B.TECH. DEGREE EXAMINATIONS: APRIL/MAY 2009

Fourth Semester

BIOTECHNOLOGY

U07BT402 Unit Operations

Time: Three Hours   Maximum Marks: 100

Answer ALL the Questions:-

PART A (20 x 1 = 20 Marks)

1. Propeller agitators are used for liquids of

   a) high viscosity   b) low viscosity
   c) medium viscosity   d) all viscosity ranges

2. Expression for power number in agitation is given by

   a) $\dfrac{Pg_c\rho^2 D_t}{\mu^3}$ b) $\dfrac{n^3 D^2 \rho}{Pg_e}$

   c) $\dfrac{Pg_e}{n^3 D^2 \rho}$ d) $\dfrac{n^2 D^3 \rho}{Pg_e}$

3. Mixing of plastic solids is generally achieved by

   a) kneading   b) dispersing   c) masticating   d) intense mixing

4. The mechanism of mixing in a pan mixer is by

   a) kneading   b) mixing-extrusion   c) dispersion   d) mulling

5. The function of a filter aid is to

   a) increase the filtration rate
   b) increase cake porosity in case of a dense impermeable cake
   c) remove the plugs from the septum
   d) decrease the filtration pressure

6. To produce a thick suspension from a thin slurry, the device used is

   a) vacuum filter   b) edge filter
   c) shell-and-leaf filter   d) pressure filter thickener

7. In a common continuous rotary drum vacuum filter, vacuum is applied

   a) throughout the drum surface   b) in the filtering zone only
   c) in the filtering and washing zones   d) in the filtering, washing and drying zones

8. The drum for the vacuum filter turns with a speed of

   a) 0.1 to 0.2 rpm   b) 2 to 10 rpm   c) 4 to 6 rpm   d) 10 to 20 rpm

9. The unit of thermal conductivity is

   a) $Kcal/hrm\,^{o}C$ b) $Kcal/m^2hr\,^{o}C$ c) $Cal/m^2hr\,^{o}C$ d) $KJ/m^2hr\,^{o}C$

10. Prandtle number is given by

    a) $\dfrac{K}{C_p\mu}$ b) $\dfrac{\mu}{KC_p}$ c) $\dfrac{C_p\mu}{K}$ d) $\dfrac{C_p}{\mu K}$

11. Fins are provided on heat transferring surface in order to increase

    a) heat transfer area   b) heat transfer coefficient

    c) mechanical strength of the equipment   d) temperature gradient

12. With increase in temperature, thermal conductivities of most liquids

    a) increase   b) decrease   c) remain unchanged   d) unpredictable

13. Dropwise condensation occurs on a

    a) smooth surface   b) oily surface   c) coated surface   d) glazed surface

14. In case of natural convection, Nusselt number is a function of

    a) Re and Pr   b) Gr and Pr   c) Gr and Re   d) Gr and Nu

15. Baffels are provided in heat exchangers to

    a) remove dirt   b) increase heat transfer rate

    c) increase heat transfer coefficient   d) provide better mechanical strength

16. Heat transfer rate is maximum in

    a) laminar flow   b) turbulent flow

    c) co-current flow   d) counter current flow

17. Overall heat transfer coefficient largely depends on

    a) the fluid whose individual coefficient is high

    b) the fluid whose individual coefficient is low

    c) independent of the individual heat transfer coefficient

    d) other external factor

18. Preheating of feed into an evaporator
    a) reduces economy   b) increases the heat transfer area

    c) decreases the heat transfer area   d) requires higher pressure of operation

19. Double pipe heat exchangers are preferred when

    a) overall heat transfer coefficient is low   b) liquid is more viscous in nature

    c) heat transfer area required is low   d) liquid is corrosive

20. Fouling factor is a

    a) factor of safety in heat exchanger design

    b) dimensionless factor

    c) conversion factor for individual heat transfer coefficient to overall heat transfer coefficient

    d) dimension factor

PART B (5 x 16 = 80 Marks)

21. (a) (i) Explain about agitator & state the methods of avoiding vortex in agitated vessel. (8)

    (ii) Explain about the scale-up of agitator design. (8)

(OR)

    (b) (i) Explain in briefly about power consumption of impellers. (8)

    (ii) Write short notes on Ribbon Blenders & Muller Mixers (8)

22. (a) Write short notes on the following:-

        (i) Leaf filter
        (ii) Constant pressure filtration
        (iii) Centrifugal filter
        (iv) Gravity settling tanks (16)

(OR)

    (b) (i) With a neat sketch, explain the operation & assembling of plate and frame filter press. (10)

    (ii) Write short notes on
        (1) Characteristics of filter medium
        (2) Filter aids. (6)

23. (a) (i) What do you mean by thermal conductivity ? & Write in brief on its variation with temperature. (8)

    (ii) A 300 mm O.D pipe is covered with two layers of insulation (k_1 = 0.105 W/m.K and k_2 = 0.07 W/m.K). The better insulating material is on the outside and is 40 mm thick. The other insulating material is of 50 mm thickness. The inner and outer surface temperatures of the insulation are 623 K and 323 K. Estimate

      1). Heat loss per metre length

      2). Heat loss per square metre of outer insulation surface.

      3).Temperature of the surface between two layers of insulation. (8)

(OR)

    (b). Explain and Derive the temperature distribution equation & heat dissipation in fin. (16)

24. (a) (i) By dimensional analysis, Buckingham method, develop and equation connecting Nusselt number, Reynolds number and Prandlt number for heat transfer inside a pipe. (16)

(OR)

(b) (i) Derive the expression for log mean temperature difference in heat exchanger. (8)

(ii) A heat exchanger is required to cool 20 kg/s of water from 360 K to 340 K by means of 25 kg/s of water entering at 300 K. If the overall coefficient of heat transfer is constant at 2000 W/ (m². K), calculate the surface area required in

1) a counter current concentric tube exchanger and

2) a co-current flow concentric tube exchanger

Data : Take Cp for water = 4.187 kJ / (kg.K) (8)

25. (a) (i) Draw neat sketch of 1-2 shell & tube heat exchanger & explain its parts. (8)

(ii) In a double pipe counter current flow heat exchanger, 10000 kg/h of an oil having a specific heat of 2095 J/(kg.K) is cooled from 353 K to 323 K by 8000 kg/h of water entering at 298 K. Calculate the heat exchanger area for an overall heat transfer coefficient of 300 W/ (m².K). Take Cp for water as 4180 J/(kg.K). (8)

(OR)

(b) (i) Draw & Explain the forward feed arrangement and backward feed arrangement for feeding multiple effect evaporation system. (8)

(ii) A single effect evaporator is fed with 5000 kg/h of solution containing 1 % solute by weight. Feed temperature is 303 K and is to be concentrated to a solution of 2% solute by weight. The evaporator is at atmospheric pressure (101.325 kPa) and area of evaporator is 69 m². Saturated steam is supplied at 143.3 kPa as a heating medium. Calculate steam economy and overall heat transfer coefficient. (8)

Data :

Enthalpy of feed at 303 K = 125.79 kJ/kg

Enthalpy of vapour at 101.325 kPa = 2676.1 kJ/kg

Enthalpy of saturated steam at 143.3 kPa = 2691.5 kJ/kg

Saturation temperature of steam = 383 K

Boiling point of solution = Boiling point of water = 373 K

Enthalpy of product = 419.04 kJ/kg

Enthalpy of saturated water at 383 K = 461.30 kJ/kg

****