Heat Exchangers

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ME30005 – Heat Transfer

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What is a heat exchanger?

Heat Exchangers (HX) are devices where <u>heat is transferred between two fluids</u> at different temperatures <u>without any mixing of fluids</u>

Classification of HX

- Hundreds of types of heat exchangers depending on designs, geometry, flow configurations, materials, etc.

- 3 broad classifications
  - **Direct Transfer type**
  - Storage type
  - Direct contact type

Focus of our course will be on Direct Transfer type

Direct Transfer Type HX

- It is that type of heat exchanger where the <u>hot and cold fluids flow simultaneously</u> through the device and <u>heat is transferred through a wall</u> separating the fluids.

warm fluid in

warmed fluid out

cold fluid in

cooled fluid out

Precision Graphics
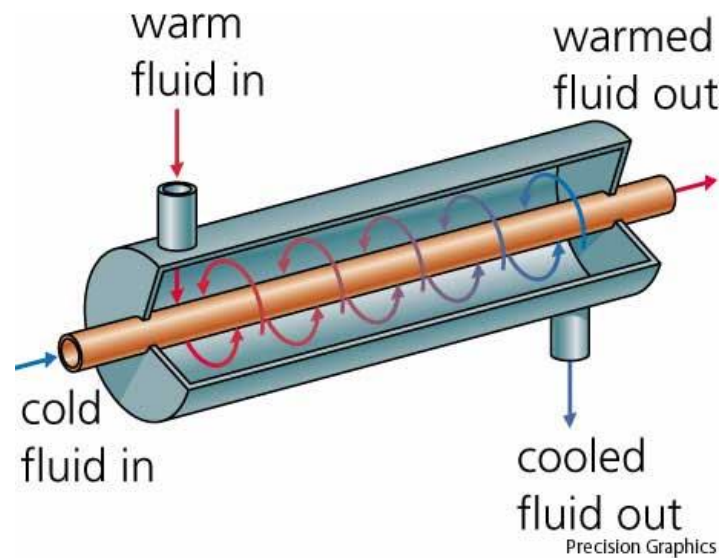
Storage type HX

- It is a heat exchanger where <u>heat transfer</u> between the hot and cold fluids <u>occurs through a coupling medium</u> in the form of a porous solid matrix. The <u>hot and cold streams flow alternately through the matrix</u>, the hot fluid storing heat in it and the cold fluid extracting heat out of it.

  – Also called regenerative type HX
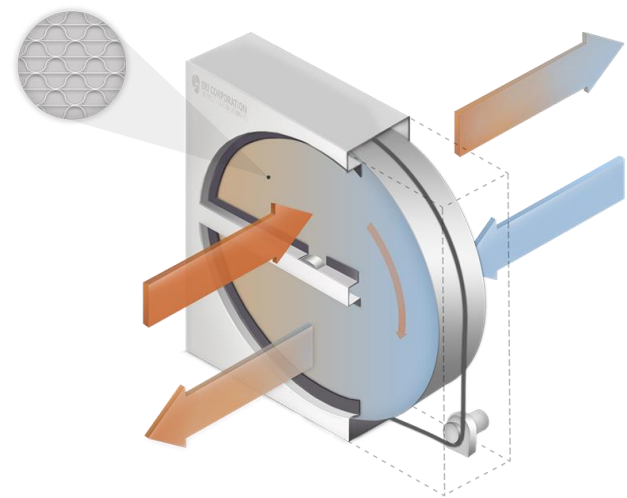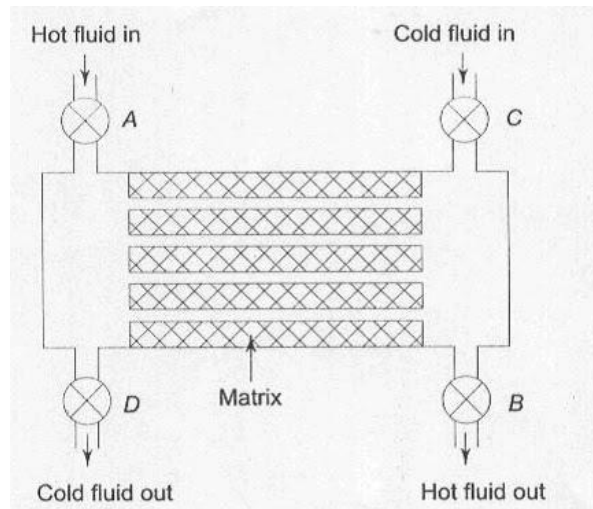
Heat Recovery Wheel

