KATHMANDU UNIVERSITY
End Semester Examination [C]
January, 2018

JAN 1 1 2018

Level : B.Tech
Year : II
Time : 2 hrs. 30 mins.

Course : BIOT 210
Semester: II
F.M. : 55

SECTION "C"

[3Q.×8=24 marks]

Attempt *ANY THREE* Questions.

1. Describe the various types of heat transfer equipment used in bioprocess technology.
2. Derive the expression for batch time for substrate conversion for enzymatic reaction.
3. Derive the mathematical expression for gas- liquid mass transfer.
4. A strain of *Azotobacter vinelandii* is cultured in a 20 m^3 stirred fermenter for alginate production. Under current operating conditions, kLa is 0.20 s^{-1}. Oxygen solubility in the broth is approximately 8 x 10^{-3} kg m^{-3}. The specific rate of oxygen uptake is 12-mmol g^{-1} h^{-1}.
   a) What is the maximum possible cell concentration?
   b) The bacteria suffer growth inhibition after copper sulphate is accidentally added to the fermentation broth. This causes a reduction in oxygen uptake rate to 3 mmol g^{-1} h^{-1}. What maximum cell concentration can now be supported by the fermenter?

SECTION "D"

Attempt *ANY SIX* questions (**Q.5 IS COMPULSORY**)

5. Write short notes on; [2×3=6]
   a. Monad Growth model
   b. Specific oxygen uptake rate
6. Heat is transferred from one fluid to a second fluid across a metal wall. The film coefficients are 1.2 and 1.7 kW $m^{-2}K^{-1}$. The metal is 6-mm thick and has a thermal conductivity of 19 W m^{-1} K^{-1}. On one side of the wall, there is a scale deposit with a fouling factor estimated at 830 W m^{-2} K^{-1}.What is the overall heat-transfer coefficient? [5]
7. Explain with labeled diagram, the principle of continuous heat sterilization by heat exchanger. [5]
8. Explain the Fick's law of diffusion for mass transfer. [5]
9. Define batch culture with an example. [5]
10. Write down the expression for log-mean temperature difference for heat exchangers. Under what condition it is used in heat transfer model? [5]
11. Differentiate between following (*ANY TWO*) [2×2.5=5]
    a. Fed Batch and Continuous culture
    b. Critical dilution rate and optimal dilution rate
    c. Oxygen balance method and Dynamic method.

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Marks Scored:

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Exam. Roll No.:

Time: 30 mins.

F. M. : 20 mins.

Registration No.:

Date JAN 1 1 2018

SECTION "A"
[20Q.×0.5=10]

1. Which of the following is false regarding sterilization with heat exchange system?
[ ] Expensive to construct
[ ] Dilution of the medium
[ ] No need of flash cooling
[ ] Fouling of internal surfaces

2. The ratio of rates of convective and conductive heat transfer is called
[ ] Nusslet number
[ ] Prandtl number
[ ] Reynolds number
[ ] Grasshof number

3. Mass flux has the unit
[ ] $mols^{-2}m^{-2}$ [ ] $mols^{-1}m^{-2}$ [ ] $mols^{-1}m^{-1}$ [ ] $mols^{-1}m^{-3}$

4. Which of the following is unimportant in forced convection?
[ ] Reynolds number
[ ] Prandtl number
[ ] Grashhoff number
[ ] None of these

5. In a shell and tube heat exchanger, baffles are provided on the shell side to
[ ] Improve heat transfer
[ ] Provide support for tubes
[ ] Prevent stagnation of shell side fluid
[ ] All of the above

6. Temperature variation in a pipe is
[ ] linear
[ ] Parabolic
[ ] logarithmic
[ ] none of the above

7. When two populations compete for a single growth limiting substrate in a continuous fermenter, which organism would not be washed out?
[ ] Organism maintaining highest substrate constant
[ ] Organism with lowest substrate constant
[ ] Organism with moderate substrate constant
[ ] Does not depend on substrate constant

8. Shell and Tube heat exchanger is required if the heat transfer area between the fluids is more than
[ ] 2-10m^2 [ ] 10 to 15 m^2 [ ] 15-20 m^2 [ ] 20-30 m^2

9. Most of the resistance to heat transfer to or from the fluid is contained in the
[ ] Liquid film
[ ] Wall barrier
[ ] Fouling layer
[ ] Bulk of the liquid

10. The heat transfer coefficient for fluid flowing inside a tube can be calculated using the equation:
[ ] $Nu = 0.23\ Re^{0.8}\ Pr^{0.4}$ [ ] $Nu = 0.23\ Re^{0.6}\ Pr^{0.4}$
[ ] $Nu = 0.023\ Re^{0.8}\ Pr^{0.4}$ [ ] $Nu = 0.023\ Re^{0.8}\ Pr^{0.2}$

11. The specific death rate of an organism can be expressed as
[ ] ln2/D [ ] D/ln2 [ ] D*ln2 [ ] 2.3*ln2*D

12. Feature of continuous sterilization method is
[ ] Easy scale up [ ] Steam economy
[ ] Medium stability [ ] All of the above

13. Feature of fed batch culture is
[ ] not effective for catabolite repression [ ] controlled oxygen demand
[ ] uniform temperature [ ] easy scale up

14. If dissolved oxygen concentration is above the critical oxygen concentration, Specific oxygen uptake rate is
[ ] constant [ ] minimum
[ ] dependent of CAL [ ] all of the above

15. The heat transfer coefficient (h) is an empirical parameter incorporating the effects of
[ ] system geometry, [ ] flow conditions,
[ ] fluid properties [ ] All of the above

16. A higher Ks value of Monod's equation means
[ ] Greater affinities to substrate [ ] Lower affinities to substrate
[ ] Unaffected with the substrate bonding [ ] Lower dissociation constant value

17. Fermentor should be filled with medium upto
[ ] 65-70% [ ] 70-75% [ ] 75-80% [ ] 80-85%

18. Temperature profile in steady state heat transfer is
[ ] Asymptotic [ ] Hyperbolic [ ] Parabolic [ ] Linear

19. In case of parallel flow heat exchanger, the lowest temperature theoretically attainable by the hot fluid is _____ the outlet temperature of the cold fluid.
[ ] equal to [ ] more than
[ ] less than [ ] either more or less than

20. A mixed fermentation is one, which produces.
[ ] alcohol and carbon dioxide [ ] acid and carbon dioxide
[ ] acid and alcohol [ ] more than one acids

SECTION "B"
[10Q.×1=10 marks]

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Fill in the blanks.

21. The _____ method is the most reliable procedure for measuring kLa, and allows determination from a single-point measurement.

22. _____ culture is used extensively in production of bakers' yeast to overcome catabolite repression and control oxygen demand.

23. The unit of heat transfer co-efficient in SI unit is _____.

24. The thickness of the thermal boundary layer in most heat transfer situations is _____ than the hydrodynamic boundary layer

25. If dissolved oxygen concentration is below critical concentration, specific rate of uptake is approximately _____ dependent on oxygen concentration.

26. The condition at high dilution rate whereby cell concentration reduces to zero is known as _____.

27. The volumetric productivity is mathematically defined as _____

28. The rate of dilution at which the biomass productivity is maximum is called _____.

29. Residence time is defined as the ratio of _____.

30. The amount of steam needed for continuous sterilization is _____ that used in batch processes.