Fin Types

A) **Rectangular Fin**
B) **Triangular Fin**
C) **Parabolic Fin**
D) **Annular (Circulator) fin of rectangular profile.**

Figure 2-11 | Efficiencies of straight rectangular and triangular fins.

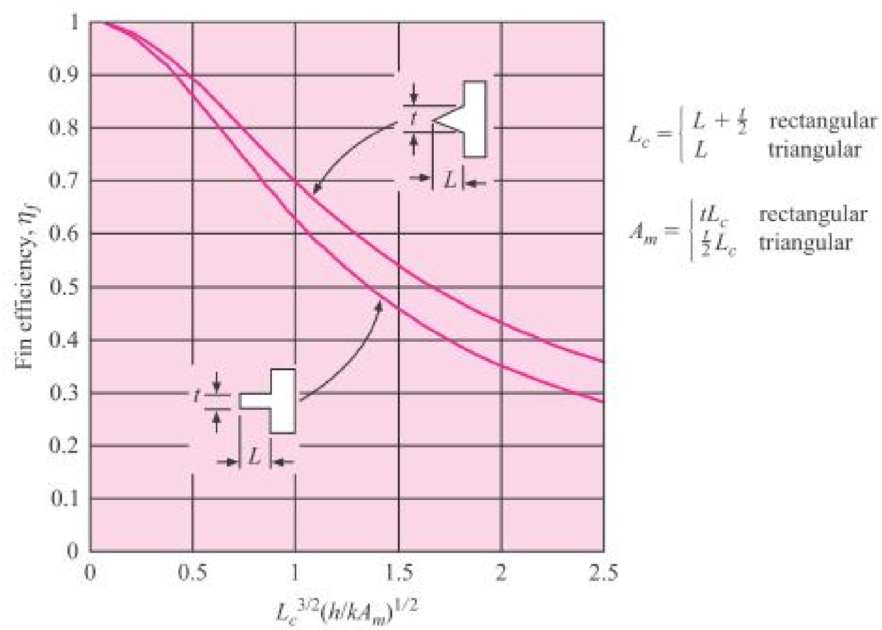
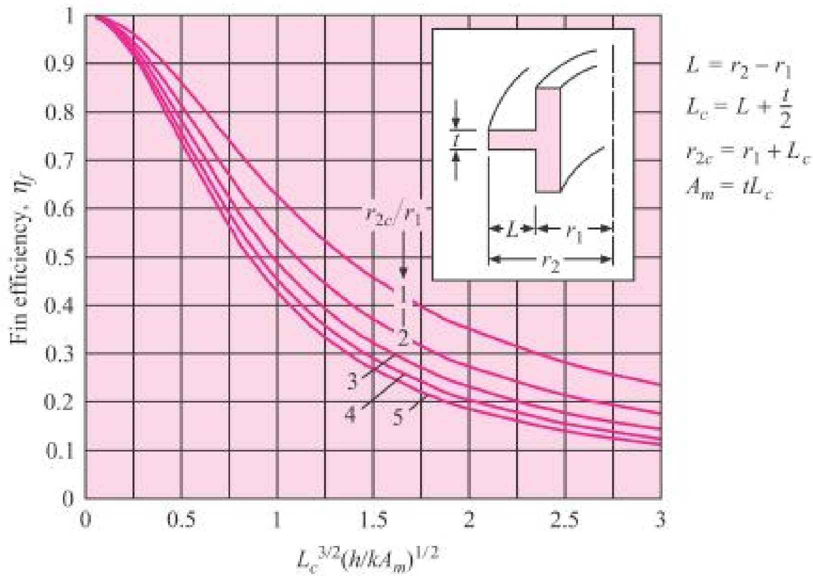


Figure 2-12 | Efficiencies of circumferential fins of rectangular profile, according to Reference 3.



For parabolic fin, *Lc*=*L* and *Am*=*L*× *t/3*.

