Heat Transfer-2

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Fins

Objectives:

- Introduce the concept of extended surfaces (fins).
- Explain how fins enhance heat transfer.
- Identify the main types of fins and their applications.

Introduction:

There are *two ways* to increase the rate of heat transfer: to increase the ***convection heat transfer coefficient h*** or to increase the ***surface area*** A_s. Increasing ***h*** may require the installation of a pump or fan, or replacing the existing one with a larger one, but this approach may or may not be practical. Besides, it may not be adequate. The alternative is to increase the surface area by attaching to the surface ***extended surfaces*** called ***fins*** made of highly conductive materials such as aluminum.

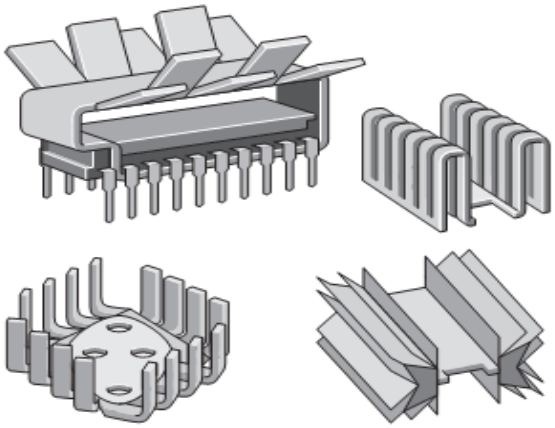
Summary:

The rate of heat transfer from a surface at a temperature T_s to the surrounding medium at T_∞ is given by Newton's law of cooling as,

$$Q = hA_s(T_s - T_\infty)$$

where A_s is the heat transfer surface area and ***h*** is the convection heat transfer coefficient. When the ***convection heat transfer coefficient h***, and the temperatures T_s and T_∞ are fixed by design considerations, as is often the case, increase the

surface area by attaching to the surface ***extended surfaces*** called ***fins*** enhance the rate of heat transfer. The car radiator is an example of a finned surface.



Some innovative fin designs.

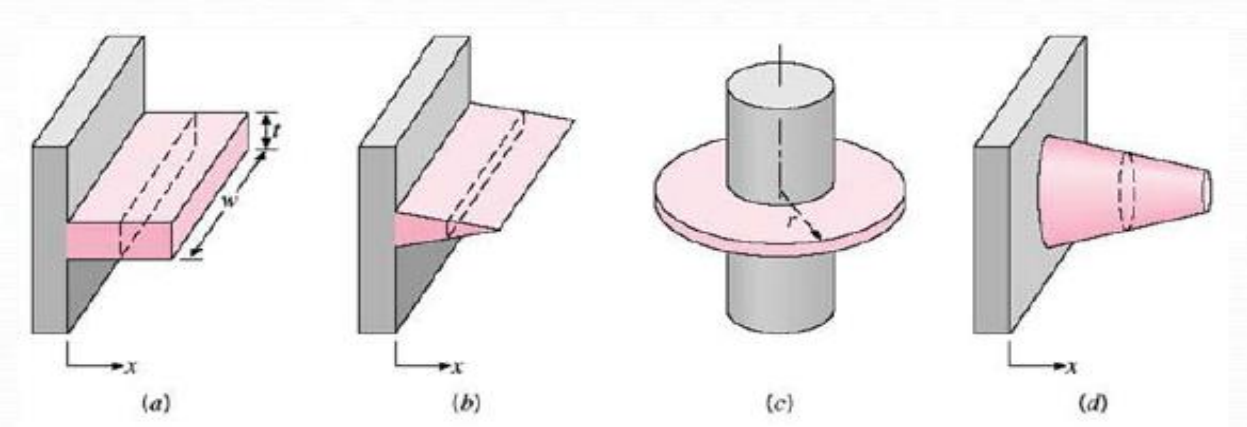
Main types:

a) Straight fins

b) Tapered Fins

c) Annular fins

d) Pin fins



Straight Fins

- Most common type
- Easy to manufacture
- Used on flat surfaces
- Good for forced convection

Straight Fin Variations

- Rectangular
- Triangular
- Trapezoidal
- Tapered

Annular Fins

- Circular fins around tubes
- Used for cylindrical surfaces
- Common in boiler & condenser tubes

Pin Fins

- Rod-shaped fins
- Cylindrical or square
- Good for multi-directional airflow
- Used in heat sinks

