DESIGN OF THERMAL EQUIPMENT
(Elective-II)

Course Code: 13ME2315

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Pre requisites: Fluid mechanics and heat transfer

Course Educational Objectives:

To teach the student

1. about different types of heat exchangers used in industries
2. the method to design multi-pass shell-and-tube heat exchanger for required specifications
3. to predict the pressure drop on shell-side and tube-side of the heat exchanger
4. to design compact heat exchanger (such as automobile radiator), condenser and evaporator

Course Outcomes:

The student will be able to

1. calculate the heat exchanger area and pressure drop for a shell-and-tube heat exchanger
2. know the implications such as fin effect, channel flow to be considered in the design of
   compact heat exchangers
3. design condensers and evaporators for application in refrigeration and air-conditioning

UNIT-I

Classification of heat exchangers: Tubular heat exchangers, plate heat exchangers, extended surface heat exchangers – flow arrangements – applications.

Basic design methods of heat exchangers: Overall heat transfer coefficient – multi pass and cross flow heat exchangers - log mean temperature difference method – effectiveness-NTU method for heat exchanger analysis–heat exchanger design calculation–heat exchanger design methodology.

UNIT-II

Correlations for forced convection heat transfer coefficients: Laminar forced convection in ducts and concentric annuli – turbulent forced convection in circular pipes – heat transfer in helical coils and spirals – heat transfer in bends.

UNIT-III

Heat exchanger pressure drop and pumping power: Tube side pressure drop in laminar and turbulent flows – pressure drop in helical and spiral coils – pressure drop in bends and fittings.

Fouling of heat exchangers: Basic considerations – effect of fouling and heat transfer and pressure drop – aspects of fouling – design of heat exchangers subject to fouling.

UNIT-IV

Double pipe heat exchangers: Pressure drop – hydraulic diameter – hairpin heat exchanger – parallel and series arrangements of hairpins – total pressure drop.

Compact heat exchangers: Plate-fin heat exchangers – tube-fin heat exchangers – pressure drop for finned-tube heat exchangers – pressure drop for plate-fin heat exchangers.

UNIT-V

Condensers and evaporators: Horizontal shell-and-tube condensers – horizontal in-tube condensers – plate condensers – air-cooled condensers, thermal design of shell-and-tube condensers – design and operational considerations.

TEXT BOOK:

1. Sadik Kakac and Hongtan Liu, "*Heat Exchangers – Selection, Rating and Thermal Design"*, CRC Press, New York, USA, 2000.

REFERENCES:

1. Donald Q. Kern, "*Process Heat Transfer"*, Tata McGraw-Hill, 2001.
2. S. Kakac, A.E. Bergles and F. Mayinger, "*Heat Exchangers: Thermal-Hydraulic Fundamentals and Design"*, Hemisphere Pub., 1981.
3. "*Standards of the Tubular Exchanger Manufacturers Association (TEMA)", Inc*., 7th Edition, New York, 1988.