Fin Heat Exchanger Design

(Used with Circulator rectangular profile)

1-Calculate the area without fins.

$$A_{noFin} = \pi\ D\ L$$

2-Calculate the heat transfer without fins

$$q_{noFin} = h\ A_{noFin}\ (T_{base} - T_{\infty})$$

3-Calculate (L)

$$L = 0.5(D_{Fin} - D_{tube})$$

4-Calculate (r_2c)

$$r_2c = Fin\ radius + \frac{Thickness(t)}{2}$$

5- Calculate (Lc)

$$Lc = L + \frac{Thickness(t)}{2}$$

6-Calculate (Am or Ap)

$$Am = Lc \times t$$

7-Calculate (r_2c/r_{tube})

8-Calculate $Lc^{3/2}\sqrt{\frac{h}{kAm}}$

9-Use the figure of circulator fins to find efficiency of fin (η_{Fin}).

10-Calculate area of fin (A_{Fin})

$$A_{Fin} = 2\pi\left(r_2c^2 - r_1^2\right)$$

11- Calculate the heat transfer of fin

$$q_{Fin} = q_{\max} = \eta_{Fin}\ h\ A_{Fin}\ \left(T_{base} - T_{\infty}\right)$$

12- Calculate area of unfin (A_{Fin})

$$A_{unFin} = \pi\ D\ S,\ \ S = Space\ between\ two\ \ fins$$

13- Calculate the heat transfer of unfin

$$q_{unFin} = h\ A_{unFin}\ \left(T_{base} - T_{\infty}\right)$$

14- Calculate the total heat transfer of fins

$$q_{totalFin} = n\left(q_{Fin} + q_{unFin}\right),\ \ n = number\ of\ \ fins$$

15-Calculate the fin performance.

$$\varepsilon = \frac{q_{total,Fin}}{q_{noFin}}$$

Example : Steam in a heating system flows through tubes whose outer diameter is 3cm and whose wall are maintained at a temperature of 120°C.Circular aluminium alloy fins (k = 180 W/m.°C) of outer diameter 6cm and constant thickness at 2mm, are attached with tubes. The space between two fins is 3mm and there are 200 fins per meter length of the tube. The heat is transferred to the surrounding air at 25°C with h = 60 W/m^2.°C. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins.

Solution.

$$A_{noFin} = \pi\, D\, L = \pi \times 0.03m \times 1m = 0.0942m^2$$

$$q_{noFin} = h\, A_{noFin}\, (T_{base} - T_{\infty}) = 60 \times 0.0942 \times (120 - 25) = 537W$$

$$L = 0.5(D_{Fin} - D_{tube}) = 0.5(0.06 - 0.03) = 0.015$$

$$r_2c = Fin\ radius + \frac{Thickness(t)}{2} = 0.03 + (0.002/2) = 0.031$$

$$Lc = L + \frac{Thickness(t)}{2} = 0.015 + (0.002/2) = 0.016m$$

$$Am = Lc \times t = 0.016 \times 0.002 = 0.000032m^2$$

$$\frac{r_2c}{r_{tube}} = \frac{0.031}{0.015} = 2.07$$

$$Lc^{3/2}\sqrt{\frac{h}{kAm}} = (0.016)^{3/2}\sqrt{\frac{60}{180 \times 0.000032}} = 0.207$$

From figure 2.12, $\eta_{Fin} = 0.96$

$$A_{Fin} = 2\pi(r_2c^2 - r_1^2) = 2\pi((0.031)^2 - (0.015)^2) = 0.004624m^2$$

$$q_{Fin} = \eta_{Fin}\, h\, A_{Fin}\, (T_{base} - T_{\infty}) = 0.96 \times 60 \times 0.004624 \times (120 - 25) = 25.3W$$

$$A_{unFin} = \pi\, D\, S = \pi \times 0.03 \times 0.002 = 0.0000283m^2$$

$$q_{unFin} = h\, A_{unFin}\, (T_{base} - T_{\infty}) = 60 \times 0.0000283 \times (120 - 25) = 1.6W$$

$$q_{totalFin} = n\,(q_{Fin} + q_{unFin}) = 200(25.3 + 1.6) = 5380W$$

$$q_{increase} = q_{totalFin} - q_{noFin} = 5380 - 537 = 4843W$$

$$\varepsilon = \frac{q_{total,Fin}}{q_{noFin}} = \frac{5380}{537} \cong 10\ per\ meter\ tube\ length$$