/12 * tank diameter

Fill in the blanks. **[10 Q. × 1 = 10 marks]**

21. The expression for calculation of biomass yield (Y_{xs}) is _____.

22. A _____ process allows either input or output of mass in a system.

23. Respiratory quotient (RQ) is defined as _____.

24. Heat of combustion for bacteria is approximately _____ kJg^{-1}.

25. Vertical strips of metal mounted against the wall of a fermenter are called _____.

26. The expression for observed biomass yield is _____

27. The most frequently used impeller in the fermentation industry is _____.

28. The mixing time is defined as the time after which the concentration of tracer differs from the final concentration by less than _____% of the total concentration difference.

29. The number of available electrons for a carbon atom is _____.

30. For a steady state process mass accumulation rate is _____.

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SECTION "B"

[3Q. × 8 = 24 marks]

Attempt *ANY THREE* questions.

1. *Acetobacter aceti* bacteria convert ethanol to acetic acid under aerobic conditions. A continuous fermentation process for vinegar production is proposed using nongrowing *A. aceti* cells immobilised on the surface of gelatine beads. Air is pumped into the fermenter at a rate of 200 gmol h^{-1}. The production target is 2 kg h^{-1} acetic acid and the maximum acetic acid concentration tolerated by the cells is 12 %. What minimum amount of ethanol is required?

2. Water at 25°C enters an open heating tank at a rate of 10 kg h^{-1}. Liquid water leaves the tank at 88°C at a rate of 9 kg h^{-1}; 1 kg h^{-1} water vapour is lost from the system through evaporation. At steady state, what is the rate of heat input to the system?
   h (liquid water at 88 °C) = 368.5 kJ kg^{-1}
   h (saturated steam at 88 °C) =2656.9 kJ kg^{-1}
   h (liquid water at 25 °C) = 104.8 kJ kg^{-1}

3. Explain the general energy balance equation for a bioprocess system.

4. Discuss on general material balance equation in bioprocess technology. Explain electron balance equation for a balanced cell growth.

SECTION "C"

Attempt *ANY SIX* questions. **(Question N.O 5 is compulsory)**

5. Write short notes on (*ANY TWO*) [3+3=6]
   a. Elemental balance
   b. Heat of reaction
   c. Mixing time

6. Define the various metabolic yield coefficients [5]

7. What is the enthalpy of 100 g formic acid at 80°C and 1 atm relative to 25°C and 1 atm? (Cp for formic acid in the temperature range = 0.524 cal g^{-1} $°C^{-1}$) [5]

8. Define volumetric and specific rate in biological reaction [5]

9. Define and explain mixing time of a typical bioreactor. [5]

10. Explain briefly on the general energy balance equation for cell culture. [5]

11. Explain how theoretical oxygen demand is calculated using electron balance [5]