FDE 208 HEAT TRANSFER AND THERMAL PROCESSES

HEAT EXCHANGERS

THEORY OF HEAT TRANSFER

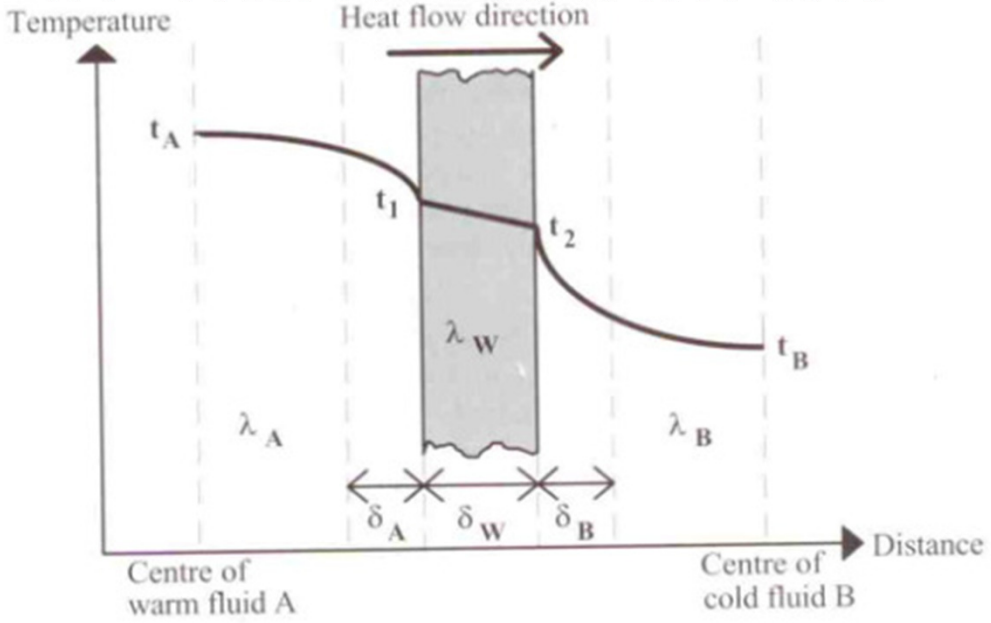
- 1- Conduction(İletim): molecular energy transfer
- 2-Convection (Taşınım): Energy transfer due to molecular flow

-Natural

-Forced

- 3- Radiation (Işınım): Electromagnetic radiation

THEORY OF HEAT TRANSFER



Q= Ma.CPa.Ta= Mb.CPb.Tb = U.A.LMTD
M(kg/s) = Mass flow rate
CP (j/kg. C) = Specific heat capacity
T (C) = Temperature difference
U (W/m2.C) = Overall heat transfer coefficient
A (m2) = Heat transfer area
LMTD (ºC) (Logarithmic mean temperature difference)

WHAT IS A HEAT EXCHANGER?

- A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another.
- Temperature difference is the driving force for energy transfer.
- No mixing of the fluids!!

- Heat transfer in heat exchangers :
  - Between fluids → convection
  - Through the equipment → conduction

- For this reason, U(overall heat transfer coefficient), which combines two different tranfer types, is used in the calculations of heat exchangers.

$$\frac{1}{UA} = \Sigma\frac{1}{hA} + \Sigma R$$

$$R = \frac{x}{k \cdot A}$$

where

x = the wall thickness (m)
k = the thermal conductivity of the material (W/(m·K))
A = the total area of the heat exchanger (m^2)

- The heat transfer rate at a certain point of heat exchanger depends on the temperature difference at that point.

- Since the temperature difference is variable through the exchanger, Logarithmic mean temperature difference, LMTD , needs to be used.

$$LMTD = \frac{\Delta T_A - \Delta T_B}{\ln\left(\frac{\Delta T_A}{\Delta T_B}\right)}$$

Heat Exchanger Types

a- Tubalar heat exchangers
b- Plate heat exchangers

Tubular Heat Exchangers

- Double pipe heat exchangers are the simplest exchangers used in industries.
- One of the fluids flows inside the tube while the other one flows outside the inner tube.
- Pipe diameter, number of inner pipes, pipe length and arrangement of the pipes can be varied. Therefore, different tubular heat echangers can be designed easily.