Direct Contact HX

- In Direct Contact type HX, the <u>two fluids are NOT separated</u>. If heat is to be transferred between a gas and a liquid (most common), the gas is either bubbled through the liquid of the liquid is sprayed into the form of droplets into the gas.
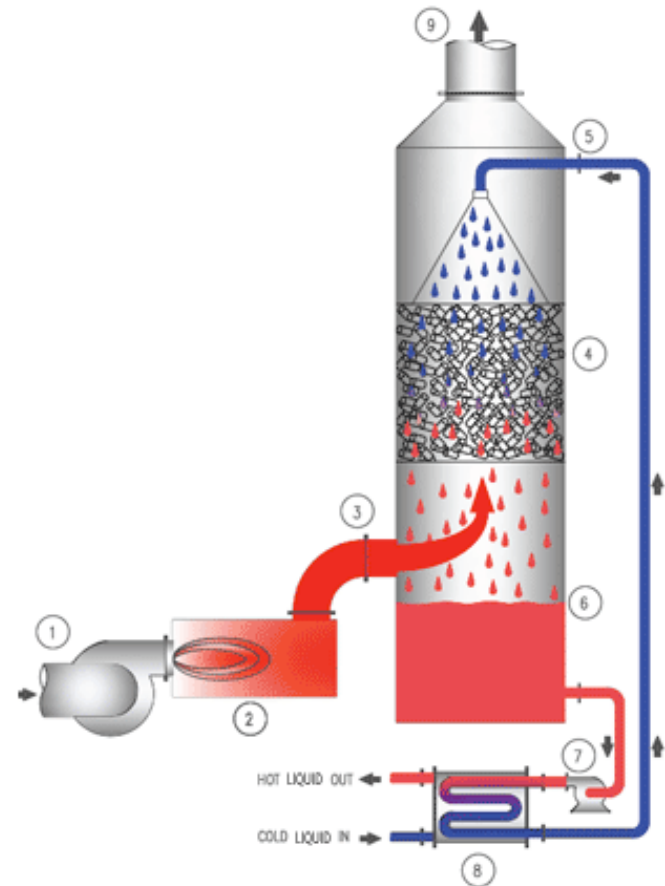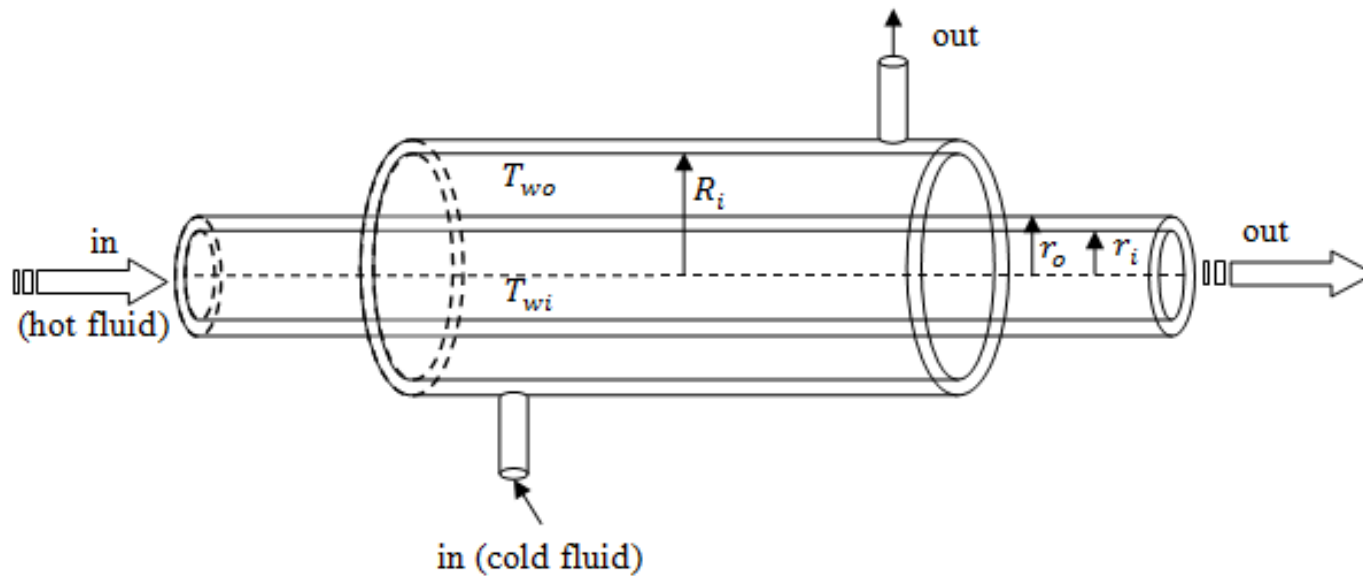
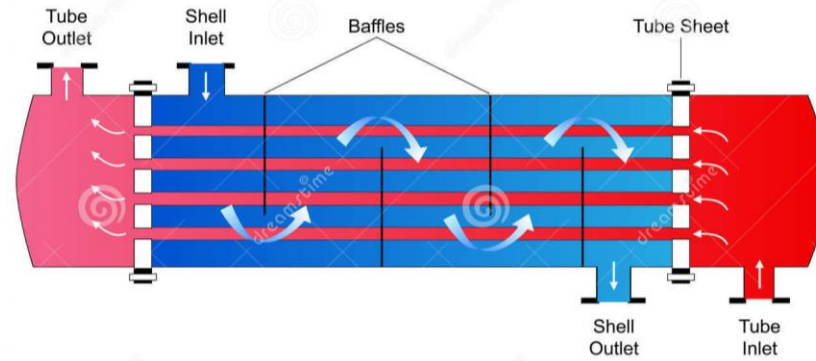# Direct Transfer HX - Classification

