NOTES ON FIN EFFICIENCY, η_{FIN}

$$\eta_{fin} = \frac{\dot{Q}_{FIN}}{\dot{Q}_{FIN,MAX}} = \frac{\text{ACTUAL HT RATE FROM FIN}}{\text{HT RATE FROM FIN IF IT IS ALL AT } T_b}$$

[SEE TABLE 10-3 IN THE "FIN REFERENCE". (SEE WK2 WEBSITE)
AND FIGURES 10-42 & 10-43.]

$$\dot{Q}_{fin,\,MAX} = h A_{FIN} (T_b - T_\infty)$$

SO $$\dot{Q}_{FIN} = \eta_{fin} \times h A_{FIN} (T_b - T_\infty)$$

RULE-OF-THUMB

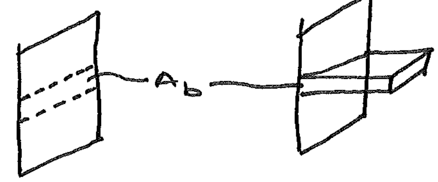
FINS WITH $\eta_{FIN} < 60\%$ ARE USUALLY UNECONOMICAL AS THE ARE TOO LONG, TAKE TOO MUCH MATERIAL AND TOO MUCH SPACE FOR THE ADDED SMALL BENEFIT OF ~~HEAT~~ A LITTLE MORE HEAT TRANSFER.

IN PRACTICE, MOST COMMERCIAL FINS HAVE $\eta_{FIN} \geq 90\%$ AND JUST USE MORE FINS TO IMPROVE HEAT TRANSFER.

NOTES OF FIN EFFECTIVENESS , ε_{FIN}

$$\varepsilon_{FIN} = \frac{\text{ACTUAL HT RATE FROM FIN}}{\text{HT RATE FROM THE SURFACE AREA } A_b}$$

$$\varepsilon_{FIN} = \frac{\dot{Q}_{FIN}}{h A_b (T_b - T_\infty)}$$



HOW MUCH BETTER IS THE HT RATE WITH THE FIN ATTACHED. USEFUL TO SELL A FIN DESIGN.

$\varepsilon_{FIN} < 1$ FIN INSULATES BASE PLATE

$\varepsilon_{FIN} = 0$ FIN DOES NOT HELP.

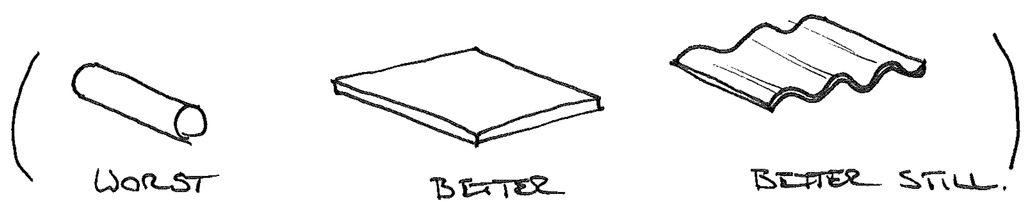
$\varepsilon_{FIN} > 1$ FIN HELPS.

NOTE: $$\varepsilon_{FIN} = \frac{\eta_{FIN} h A_{FIN} (T_b - T_\infty)}{h A_b (T_b - T_\infty)} = \frac{A_{FIN}}{A_b} \eta_{FIN}$$

TO ENHANCE ε_{FIN}

k SHOULD BE AS LARGE AS POSSIBLE. (METALS ARE GOOD)

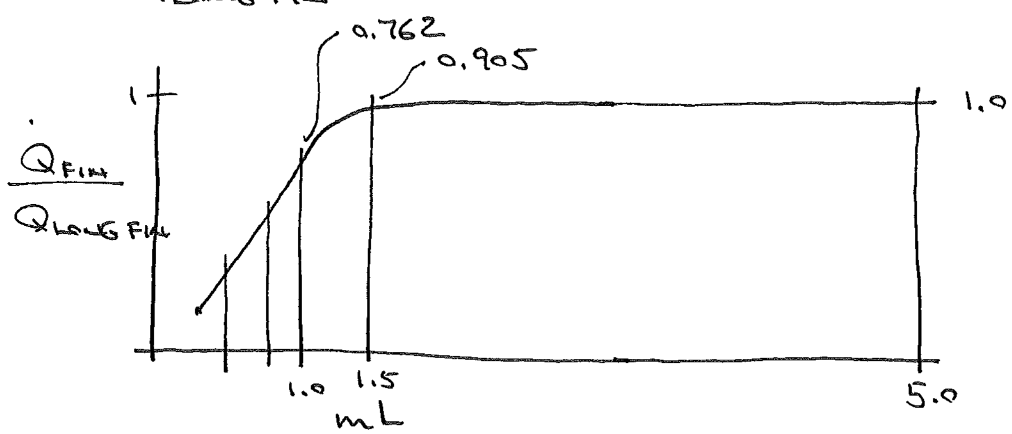
$\frac{P}{A_b}$ SHOULD BE AS BIG AS POSSIBLE



PROPER FIN LENGTH (Pg 442 OF "FIN REFERENCE").

COMPARING A REAL FIN TO ONE THAT IS VERY LONG

$$\frac{\dot{Q}_{FIN}}{\dot{Q}_{LONG\ FIN}} = \tanh(mL).$$



IN PRACTICE, IF YOU MAKE FINS HAVE AN $\boxed{mL \simeq 1}$ YOU WILL GET 76.2% OF THE LONG FIN HEAT TRANSFER RATE.

THIS IS A GOOD ECONOMICAL BUT EFFECTIVE FIN.

FIN THERMAL RESISTANCE (TEXT PAGE 35)

RECALL THAT $q = \frac{T_{HOT} - T_{COOL}}{R}$

IN ~~OUR~~ THE FIN CASE: $q_{FIN} = \frac{T_b - T_\infty}{R_{FIN}}$

SO $R_{FIN} = \frac{T_b - T_\infty}{q_{FIN}} = \frac{(T_b - T_\infty)}{\eta_{FIN} h A_{FIN} (T_b - T_\infty)}$

THUS $\boxed{R_{FIN} = \frac{1}{\eta_{FIN} h A_{FIN}}}$ $\left[\frac{1}{\frac{W}{m^2 \cdot °C} \times m^2} = \frac{1}{\left(\frac{W}{°C}\right)} = \frac{°C}{W} \right]$

THE UNITS OF R.