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16BT206 HEAT AND MASS TRANSFER

Hours Per Week :

L	T	P	C
3	-	2	4

Course Description and Objectives:

The course provides the basics of major heat and mass transfer operations. The objective of this course is to impart knowledge on design of heat and mass transfer equipments . In addition, it also imparts knowledge on optimization of the cost of heat transfer operations used in bioprocess industries.

Course Outcomes:

Upon completion of the course, the student will be able to

CO1: Understand the basic modes of heat and mass transfer.

CO2: Apply principles of heat and mass transfer to predict transfer coefficients

CO3: Analyze working of various heat transfer equipment

CO4: Design heat and mass transfer equipment.

CO5: Evaluate no. of stages required for given mass transfer problem.

SKILLS:

- ✓ *Design heat exchangers.*
- ✓ *Estimate heat and mass transfer coefficients.*
- ✓ *Estimate Log Mean Temperature Difference (LMTD) in heat exchangers.*

UNIT - 1 L-9

MODES OF HEAT TRANSFER: Modes of heat transfer; Fourier's law, thermal conductivity, steady state conduction in plane wall and composite walls; Heat flow in cylinder and spheres, countercurrent and parallel current flows; Energy balances, rate of heat transfer, overall heat transfer coefficient, logarithmic mean temperature difference, individual heat transfer coefficients, and fouling factors.

UNIT - 2 L-9

HEAT TRANSFER TO FLUIDS WITHOUT PHASE CHANGE AND WITH PHASE CHANGE: Thermal boundary layer, heat transfer by forced convection in laminar flow and turbulent flow; Natural convection to air from vertical and horizontal planes, heat transfer from condensing vapors and heat transfer to boiling liquids.

UNIT - 3 L-9

DESIGN OF HEAT TRANSFER EQUIPMENTS: General design of heat exchange equipment, heat exchangers, condensers, boilers and calandrias; Liquid characteristics, types of evaporators, performance of tubular evaporators, enthalpy balances for single effect evaporator.

UNIT - 4 L-9

DIFFUSION AND MASS TRANSFER: Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law of diffusion, equation of continuity, steady state equimolar counter current diffusion, Stefan's estimation of diffusivity in gases and liquids, application of molecular diffusion, theories of mass transfer.

UNIT - 5 L-9

MASS TRANSFER OPERATIONS: Introduction, counter and cocurrent isothermal absorption and stripping of single component, operating lines, minimum flow rate, determination of number of transfer units and height of continuous absorber, determination of number of plates; Steam distillation, flash vaporization and differential distillation for binary and multi component mixtures.

ACTIVITIES:

- *Handle sterilizers.*
- *Estimate heat transfer area for condensers, evaporators and boilers.*
- *Control temperature in bio-reactors.*

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Verification of Bernoulli's equation for variable cross sectional pipe.
2. Determination of coefficient of discharge for Venturi meter.
3. Estimation of coefficient of discharge for Orifice meter.
4. Determination of pressure drop for fluidized bed reactor.
5. Determination of various characteristic curves of single stage centrifugal pump.
6. Determination of minor losses for flow through pipes.
7. Calculation of heat transfer coefficient through natural convection.
8. Calculation of heat transfer coefficient through forced convection.
9. Assessment of LMTD and rate of heat transfer for double pipe heat exchanger in cocurrent and counter current pattern.

TEXT BOOKS:

1. A. Suryanarayana, "Mass Transfer Operations", 1st edition, New - Age, International, 2006.
2. McCabe, W.L. Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th edition, McGraw Hill, 2004.

REFERENCE BOOKS:

1. D. Q. Kern, "Process Heat Transfer", McGraw-Hill, 2001.
2. C. J. King, "Separation Processes", 2nd edition, McGraw Hill, 2014.
3. P.M. Doran, "Bioprocess Engineering Principles", 2nd edition, Academic Press, 2012.
4. R.E.Treybal, "Mass Transfer Operations", 3rd edition, Mc-Graw Hill, 2012.