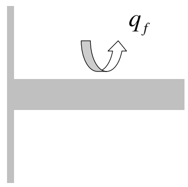
3.6.3 **FIN PERFOMANCE**

Single Fin



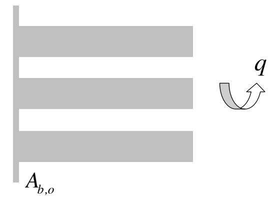
A_f = *fin area*

$$\eta_f = \frac{q_f}{q_{max}} = \frac{q_f}{h(T_b - T_\infty)A_f}$$ *definition of fin efficiency*

$$q_f = \frac{T_b - T_\infty}{R_{t,f}}$$ *rate of heat transfer from a fin*

$$R_{t,f} = \frac{1}{hA_f\eta_f}$$ *fin thermal resistance*

Fin Array



N = *number of fins*

A_t = *total area of N fins plus area of exposed base* $A_{b,o}$

$$A_t = NA_f + A_{b,o}$$

$$\eta_0 = 1 - N\frac{A_f}{A_t}(1-\eta_f)$$ *overall fin efficiency*

$$q = \frac{T_b - T_\infty}{R_{t,o}}$$ *total rate of heat transfer from fins and exposed base*

$$R_{t,o} = \frac{1}{hA_t\eta_o}$$ *overall resistance*

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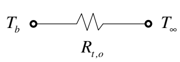
fin array w/o contact resistance

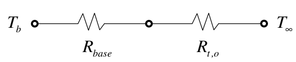
$$q = \frac{T_b - T_\infty}{R_{t,o}}$$



$$R_{t,o} = \frac{1}{hA_t\eta_o}$$

fin array with a base w/o contact resistance

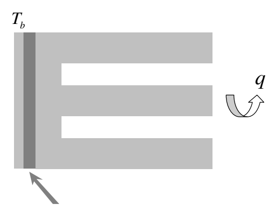
$$q = \frac{T_b - T_\infty}{R_{base} + R_{t,o}}$$



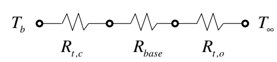
$$R_{base} = \frac{L_{base}}{kA_b}$$

$$R_{t,o} = \frac{1}{hA_t\eta_o}$$

fin array with a base with contact resistance



$$q = \frac{T_b - T_\infty}{R_{t,c} + R_{base} + R_{t,o}}$$

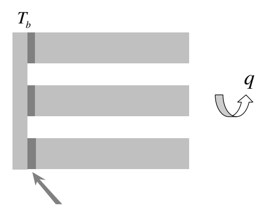


$$R_{t,c} = R''_{t,c}/A_b$$

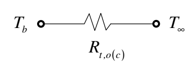
$$R_{base} = \frac{L_{base}}{kA_b}$$

$$R_{t,o} = \frac{1}{hA_t\eta_o}$$

fin array with contact resistance



$$q = \frac{T_b - T_\infty}{R_{t,o}}$$



$$R_{t,o(c)} = \frac{1}{hA_t\eta_{o(c)}}$$

$$\eta_{0(c)} = 1 - N\frac{A_f}{A_t}\left(1 - \frac{\eta_f}{c_1}\right)$$

$$c_1 = 1 + \eta_f hA_f\frac{R''_{t,c}}{A_{c,f}}$$

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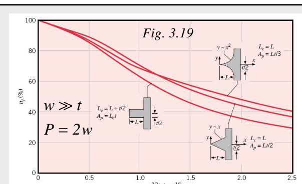
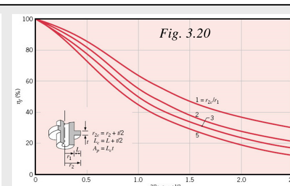
fin efficiency η_f *can be determined*

- *from figures 3.19, 3.20 (p.190)*

  L_c = *corrected fin length applied to adiabatic boundary conditions*





- *from Table 3.5 (p.169)*

$$m = \left(\frac{2h}{kt}\right)^{1/2} \quad \text{for } (a)$$

$$m = \left(\frac{4h}{kD}\right)^{1/2} \quad \text{for } (b)$$

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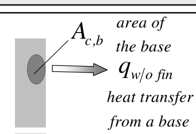
fin effectiveness ε_f

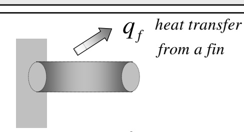
Single Fin

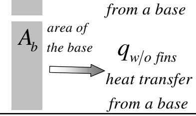
$$\varepsilon_f = \frac{q_f}{q_{w/o\ fin}} = \frac{q_f}{h(T_b - T_\infty)A_{c,b}}$$

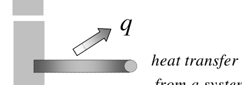
Fin Array

$$\varepsilon = \frac{q}{q_{w/o\ fins}} = \frac{q}{h(T_b - T_\infty)A_b}$$



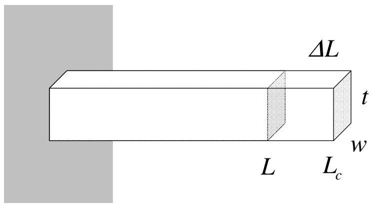






Addition to the Table 3.5 (p.152) ***Efficiency of common fin shapes* – Pin Fins**

Rectangular[b] *(all sides are included)*



$$t \cdot w = 2(t+w)\Delta L$$

$$\Delta L = \frac{t \cdot w}{2(t+w)}$$

	$P = 2(t+w)$ $L_c = L + \frac{t \cdot w}{2(t+w)}$ $A_f = 2L_c(t+w)$	$\eta_f = \frac{tanh\, mL_c}{mL_c}$	$m = \sqrt{\frac{hP}{kA_c}} = \sqrt{\frac{2h(t+w)}{ktw}}$

$t = w \quad (square)$ 	$P = 4w$ $A_f = 4L_c w$ $L_c = L + \frac{w}{4}$	$\eta_f = \frac{tanh\, mL_c}{mL_c}$	$m = \sqrt{\frac{hP}{kA_c}} = \sqrt{\frac{4h}{kw}}$