19CH203 PROCESS HEAT TRANSFER

https:// www.engineering equipmentindia.com /shell-and-tube-heat-exchanger/

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
25	55	1	-	5	5

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the phenomena of heat transfer. The objective of this course is to provide theoretical and practical knowledge in various modes of heat transfer and its application for designing of process equipments.

COURSE OUTCOMES:

Upon completion of the course, the student will able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Determine critical radius of insulation for any given system.	2
2	Determine heat transfer coefficient for a given system.	2
3	Design heat exchange equipment.	3
4	Identify the suitable evaporators.	3

SKILLS:

- ✓ *Estimate the rate of heat flow.*
- ✓ *Calculate the insulation thickness for a specified heat loss target.*
- ✓ *Determine heat transfer coefficient in simple geometries for forced and natural convection.*
- ✓ *Estimate area of heat exchanger required for specified conditions.*
- ✓ *Design of heat exchanger.*
- ✓ *Determine the emissivity of a given body.*

UNIT- I **L-10**

HEAT TRANSFER BY CONDUCTION : Nature of heat flow; Modes of heat transfer- conduction, convection, radiation; Conduction- Fourier's law, concept of electrical analogy, one dimensional heat flow through slab/cylinder/sphere, thermal resistance, heat flow through composite wall/cylinder and sphere, thermal contact resistance.

UNIT- II **L-9**

HEAT TRANSFER TO FLUIDS WITHOUT PHASE CHANGE : Principles of heat flow in fluids; Heat exchange equipment; Counter current & parallel current flows; Energy balances; Rate of heat transfer; LMTD; Individual heat transfer coefficients; Overall heat transfer coefficient**;** Regimes of heat transfer; Thermal boundary layer; Dimensional analysis- Buckinghum pi theorem, dimensionless groups in natural and forced convection, significance of dimensionless groups; Forced convection: heat transfer in laminar flow, heat transfer in turbulent flow, analogy between transfer of momentum and heat, Reynolds analogy, Colburn analogy; Natural convection- heat transfer by natural convection from vertical and horizontal shapes.

UNIT- III **L-8**

HEAT TRANSFER TO FLUIDS WITH PHASE CHANGE : Boiling heat transfer; Types of boiling; Critical heat flux concept; Pool boiling of saturated liquids; Film boiling; Condensation heat transfer-drop wise and film type condensation.

RADIATION : Radiation; Emissivity; Absorptivity; Transmissivity; Laws of black body and grey body radiation; Radiation between black surfaces; Radiation between grey surfaces; Shape factors; Combined heat transfer by conduction; Convection and radiation.

UNIT- IV **L-8**

HEAT EXCHANGE EQUIPMENT : Types of heat exchange equipment- double pipe, shell and tube, extended surface and plate type; General design of heat exchange equipment; Bell Delaware method, ; Kern method; Condensers; Boilers- water tube boilers, fired tube boilers.

UNIT- V **L-10**

EVAPORATION : Liquid characteristics; Types of evaporators- falling film, climbing film, forced circulation and agitated film type evaporators; Performance of single effect evaporators- material and energy balance, capacity and economy; Multiple effect evaporators; Methods of feeding.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS **TOTAL HOURS: 30**

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of metal rod.
3. Determination of thermal conductivity of a liquid.
4. Determination of overall resistance in composite wall.
5. Determination of heat transfer coefficients of double pipe heat exchanger.
6. Estimation of heat transfer coefficient in forced convection.
7. Estimation of natural convection heat transfer coefficient.
8. Determination of overall heat transfer coefficient of a given coil.
9. Determination of critical heat flux of nichrome wire.
10. Verification of Stefan-Boltzmann's law of radiation.
11. Estimation of emissivity of a test plate.
12. Determination of heat transfer coefficient in Shell and Tube Heat Exchanger.
13. Determination of temperature distribution and effectiveness of the fin.
14. Determination of overall heat transfer coefficient in vertical condenser.
15. Determination of steam economy and the overall heat transfer coefficient for evaporator.

TEXT BOOKS:

1. W. L. McCabe, J. C. Smith and P. Harriott,"Unit Operations of Chemical Engineering", 7th edition, McGraw-Hill, Inc., 2005.
2. D. Q. Kern, "Process Heat Transfer", 1st edition, Tata McGraw-Hill, 2002.

REFERENCE BOOKS:

1. J. P. Holman, "Heat Transfer", 8th edition, McGraw-Hill, New York, 1997.
2. Y. V. C. Rao, "Heat Transfer", 1st edition, University Press, 2001.
3. D. Pitts, E. Leighton and Sissom, " Schaum's Outline of Heat Transfer", 2nd edition, McGraw-Hill publications, 1998.
4. J. M. Coulson and J. F. Richardson," Chemical Engineering, Vol -1", Oxford, Pergamon Press,1968.