- Classification by Design Type
  - Tubular
    - Concentric Tube or Double pipe
    - Shell and Tube
  - Parallel Plate
  - Extended Surfaces

  Note: many other designs are possible; above three are the most commonly encountered ones
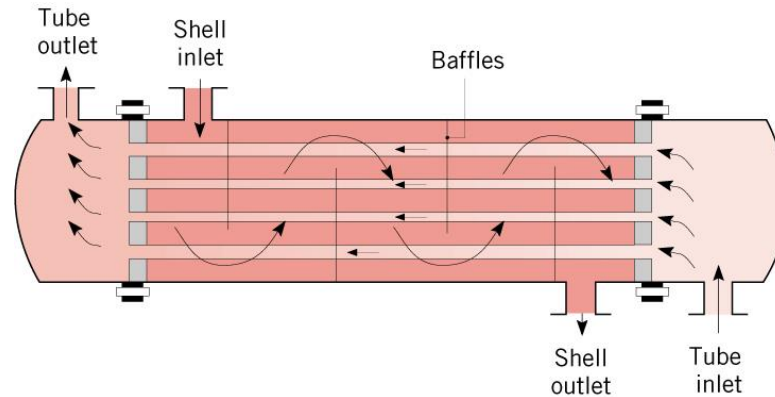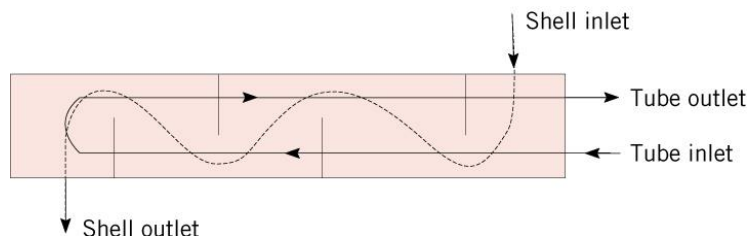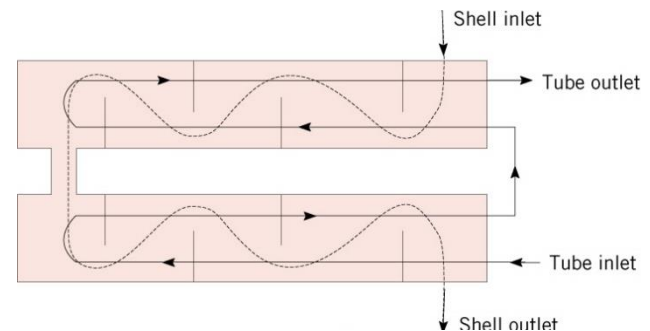
Concentric tube

