

Heat Exchangers: Applications & Classifications

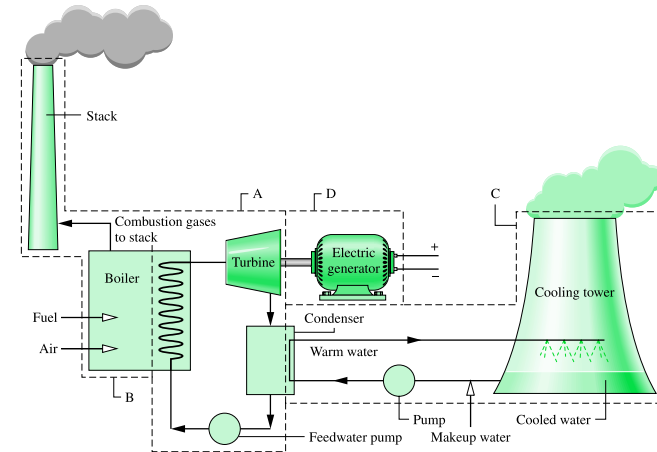
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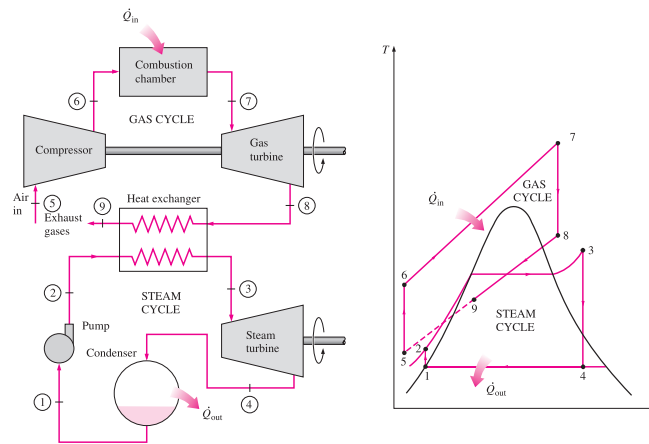
ME 307: Heat Transfer Equipment Design
<http://zahurul.buet.ac.bd/ME307/>

