T2525 / T0522 HEAT TRANSFER OPERATIONS I

23/05/17

T E | V | chem | CBSGS | HTO-1

(23)

QP Code:573701

(Revised Course)
(3 Hours)

Total Marks: 80

N.B.: (1) Question No.1 is compulsory.
(2) Attempt any **Three** out of remaining questions.
(3) Assume any suitable data if necessary and indicate it clearly.
(4) Draw neat sketches wherever required.
(5) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

Q.1

a) Explain Fourier's Law & it's applications in Chemical Industries. (06)

b) Describe any four dimensionless groups used in Heat transfer calculations. (06)

c) Write note on Heat transfer in Agitated Vessels. (05)

d) Describe Stefan-Boltzmann Law. (03)

Q 2a) A heat exchanger is used to heat Oil in tubes from 15^0C to 85^0 C. 5.2 kg/s steam flows cross currently on the shell side with temperature change from 130 ^{0}C to 110^0 C. Find the area of heat transfer. Data: Cp Oil=1.9KJ/kgK. Cp steam=1.86KJ/kgk. U=275W/m^{2}k.LMTD correction factor=.97 (05)

b) Derive the equation for Overall heat transfer coefficient, in terms of film coefficients (10)

c) Describe the various types of fins. (05)

Q3 a) Cold water at 30^0 C, a rate 0.2kg/s flows thro' the inner tube with O.D 25mm.Hot oil in annular area, at a rate 0.1kg/s is cooled from100^0 C to 60^0 C. Find the length of the Double pipe heat exchanger using LMTD & NTU method. Data; Cp Oil 2.13 KJ/kgk, Cp water 4.187KJ/kgk. U -300. Assume countercurrent flow. (10)

b) Using Dimensional analysis, derive empirical equation for rate of heat transfer in forced convection (10)

Q 4a) Water at 60 ^{0}C flows at a rate of 10Kg/S through a pipe with a 7.5 cm inside diameter. (10)
Find the heat transfer coefficient using

i) The Colburn analogy
ii) The Prandtl analogy
iii) Von- Kar man analogy

Data:- For water at 60 0C ,
k = 0.6507 W/m K, ρ = 983.1kg/m^3, μ = 4.67 * 10-4 kg/m-s, cp = 4.186 KJ/ Kg K

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b) A surface condenser was designed for a condensation rate of 50 kg vapor per hour. It contained 100 tubes of 10 mm OD and of 1 m length arranged in a 10*10 array. The condenser was by mistake installed in the vertical position instead of in the horizontal position for which position it was designed. What is the condensation rate in vertical position? (10)

Q 5a) A 20 cm diameter horizontal heater is maintained at a surface temperature of 313 k and submerged in water at 298 K. Estimate the heat loss per unit length of the heater by natural convection. Data:-

Properties of water at mean film temperature k = 0.63 W/m K, $\beta = 3.04 * 10^{-4} K^{-1}$, $\rho = 100 kg/m^3$, $\mu = 8 * 10\text{-}4$ kg/m-s, cp = 4.187 KJ/ Kg K (7)

b) 80 mm O.D pipe is insulated with 40mm thick material of K=.087 & 30mm thick, material with K=.064.If the temp.differ.is 623K to 313K, find the heat loss per meter of the pipe.(assume SI units.) (10)

c) Give the formulae for unsteady state heat transfer & it's importance. (03)

Q 6a) A wall of unit area is attached with 2 layers of insulation.100mm layer of brick with K=0.7, followed by 40 mm gypsum (k=0.48).If the heat loss is to be reduced by 25%, by adding one more layer, find it's thickness.(k=0.065).

b) Derive the formula to calculate critical insulation thickness for a cylindrical pipe. (10)
Also explain optimum thickness with graph.