Shell and Tube

Tube Outlet   Shell Inlet   Baffles   Tube Sheet

Shell Outlet   Tube Inlet
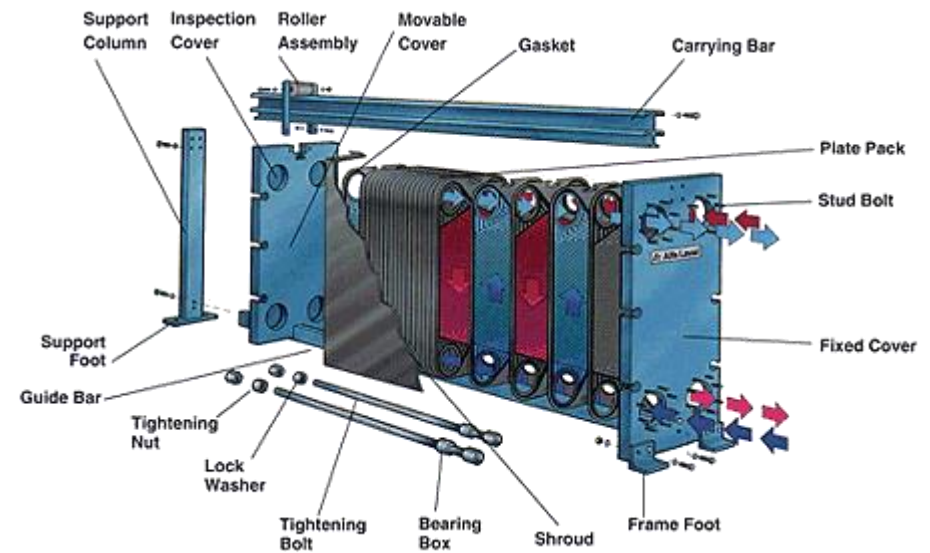
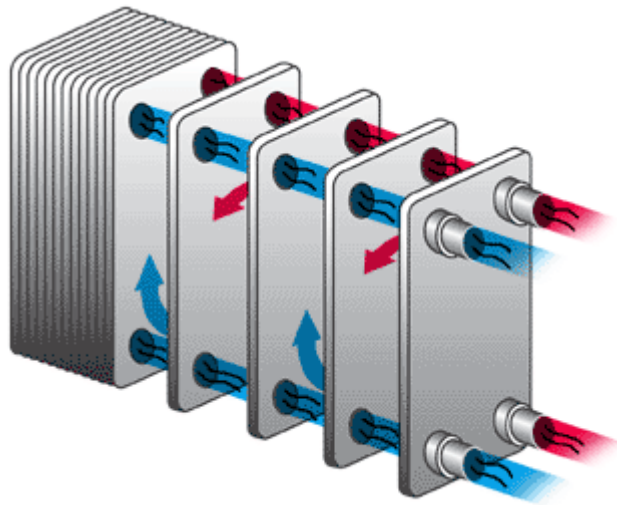# Shell and Tube types
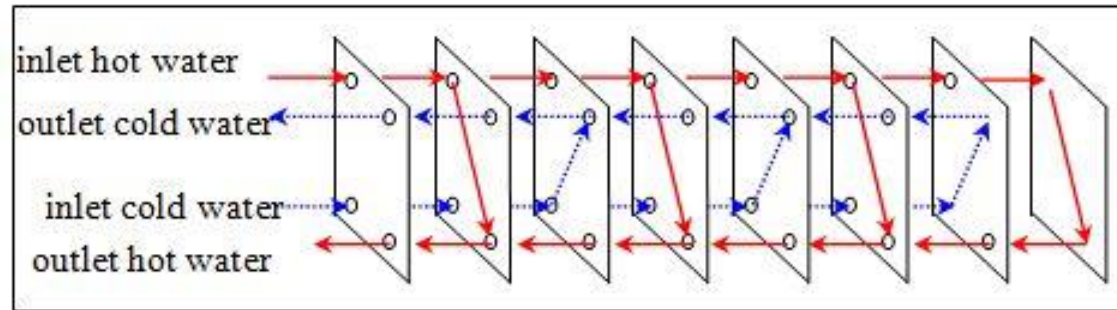

