S.E- IV Sem Biotech 12/6/15

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Unit Operation.

BT/IV/CBGS/UO - II

12/6/15

QP Code : 3678

(3 HOURS) **Max. Marks: 80**

Note:

1. Question No. 1 is compulsory.
2. Attempt any three questions out of remaining five questions.
3. Assume suitable data wherever necessary.
4. Figures to right indicate full marks.

Q. 1 Answer the following (Any four) 20

a. Derive Rayleigh's equation for simple distillation.
b. Explain Kirchoff's law of radiation.
c. Discuss oxygen transfer from gas bubble to cell.
d. Explain the effect of temperature and pressure on diffusivity.
e. What is fouling factor? Discuss its importance in design of heat exchange equipments.
f. What is Critical radius of insulation?

Q.2 a. A steel ball 50mm in diameter initially at uniform temperature of 723 K is suddenly placed in a controlled environment in which temperature is maintained at 373 K. Calculate the time required for the ball to attain a temperature of 423K. 10
Data: Thermal conductivity for a steel ball = 35 w/m. K. h = 10 w/m^2. K
Specific heat for steel = 0.46kJ/kg. K, Density of steel = 7800 kg/m^3

b. A cylindrical tube of inside radius r_1 and outside radius r_2 is lagged with insulating material with r_3 as its outer radius. Derive the expression for rate of heat flow. 10

Q.3 A heat exchanger is to be designed to heat 1720kg/hr of water from 293K to 318K with steam condensing on outside surface of brass tube of outer diameter 25 mm and inner diameter 22.5 mm and 4 m long. The water velocity is 1.2 m/s, find the number of tubes required. 20
Data: k of tube material = 111.65 w/m.K, weight of steam condensed,
latent heat of water = 2230 kJ/kg, temperature of steam = 383 K,
Steam side film coefficient = 4650 w/m^2. K
Physical properties of water at mean temperature are;
$\rho = 995.7\ kg/m^3$, Cp = 4.174 kJ/kg. K, k = 0.617 w/m.K,
Kinematic viscosity = $0.659 \times 10^{-6} m^2/s$

Q.4 a. Differentiate between Drop wise and film wise condensation. 05

b. A mixture of 35 mol% A and 65 mole % B is to be separated in a fractionating column. The concentration of A in the distillate is 93 mole% A and 96% of all A is in distillate. The feed is half vapour and the reflux ratio is 4 and $\alpha = 2$. Calculate the number of theoretical plates required for the column and also locate the feed plate location. 15

[P.T.O.]

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Q.5 a. Explain the following;

i) Evaporator capacity ii) Evaporator economy

b. Find out the heat transfer rate per unit area due to radiation between two infinitely long parallel planes. The first plane has an emissivity of 0.4 and is maintained at 473K. Emissivity of second plane is 0.2 and is maintained at 300K. If a radiation shield having emissivity 0.5 is introduced between the given planes, Find the % reduction in heat transfer rate and steady state temperature attained by the shield.

c. Derive the equation for molar flux for equimolar counter diffusion.

Q.6 Write a note on (Any four)

a. Nucleate and film boiling
b. Shell and tube heat exchanger
c. Two film theory
d. Factors affecting cellular oxygen demand
e. Oxygen transfer in fermenters
f. Minimum and maximum boiling azeotrope