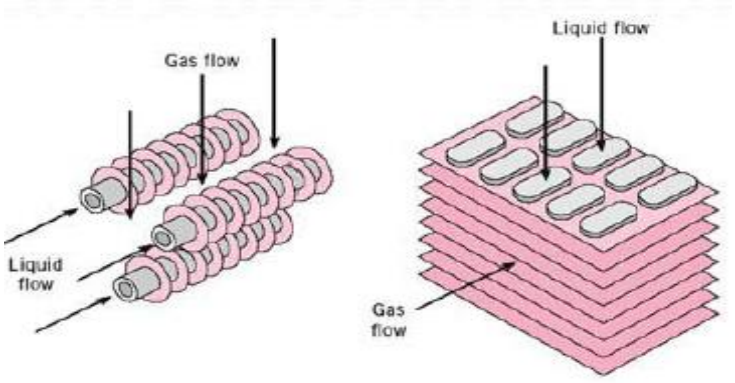
Fins are applied in various systems such as:

• Heat exchangers.

• Engine cooling systems.

• Electronic heat sinks.

• Condensers and evaporator tubes in refrigeration systems.



How to increase the heat transfer rate?

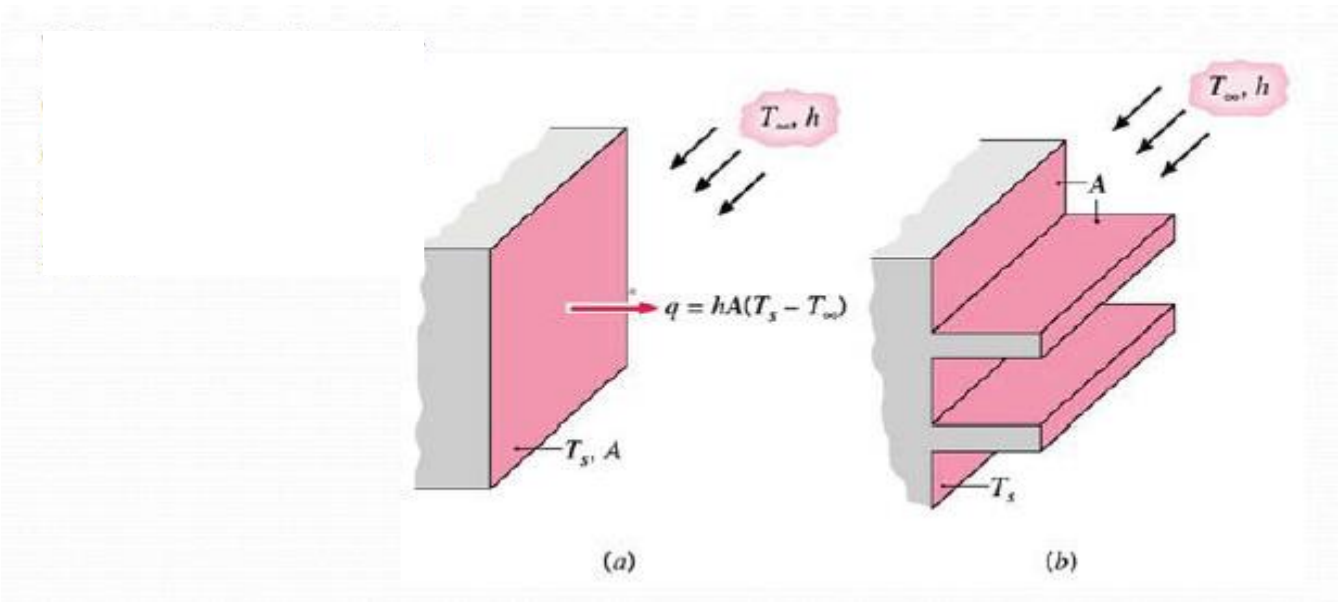
❖ However, increasing *h* to the maximum possible value is either

- Insufficient to obtain the desired heat transfer rate or
- The associated costs are prohibitive

- Costs are related to the **blower or pump power requirements** needed to increase *h* through increased fluid motion.
- Moreover, the second option of reducing *To* is often impractical.

There exists a third option that is, the heat transfer rate may be increased by increasing the surface area across which the convection occurs.

This may be done by employing fins that extend from the wall into the surrounding fluid.



Primary References

• *Holman, J.P., Heat Transfer, 10th Edition, McGraw-Hill.*

• *Kern, D.Q., Process Heat Transfer, McGraw-Hill.*

Additional Reference

• *Çengel, Y.A. & Ghajar, A.J., Heat and Mass Transfer: Fundamentals and Applications, McGraw-Hill.*

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