One Shell Pass and One Tube Pass

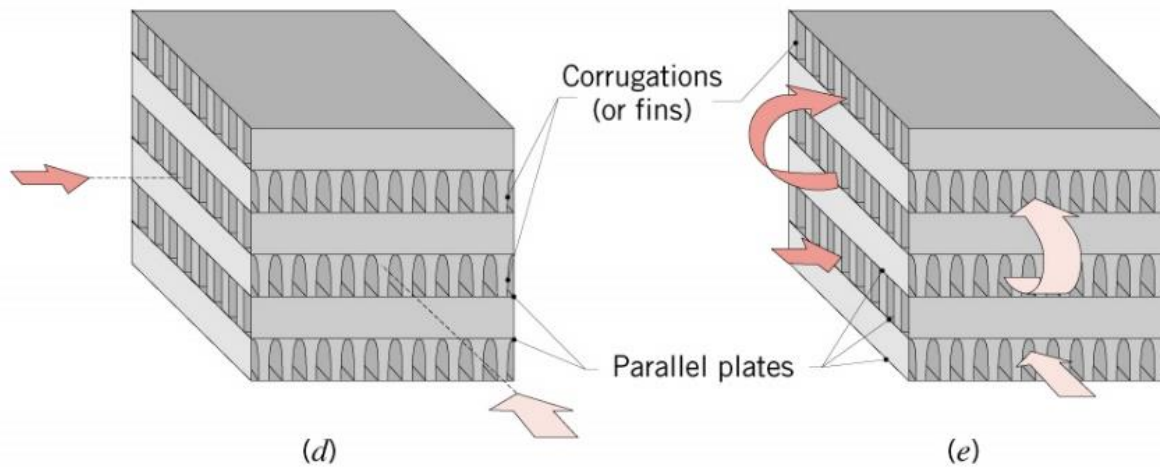
**One Shell Pass,
Two Tube Passes**

**Two Shell Passes,
Four Tube Passes**

Parallel plate HX

inlet hot water
outlet cold water
inlet cold water
outlet hot water

Support Column
Inspection Cover
Roller Assembly
Movable Cover
Gasket
Carrying Bar
Plate Pack
Stud Bolt
Support Foot
Guide Bar
Tightening Nut
Lock Washer
Tightening Bolt
Bearing Box
Shroud
Frame Foot
Fixed Cover

Extended Surfaces
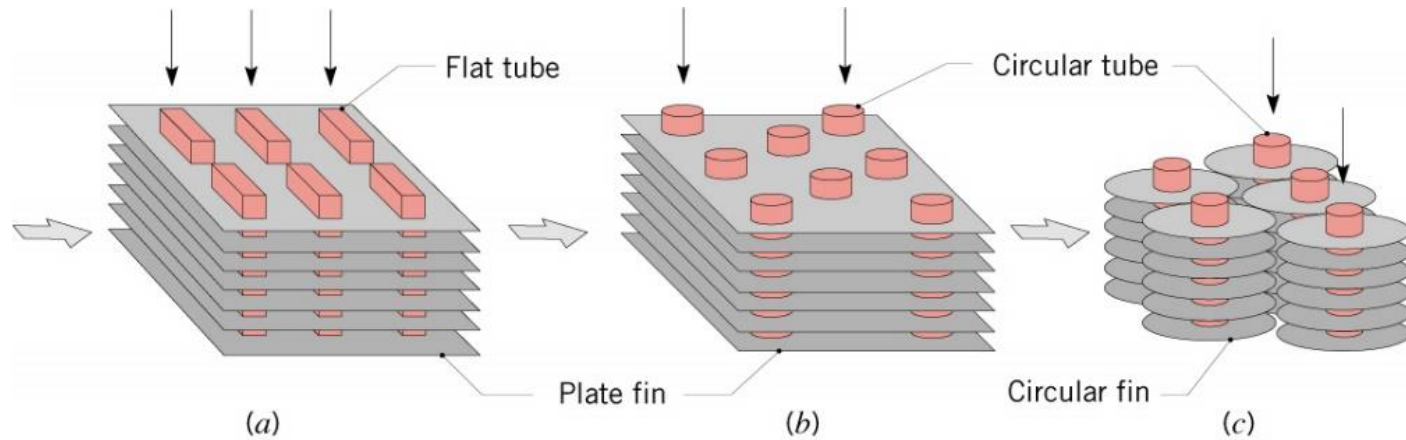
Cross Flow HX – mixed/unmixed

