

C 3085

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Fourth Semester

Bio - Technology

BT 1252 — UNIT OPERATIONS

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define power number and indicate what each term in it denotes.
2. What impellers would you recommend for producing
 - (a) Axial flow
 - (b) Radial plus axial flow in liquid agitation.
3. State the formula for calculating Diameter D_B of particle (density ρ_B) having the same settling velocity as particle (D_A, ρ_A) in a liquid of density ρ_L under Stokes region.
4. What is sigma value in a centrifuge?
5. What is shape factor for a hollow cylindrical wall of length L , ID = D_1 , OD = D_2 for steady state conduction given by $q = k.S. \Delta T$ where S is shape factor.
6. State Dittus — Boelter and Sieder — Tate equations relating N_{Nu} , N_{re} , N_{pr} .
7. If h_1 & h_2 are heat transfer coefficients on two sides of a plane wall (thermal conductivity k , thickness ΔX) what is overall heat transfer coefficient.
8. When a sphere is being heated or cooled by a fluid flowing past, h is calculated by $N_{Nu} = 2 + 0.6 N_{Re}^{0.5} N_{Pr}^{1/3}$.
What are the terms in N_{Nu}

9. In a 1-1 heat exchanger calculate heat transfer area if $Q = 150\text{KJ/S}$, $U = 500\text{ w/m}^2\text{ K}$ & temperature of approach at two ends are 20°C & 30°C .
10. In an evaporator steam Temp is 385°K , solution is at 375°C , $U = 1700\text{ w/m}^2\text{ K}$ & steam consumption is 4200Kg/HR ($\lambda_{\text{Steam}} = 2230\text{ KJ/Kg}$). What is the heat transfer area?

PART B — ($5 \times 16 = 80$ marks)

11. (a) A flat — blade turbine agitator having six blades is installed in a tank. The diameter of the impeller is 0.61 m . The tank is baffled. The geometric dimensions of the mixing equipment satisfy standard geometric ratios. The turbine rotates at 90 rpm . The solution that is agitated has viscosity of 10 cp and density of 0.929 gm/cc . Calculate the power required for agitation in kw.

DATA

N_{Re} 10^3 10^4 10^5

N_{po} 3.5 5 5

Or

- (b) (i) State the purposes for agitation (5)
- (ii) Explain blending & mixing (4)
- (iii) Describe Jet Mixers & motionless mixers (7)
12. (a) Data for laboratory filtration of limestone slurry in water are given below. Calculate specific resistance of filter cake and resistance of filter medium

t(s)	0	9.5	16.3	24.6	34.7	46.1	59	73.6	89.4	107.3
V(lit)	0	1.0	1.501	2.0	2.498	3.002	3.506	4.004	4.502	5.009

DATA : Constant pressure filtration ($-\Delta P$) = 338 kPa

Filter press — area of filtration = 0.0439 m^2

Slurry concentration = 23.47 kg/m^3

Viscosity of liquid = $8.94 \times 10^{-4}\text{ pa.s}$.

Or

(b) For a tubular bowl centrifuge used for sedimentation of solid particles from liquid derive.

(i) Equation for residence time $t\tau$ (8)

(ii) Volumetric feed rate to centrifuge (4)

(iii) Critical volumetric flow rate to separate particles of cut Diameter (4)

13. (a) A Thick walled cylindrical rubber having 10 mm ID and 40 mm OD is used in the form of cooling coil. The inside wall temperature is 1.9°C and outside surface temperature is 24.1°C . Heat load is 30J/s . How many meters of the tubing is required.

DATA: Thermal conductivity = 0.200 w/m.K

Or

(b) Derive the steady state conduction equation for

(i) Three plane walls (k_1, k_2, k_3) in series (8)

(ii) The three plane walls in parallel [(ie) side by side] (8)

Thickness of each wall is same

14. (a) Air at 206.8 kPa and average temperature (between Inlet & outlet Temperatures) of 477.6 K is heated by passing it through a pipe of Dia 2.54 cm at a velocity of 7.62 m/s . The inside pipe wall temperature is 488.7 K .

Neglecting viscosity correction factor & using

$\text{Nu} = 0.027 \cdot \text{Re}^{0.8} \text{Pr}^{1/3}$ calculate

(i) heat transfer coefficient for air

(ii) heat flux.

DATA: At 477.6 K : $\mu = 2.60 \times 10^{-5}\text{ kg/m.s}$

$k = 0.03894\text{ J/s.m}$

$(C_p \cdot \mu / k) = 0.686$

$\rho = 1.509\text{ kg/m}^3$

Or

(b) A heavy hydrocarbon oil is being cooled in a heat exchanger from 371.9 K to 349.7 K . The flow rate of the oil inside tube is 3630 Kg/hr . water flows counter currently outside the tube at a rate of 1450 kg/hr and its inlet temperature is 288.6 K .

(i) Calculate the heat transfer area required if $U = 340\text{ w/m}^2\text{ K}$

- (ii) Repeat the problem if the flow of the two liquids are in cocurrent & calculate heat transfer area required.

DATA: heat Capacity of oil = 2.30 kJ/kg K

Heat Capacity of water = 4.187 KJ/Kg K.

15. (a) (i) Discuss processing factors in evaporation (8)
(ii) Discuss Natural circulation vertical evaporator and forced circulation evaporator (8)

Or

- (b) (i) Discuss effect of processing variables on evaporator operation (8)
(ii) Compare forward feed and backward feed multiple effect evaporators. (8)
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