Applications of Heat Exchangers



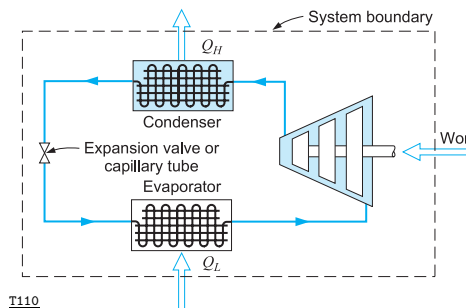
T193

Components of a simple vapour power plant



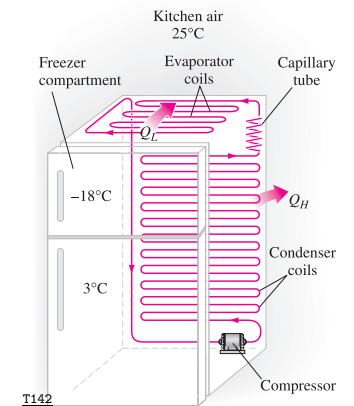
T214

Combined cycle power plant

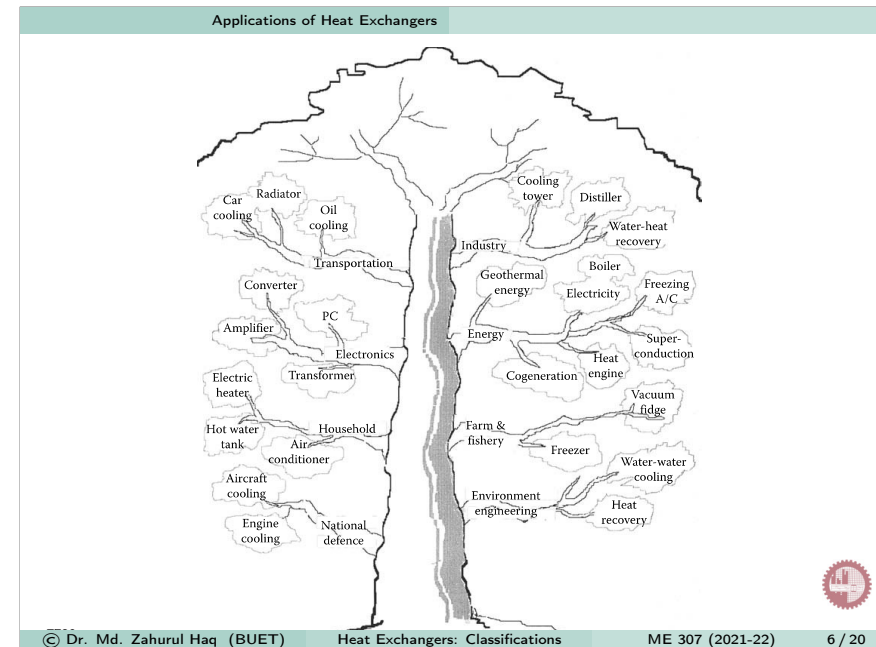
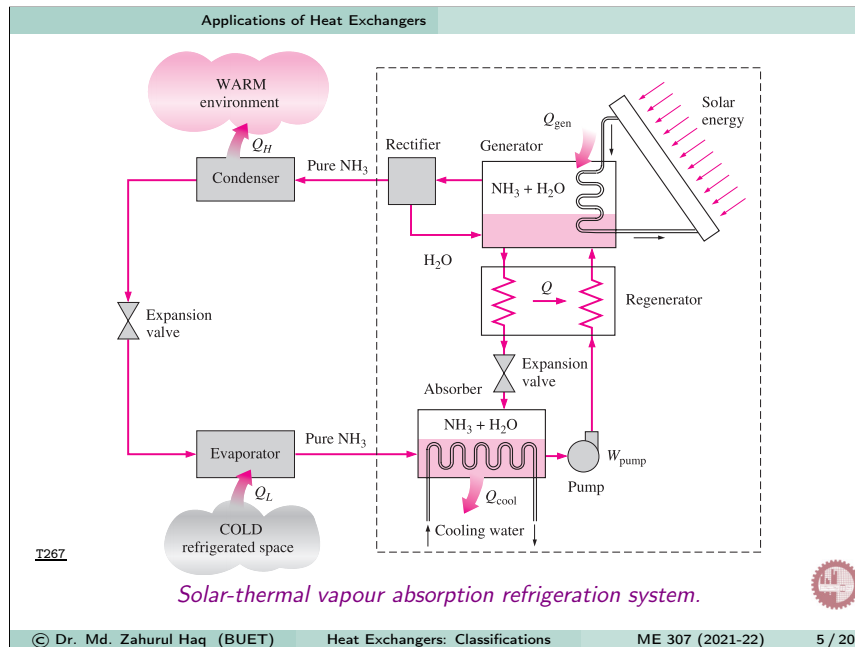


T110

Refrigerators.



T142



Applications of Heat Exchangers

- **Heat Exchangers (HXs)** are devices that facilitate transfer of heat between two or more fluids at different temperatures.
- HX final design:
 - heat transfer and pressure drop analysis,
 - sizing and performance analysis,
 - economic aspect.

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Classification of Heat Exchangers

Classification of Heat Exchangers

A. Classification by Transfer Processes:

- ① Direct contact e.g. cooling tower
- ② Indirect contact e.g. shell-tube HX

B. Classification by Construction Type:

- ① Tubular HX
 - Double-pipe HX
 - Shell-and-tube HX
 - Spiral-tube-type HX
- ② Plate HX
 - Gasketed plate HX
 - Spiral plate HX
- ③ Extended surface HX

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Classification of Heat Exchangers

Counterflow configuration

Parallel-flow configuration

T734

Counterflow and parallel-flow configurations for double-pipe heat exchangers

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Classification of Heat Exchangers

Tube sheet

Shell fluid in

Tube fluid out

Inlet plenum

Outlet plenum

Tube fluid in

Baffles

Shell fluid out

Tube fluid out

Shell fluid in

Outlet plenum

Inlet plenum

Tube fluid in

Shell fluid out

Tube sheet

2-tube pass STHX

T735

1-tube pass and 2-tube pass STHXs.

