B.Tech. SEM -IV (Chemical) 2014 Course (CBCS) : SUMMER - 2019
SUBJECT: PROCESS HEAT TRANSFER

Day : Tuesday
Date : 28/05/2019

Time : 10.00 AM TO 01.00 PM
Max. Marks : 60

S-2019-2593

N. B. :

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labeled diagram **WHEREVER** necessary.
4) Assume suitable **DATA**, if necessary.

Q. 1 Derive an expression for steady state heat conduction in a sphere **(10)**

OR

A furnace wall consists of 200 mm of refractory fireclay brick, 100 mm of kaoline brick, and 6 mm of steel plate. The fire side of the refractory is at 1150°C, and the outside of the steel is at 30°C. An accurate heat balance over the furnace shows the heat loss from the wall to be 300 W/m^2. It is known that there may be thin layer of air between the layers of brick and steel. To how many millimeters of kaoline are these air layers equivalent? **(10)**

$\bar{k}_A = 1.52\ W/m^0C$ – fireclay brick

$\bar{k}_B = 0.138\ W/m^0C$ – sil-o-cel brick (kaoline)

$\bar{k}_C = 45\ W/m^0C$ – steel

Q. 2 a) Write any three dimensionless numbers with their significance used in convection heat transfer **(06)**

b) Explain Newton's law of cooling **(02)**

c) Write short note on fouling resistance **(02)**

OR

A 20 mm diameter horizontal heater is maintained at a surface temperature of 40°C and submerged in water at 25°C. Estimate the heat loss per unit length of the heater by free convection. The properties of water at film temperature T_F = (40+25)/2= 32.5°C are as follows: **(10)**

$k = 0.63\ W/mK$

$\rho = 1000\ kg/m^3$

$\mu = 8 \times 10^{-4}\ kg/\text{m s}$

$C_p = 4.187\ kJ/kg\,K$

Q. 3 a) Differentiate film wise and drop wise condensation **(04)**

b) Explain with neat diagram pool boiling curve **(06)**

OR

P. T. O.

A tube of 2 m length and 25 mm O.D. is to be used to condense saturated steam at 100°C while the tube surface is maintained at 92°C. Estimate the average heat transfer coefficient and the rate of condensation of steam if the tube is kept horizontal. **(10)**

$At\ 96^0C$

$k_f = 0.68\ W/mK$

$\mu_f = 293.4 \times 10^{-6}\ Ns/m^2$

$\rho = 961\ kg/m^3$

$\lambda = 2257\ kJ/kg$

Q. 4 **a)** What is opaque body? How its absorptivity can be increased or decreased? **(04)**

b) A black body emits radiation at 2000K. Calculate **(06)**

i. Monochromatic emissive power at 1 μm wavelength
ii. Wavelength at which the emission is maximum
iii. Maximum emissive power

OR

A black body of infinite dimensions at 1000K is inserted into an infinite medium at 300K. Given Stefan Boltzman constant is 1.8×10^{-8} W/mK^4. What will be the radiative heat transfer coefficient? **(10)**

Q. 5 **a)** Write material balance for single effect evaporator **(07)**

b) Write note on economy of evaporator **(03)**

OR

a) Explain the criteria for selection of evaporator **(04)**

b) Explain with neat diagram backward feed arrangement in evaporator **(06)**

Q. 6 Derive generalized equation of heat conduction and enumerate physical significance of thermal diffusivity **(10)**

OR

An ice ball of initial diameter 0.06 m is suspended in a room at 30°C. The ice melts by absorbing heat from the ambient, the surface HTC being 11.4 W/m^2°C. The air in the room is essentially dry. If the shape of the ball remains unchanged, calculate the time required for reduction in its volume by 40 %. The density of ice is 929 kg/m^3 and its latent heat of fusion is 3.35×10^5 J/kg. **(10)**

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