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Heat exchanger

What is the heat exchanger?

Heat exchangers are devices that facilitate the **exchange of heat** between **two fluids** that are at different temperatures

Prevent the two fluids from mixing with each other

Heat transfer in a heat exchanger involves:

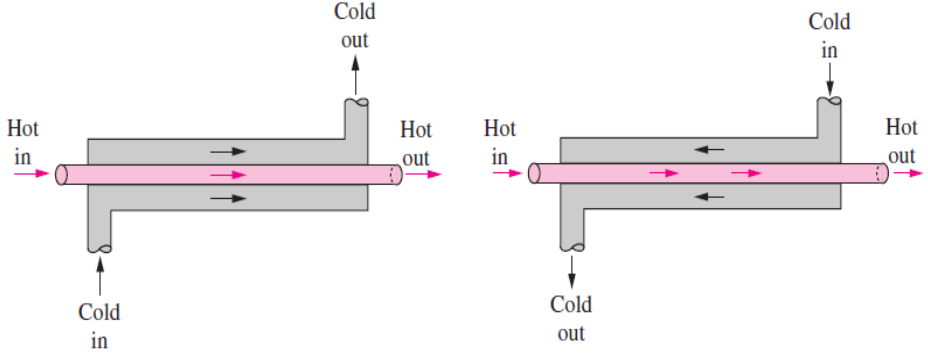
Convection in each fluid

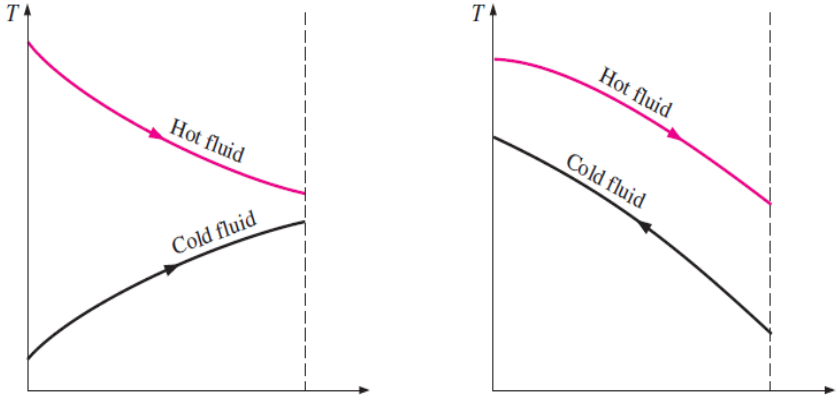
Conduction through the wall separating the fluids

Types of Heat Exchanger

- **Double Pipe HE**

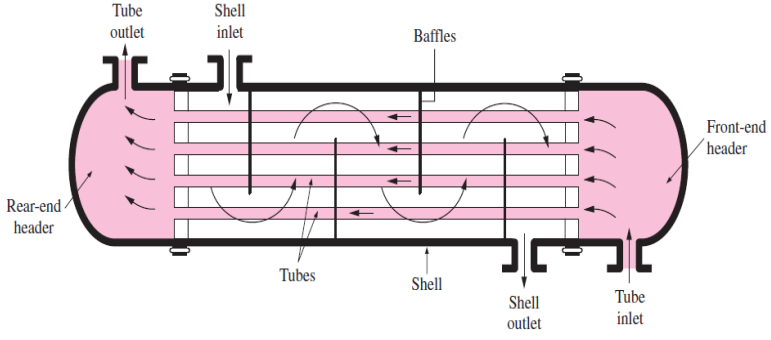
Double pipe HE consist of two concentric pipes of different diameters





- **Shell and Tube HE**

Most common type of HE in industrial applications are shell and tube heat exchangers

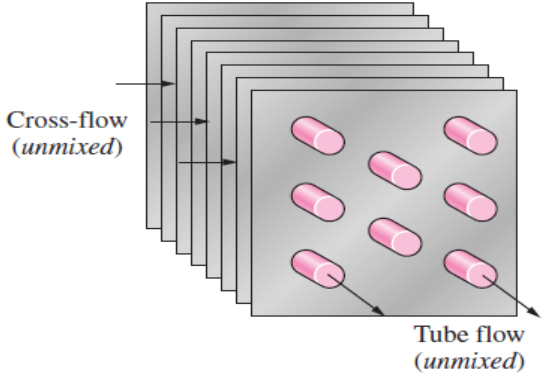

Tube outlet
Shell inlet
Baffles
Front-end header
Rear-end header
Tubes
Shell
Shell outlet
Tube inlet