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Classification of Heat Exchangers

T733

T736

Gasketed plate HX.

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Classification of Heat Exchangers

T731

Condenser

Evaporator/re-boiler

Vapours

Water

Vapour

Water

Hot water

Inerts

Condensate

Liquid

T732

Spiral-plate HX

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C. Classification by Flow Arrangement:

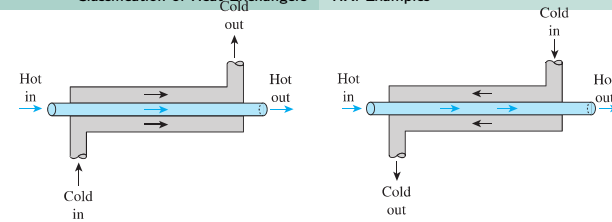
- 1 Parallel-flow
- 2 Counter-flow
- 3 Cross-flow
- 4 Multipass-flow

D. Classification by Heat Transfer Mechanism:

- 1 Single phase, free or forced convection
- 2 Phase change, boiling or condensation
- 3 Radiation or combined radiation and convection

E. Compact Heat Exchangers:

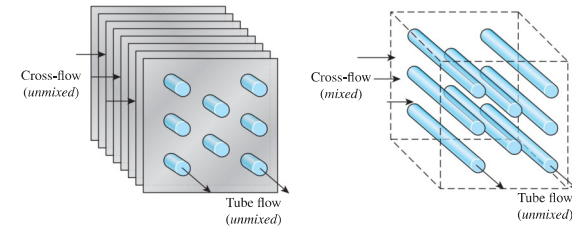
- Compact HX, if surface area density $> 700 \text{ m}^2/\text{m}^3$.
- Automotive HX: $1100 \text{ m}^2/\text{m}^3$.
- Human lungs: $20000 \text{ m}^2/\text{m}^3$.



T724

(a) Parallel flow (b) Counter flow

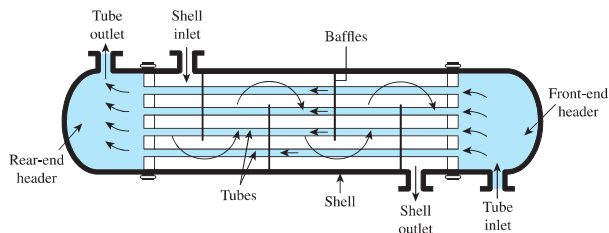
Parallel-flow and Counter-flow HX



T725

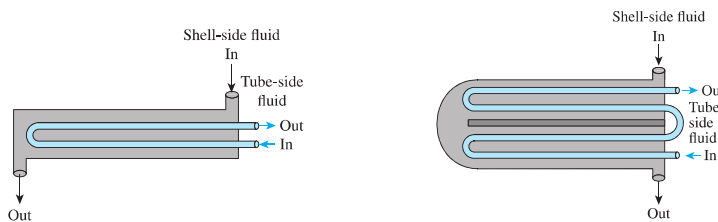
(a) Both fluids unmixed (b) One fluid mixed, one fluid unmixed

Cross-flow HX



T726

A shell-and-tube heat exchanger (one-shell pass and one-tube pass).



T727

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

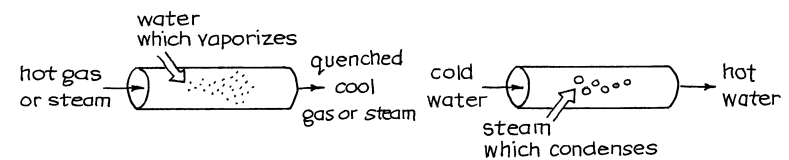
T728

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

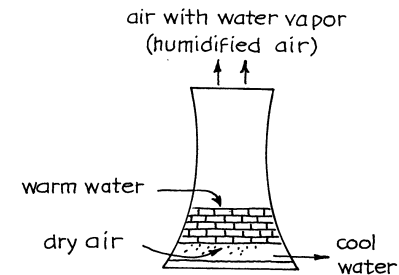
Multipass flow arrangements in shell-and-tube heat exchangers