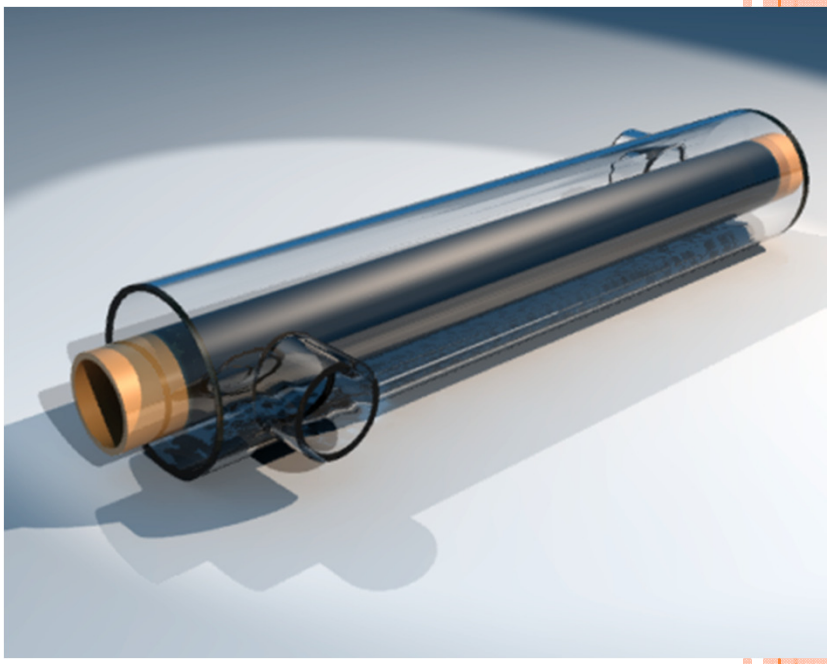
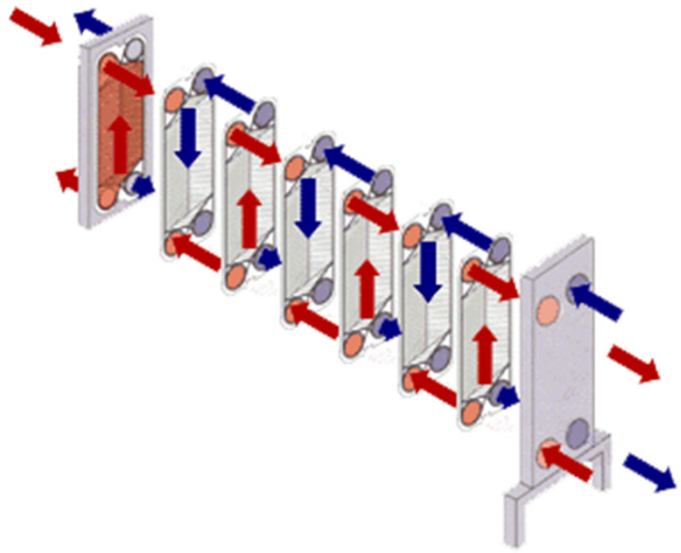


Plate Heat Exchangers

- Another type of heat exchanger is the plate heat exchanger.
- It is composed of multiple, thin, slightly separated plates that have very large surface areas and fluid flow passages for heat transfer.
- This stacked-plate arrangement can be more effective, in a given space, than the shell and tube heat exchanger.



Selection of a Heat Exchanger

- Factors to be considered while selecting a heat exchanger:
  - Construction material,
  - Pressure and temperature,
  - Performance parameters (flow rates, pressure drops),
  - Fluid type
  - Size of the heat exchanger
  - Availability and economic factors.