PROCESS HEAT TRANSFER

Course Code :15CH1109

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Course Outcomes:

On successful completion of the course, the student should be able to

CO 1 State the laws of heat transfer and derive the relevant equations.

CO 2 Identify the modes of heat transfer and estimate the heat transfer rates.

CO 3 Explain heat transfer by forced convection in different flows.

CO 4 Explain heat transfer by radiation and calculate the heat transfer rates by radiation.

CO 5 Design and draw different types of heat transfer equipment .

UNIT-I (10 Lectures)

HEAT TRANSFER BY CONDUCTION IN SOLIDS:

Fourier's law, thermal conductivity, steady state conduction in plane wall, cylinder and sphere, unsteady state heat conduction, heat conduction equation with and without internal heat generation, semi-infinite solid, finite solid, critical insulation thickness.

PRINCIPLES OF HEAT FLOW IN FLUIDS:

Typical heat exchange equipment, range, approach, temperature versus length curves, countercurrent and co-current flows, energy balances, overall heat transfer coefficient, LMTD, resistance form of overall coefficient, fouling factors, effective coefficients for unsteady-state heat transfer.

UNIT-II (10 Lectures)

HEAT TRANSFER TO FLUIDS WITHOUT PHASE CHANGE:

Thermal boundary layer, heat transfer by forced convection in laminar and turbulent flows, viscosity correction factor, analogies between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes, brief discussion about heat transfer to fluids in laminar flow with constant heat flux and constant wall temperature.

UNIT-III (10 Lectures)

NATURAL CONVECTION:

Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer, free convection in enclosed spaces, mixed convection.

HEAT TRANSFER TO FLUIDS WITH PHASE CHANGE:

Heat transfer from condensing vapors, heat transfer to boiling liquids.

UNIT-IV (10 Lectures)

RADIATION:

Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials, combined heat transfer by conduction, convection and radiation.

UNIT-V (10 Lectures)

HEAT EXCHANGE EQUIPMENT:

General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, compact heat exchangers, plate type heat exchangers, heat transfer in packed beds, heat exchanger (effectiveness) NTU method, and LMTD method.

EVAPORATORS:

Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, vapor recompression.

TEXT BOOK:

1. McCabe W.L., Smith J.C. and Harriott P., *"Unit Operations in Chemical Engineering"*, 7th Edition, McGraw Hill, 2005.

REFERENCES:

1. Geankoplis,C.J., *"Transport processes and Unit operations"*, 3rd Edition, PHI, 2002.
2. Kern D Q, *"Process Heat Transfer"*, McGraw Hill, 1986.