HX: Direct Contact



T647

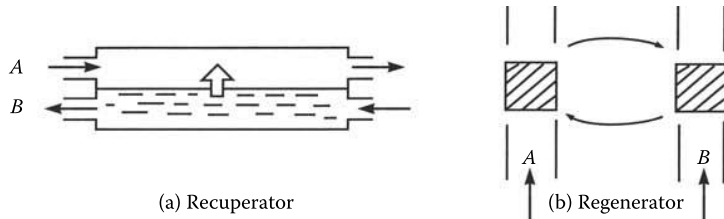


COOLING TOWER
(to cool warm water without refrigeration)

Fluid-fluid direct-contact exchangers where one phase can dissolve in the other



HX: (a) Recuperator / (b) Regenerator



(a) Recuperator

(b) Regenerator

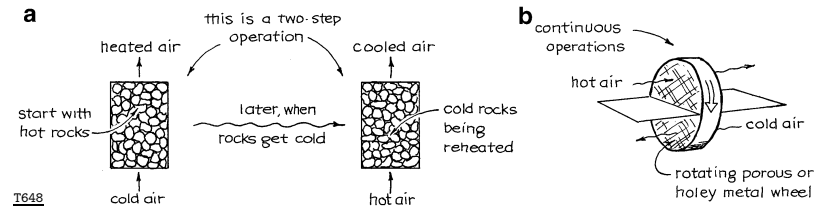
T642

Recuperator: Hot and cold fluids are separated by surfaces, and heat is transferred by combination of convection to and from the walls and conduction through the walls.

Regenerator: Hot and cold fluids alternatively occupy the same space in the exchange core (matrix). Matrix serves as the heat storage device that is periodically heated by the warmer fluid and then transfers heat to the cold fluid.



HX: Regenerator

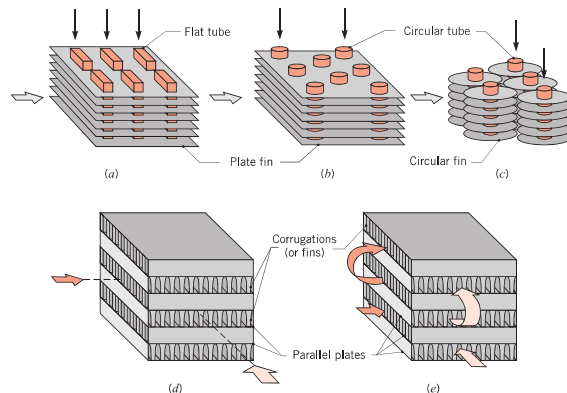


T648

Heat regenerators or heat storing exchangers: (a) Heat storing solids are stationary; (b) heat storing solids continuously circulate between hot and cold streams



Compact HX

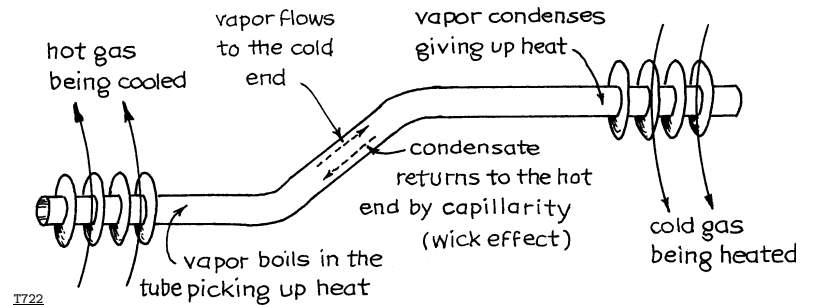


T723

Compact heat exchanger cores. (a) Fin-tube (flat tubes, continuous plate fins). (b) Fin-tube (circular tubes, continuous plate fins). (c) Fin-tube (circular tubes, circular fins). (d) Plate-fin (single pass). (e) Plate-fin (multipass).



HX: Heat Pipe



T722

Heat pipe transfers heat from one place to another, often far apart.

