Feb. 25/19

2. Extended Surfaces (Fins) as Heat Sinks

Definition: A heat sink is a device that effectively absorbs or dissipates heat (thus involving heat transfer) from the surroundings using extended surfaces, such as fins.

Seat number: 30

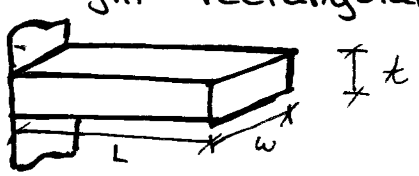
The term extended surface is commonly used to represent an important special case involving heat transfer by conduction within a solid and heat transfer by convection and/or radiation from the boundaries of the solid.

(*) The maximizing of thermal performance of fins means optimizing these aspects: material / design / rating

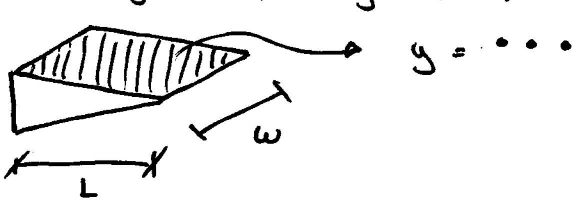
Configurations of Fins: (Table 3-3) → Pg. 177 (*)

Different configurations are existing in practice. For exampe,

- Straight rectangular fin:



- Straight trianguiar fin:



etc... see table 3-3.

Analytical Heat Transfer from Finned Surface

- The rate of heat transfer from a surface at a temperature T_s to the surroundings medium at T_∞ is governed by Newton's Law of Cooling, given by:

(2-1) $$\dot{Q}_{conv} = hA_s(T_s - T_\infty)$$

When T_s & T_∞ are fixed from design point of view, the rate of convective heat transfer can be increased by two ways:

① increasing h

② increasing A_s

→ Increasing h requires the installation of a fan or a pump or replacing the existing one by a larger size one, which may or may not be practical! (It may not be sufficient too)

→ The alternative solution would be to increase the surface area A_s by attaching to a fin (extend the surface) made of a highly conductive material.

Heat Fin Transfer Analysis & Formulation

Consider the following figure below:

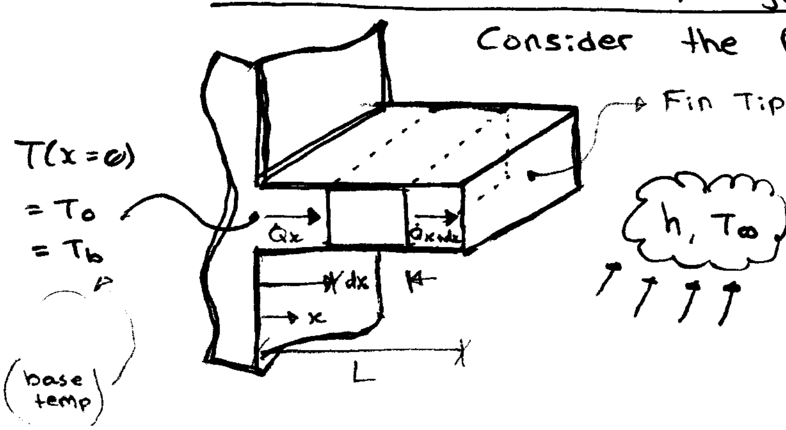
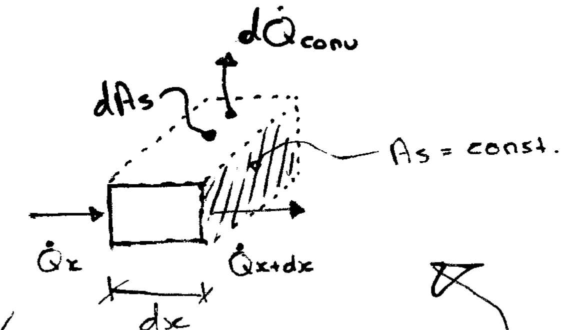


Fig (2-4): Fin Analysis for a fin of uniform cross-sectional area



A differential element

Application of energy (steady-state) balance over the Fin element shown above, gives

$$\dot{E}_{in} - \dot{E}_{out} + \dot{E}_{gen} = \dot{E}_{st}$$

or

$$\underbrace{\dot{Q}_{cond,x}}_{\sum \dot{E}_{in}} - \underbrace{(\dot{Q}_{cond,x+dx} + d\dot{Q}_{conv})}_{\sum \dot{E}_{out}} = 0$$

(2-2) OR

$$\boxed{\dot{Q}_x = \dot{Q}_{x+dx} + d\dot{Q}_{conv}}$$

or $\dot{Q}_{x+dx} - \dot{Q}_x + d\dot{Q}_{conv} = 0$

$$d\dot{Q}_{conv} = h\,dA_s(T - T_\infty)$$