Menoufiya University
Faculty of Engineering
Shebin El-Kom
Academic Year: 2016-2017
Final Exam, 27/5/2017

Department: MPE.
Post-graduate: (Master)
Subject: MassTransfer (MPE601)
Time Allowed: 3 hour
Total marks: 100 mark

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Answer the following questions:

Question (1) .....(5 + 6 + 4+10 = 25 mark)

1-a) Give examples for (*a*) liquid-to-gas, (*b*) solid-to-liquid, (*c*) solid-to-gas, and (*d*) gas-to-liquid mass transfer.

1-b) Discuss the following items:

Range, Make-up, Approach, Fill, Head

1-c) In a mass production facility, steel components are to be hardened by carbon diffusion. Would you carry out the hardening process at room temperature or in a furnace at a high temperature, say 900°C? Why?

1-d) Consider a rubber plate that is in contact with nitrogen gas at 298 K and 300 kPa .If The solubility of nitrogen in rubber at 298 K is 0.00156 kmol/m^3 · bar. Determine the molar and mass density of nitrogen in the rubber at the interface.

Question(2).....(5 + 20 = 25 mark)

2 –a) What is the relation [$h_{heat} = \rho C_p h_{mass}$] known as? For what kind of mixtures is it valid? What is the practical importance of it?

2 –b) The roof of a house is 15 m x 8 m and is made of a 20-cm-thick concrete layer. The interior of the house is maintained at 25°C and 50 percent relative humidity and the local atmospheric pressure is 100 kPa. Determine the amount of water vapor that will migrate through the roof in 24 h if the average out- side conditions during that period are 3°C and 30 percent relative humidity. The permeability of concrete to water vapor is 24.7 x 10^{-}12 kg/s · m · Pa.

In order to reduce the migration of water vapor, the inner surface of the wall is painted with vapor retarder latex paint whose permeance is 26 x 10^{-}12 kg/s · m^2 · Pa. Determine the amount of water vapor that will diffuse through the roof in this case during a 24-h period.

Take P_{sat} @ $3^oC = 768Pa$, and P_{sat} @ $25^oC = 3169$ Pa

Question (3):..... (6 + 6 + 6+ 32 = 50 mark)

2- a) How does the mass diffusivity of a gas mixture change with (*a*) temperature and (*b*) pressure?

2 –b) How does the condensation or freezing of water vapor in the wall affect the effectiveness of the insulation in the wall? How does the moisture content affect the effective thermal conductivity of soil?

2-c) Explain by net diagram, the Graphical representation of the cooling tower characteristic.

2-d) A 2-m-deep 20-m x 20-m heated swimming pool is maintained at a constant temperature of 30°C at a location where the atmospheric pressure is 1 atm. If the ambient air is at 20°C (where p_{sat} = 2.239 kPa) and 60 percent relative humidity and the effective sky temperature is 0°C, determine the rate of heat loss from the top surface of the pool by (*a*) radiation, (*b*) natural convection, and (*c*) evaporation. (*d*) What the electric power required to maintain the water temperature is constant. *(E)* What the quantity of make-up water to maintain the water level in the swimming pool.

Treating the water vapor and the air as ideal gases and take the following properties:

For liquid water:

$\varepsilon = 0.95$, $h_{fg} = 2431 kJ/kg$, $P_v = 4.246\ kP_a$, and $R = 0.4615\ kJ/kg.K$

For air:

$K = 0.0255\ w/m.^0C$, $Pr = 0.73$, $\alpha = 2.14 \times 10^{-5}\ m^2/s$, and $\nu = 1.56 \times 10^{-5}\ m^2/s$

For natural convection:

$$Nu = 0.15\,(Gr.Pr)^{1/3} \quad \text{where} \quad Gr = \frac{g\,(\rho_\infty - \rho_s)\,L_c^3}{\rho_{ave}\,\nu^2}$$

For mass transfer:

$$Sh = 0.15\,(Gr.Sc)^{1/3} \quad \text{where} \quad Sc = \frac{\nu}{D_{AB}}$$

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د| السيد حسين فرج