B 406

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

Fourth Semester

Industrial Biotechnology

IB 240 — UNIT OPERATIONS

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

Assume missing data suitably.

PART A — (10 × 2 = 20 marks)

1. Give some examples and advantages of extended surfaces.

2. Give two examples for combined conduction–convection heat transfer equipments.

3. Define 'π' theorem.

4. What is Leiden frost point?

5. Define overall heat transfer coefficient.

6. Define steam economy and capacity of an evaporator.

7. List some drying equipments used in industries.

8. Define bound and unbound moisture.

9. What are Filter aids? Give some examples.

10. Mention the types of forces acting on a particle in settling conditions.

PART B — (5 × 16 = 80 marks)

11. (i) Derive from fundamentals, by dimensional analysis, the relation between Nusselt no. and Reynold's no. under forced convection heat transfer. (12)

    (ii) Briefly explain the principles involved in heat transfer to non–Newtonian fluids. (4)

12. (a) (i) Derive a relationship between heat flux and temperature difference when heat transfer takes place by conduction through a hollow cylinder. (8)

    (ii) A thick-walled cylindrical tubing of hard rubber having an inside radius of 5 mm and an outside radius of 20 mm is being used as a temporary cooling coil in a bath. Ice water is flowing rapidly inside and the inside wall temperature is 274. 9 K. The outside surface temperature is 297.1 K. A total of 14.65 W must be removed from the bath by the cooling coil. How many metre length of tubing are needed? K = 0.151 w/mK (assumed constant) (8)

Or

    (b) With a neat diagram, explain the principles and theory involved in boiling of a fluid. Discuss the mechanism of boiling and indicate the regimes of boiling in a graph. (16)

13. (a) (i) With a sketch, indicate the different types of Heat Exchanger commonly used in industries? (8)

    (ii) From fundamentals, derive the expression for finding the effectiveness of a heat exchanger. (8)

Or

    (b) (i) List out the properties or process factors of solution that affect the processing methods in an evaporator and discuss them in detail. (6)

    (ii) With a sketch, neatly explain the methods, principle involved in the operation of evaporators. (10)

14. (a) (i) With diagram, explain the principle, operation and working of equipments for drying of solids in industries. (12)

    (ii) Discuss in detail about the various properties of Air associated with drying operations. (4)

Or

2   B 406

(b) (i) Discuss in detail about the method for the determination of thermal process time for sterilization of biological materials. (12)

(ii) Cans of a given food were heated in a retort for sterilization. The F_0 for Cl. botulinum in this type of food is 2.5 min and $z = 10°C$. The temperatures in the center of a can (the slowest-heating region) were measured and were approximately as follows, where the average temperature during each time period is listed :

$t_1(0 - 20\text{ min})$, $T_1 = 71.1°C$; $t_2 = (20 - 40)$ min, $T_2 = 98.9°C$; $t_3 = (40 - 73$ min$)$; $T_3 = 110°C$. Determine if this sterilisation process is adequate. (4)

(a) (i) With a neat sketch, explain the operation and assembling of plate and frame filter press. (8)

(ii) Data for the laboratory filtration of $CaCO_3$ slurry in water at 298.2 K (25°) are reported as follows at a constant pressure $(-\Delta P)$ of 338 kN/m². The filter area of the plate and frame press was $A = 0.0439$ m² and the slurry conc. was $Cs = 23.47$ kg/m³. Calculate α and R_m from the data given, where t is time in s and V is filtrate volume collected in m³.

t	V	t	V	t	V
4.4	0.498×10^{-3}	34.7	2.498×10^{-3}	73.6	4.004×10^{-3}
9.5	1.000×10^{-3}	46.1	3.002×10^{-3}	89.4	4.502×10^{-3}
16.3	1.501×10^{-3}	59.0	3.506×10^{-3}	107.3	5.009×10^{-3}
24.6	2.000×10^{-3}				

At 298.2 K, the viscosity of water is assumed to be $= 8.937 \times 10^{-4}$ Pa.s.

$= 8.937 \times 10^{-4}$ kg/ms (8)

Or

(b) (i) Obtain an expression for determining the rates of settling in centrifuges? (10)

(ii) Calculate the hindered settling velocity of glass spheres having a diameter of 1.554×10^{-4} m in water at 293.2 K (20°C). The slurry contains 60 wt % solids. The density of the glass spheres is $\rho_P = 2467$ kg/m³. Assume density of water at this temp. is $\rho_{\text{water}} = 998$ kg/m³.

Viscosity of water at this temp. is 1.005×10^{-3} kg/ms. (6)

———————————

B 406