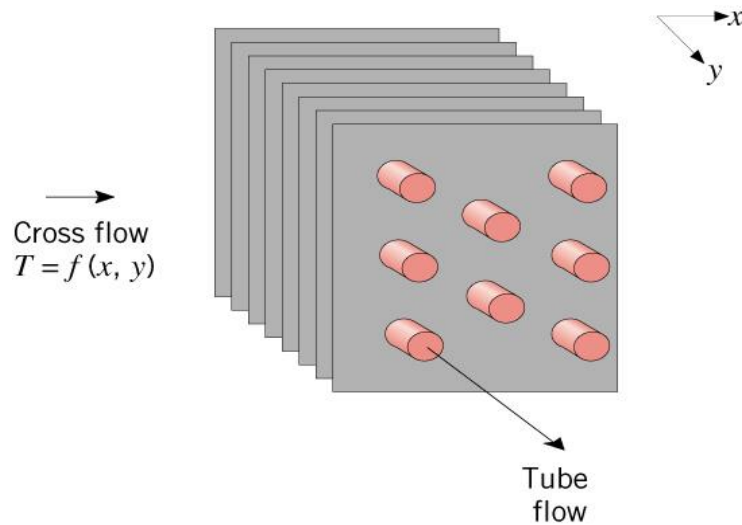
Cross flow
$T = f(x, y)$

Tube flow

Finned-Both Fluids Unmixed

Cross flow
$T \approx f(x)$

Tube flow
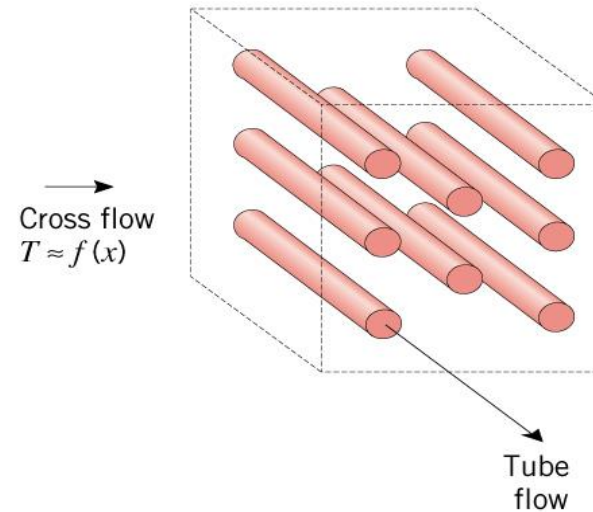
Unfinned-One Fluid Mixed the Other Unmixed

Note: Finned tube HX is BOTH FLUIDS UNMIXED

Class Notes topics

- Parallel & Counter Flow
- Concept of Overall Heat Transfer Coefficient (U)
  - Fouling
- Mean temperature difference – LMTD
  - Parallel Flow
  - Counter Flow
  - Cross Flow & Shell and Tube (*F charts*)
    - Refer to any text book on Heat Transfer

Effectiveness – NTU Method

Refer to Class Notes

- Definition of Effectiveness

- Calculation of Effectiveness for Parallel and Counter Flow HX

- NTU and Heat Capacity Ratio (C) definitions

- Charts for different types of HX

  - Refer to any text book on Heat Transfer

- Special case of C = 0

  - Expected to remember e – NTU relationship

Thank You!