- **Plate and Frame HE**

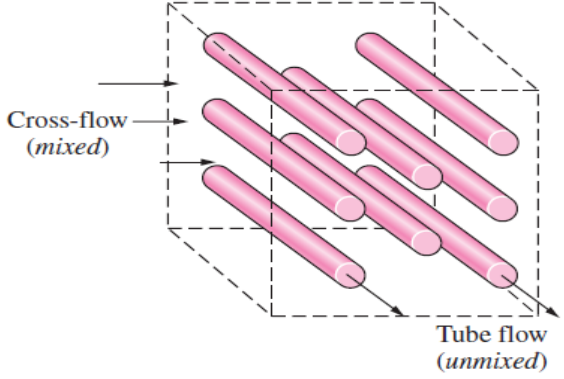
Consists of a series of plates with corrugated flat flow passages

- **Cross Flow HE**

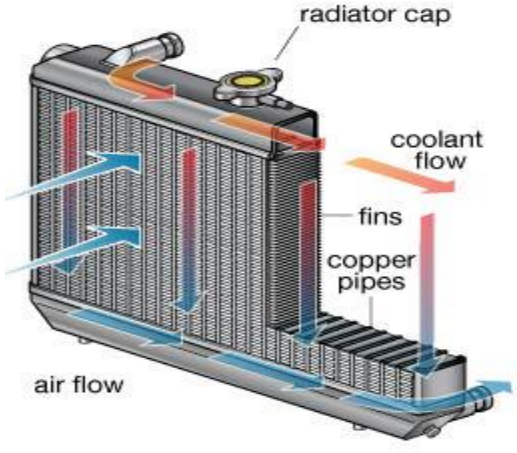
In a cross flow HE, the two flows usually move perpendicular to each other



(a) Both fluids unmixed



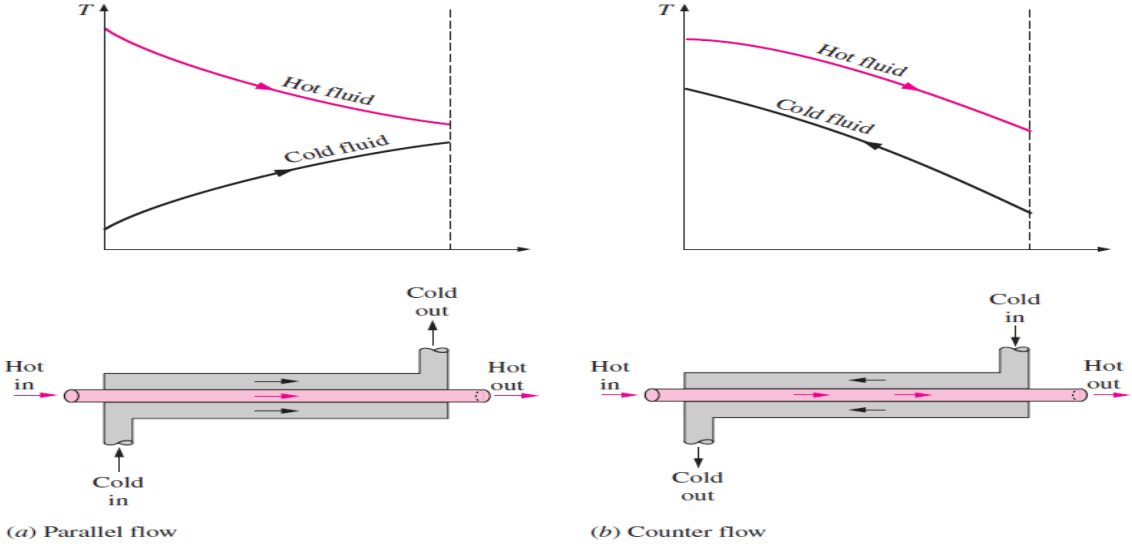
(b) One fluid mixed, one fluid unmixed

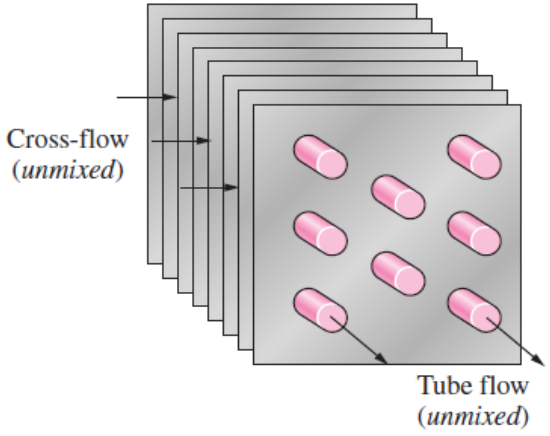

radiator cap
coolant flow
fins
copper pipes
air flow

Classifications

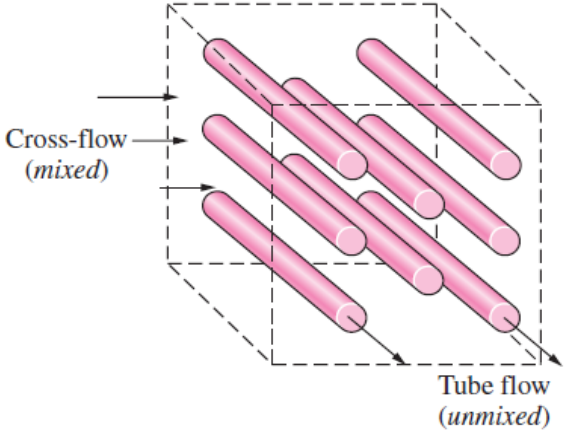
- Based on **direction** of the flow (parallel, counter or cross)
- Based on the **contact**(mixed or unmixed)
- **Compactness**(compact or non–compact)
- **Multiple pass** heat exchangers
- **Fluid type** (Gas-gas, Liquid-liquid, Gas-liquid)

- **Flow Direction and Mixed/Unmixed**





(*a*) Both fluids unmixed



(*b*) One fluid mixed, one fluid unmixed

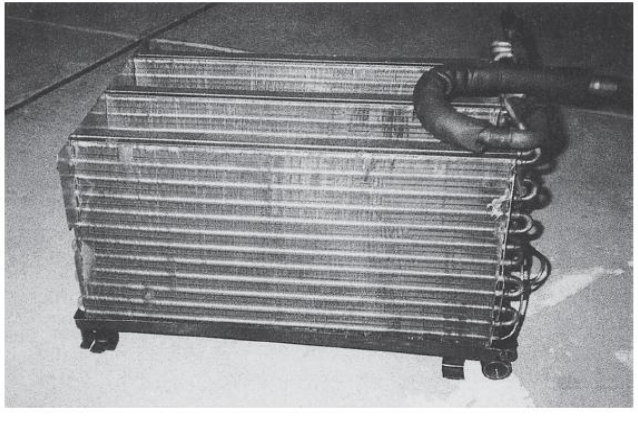
- **Compactness**

Compact heat exchangers are designed to realise a large heat transfer surface area per volume

Expressed as the *area density* β.Ratio of surface area of a heat exchanger to its volume

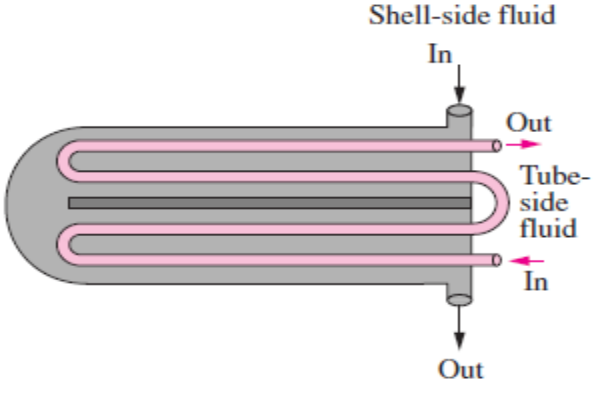
HE is considered compact if β >700 $m2/\ m3$

Examples: Car Radiator (β ≈1000 $m2/\ m3$), glass ceramic gas turbine heat exchangers (β ≈6000 $m2/\ m3$), Stirling engine regenerator (β≈15,000 $m2/\ m3$)

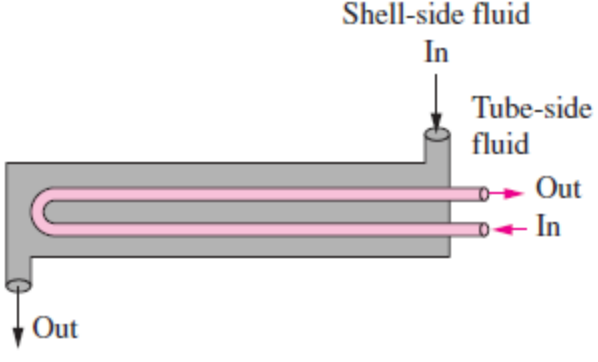


- **Multiple pass heat exchangers**

Shell-and-tube heat exchangers are classified according to the number of shell and tube passes involved.



(*b*) Two-shell passes and four-tube passes



(*a*) One-shell pass and two-tube passes