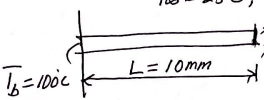
2- Consider an alloyed aluminum rectangular fin (k = 180 W/m.K) of length L = 10 mm, thickness t = 1 mm, and width w. The base temperature of the fin is T_b = 100 °C, and the fin is exposed to a fluid of temperature T = 25 °C. Assume a uniform convection coefficient of h = 100 W/m².K over the entire fin surface, determine: (a) the fin heat transfer rate per unit width, (b) fin efficiency. (c) fin effectiveness.

$T_\infty = 25^\circ C$, $h = 100\ W/m^2K$, $K = 180\ W/mK$



$q_f = M \tanh mL_c$

$L_c = L + t/2 = 10 + \frac{1}{2} = 10.5\ mm$

$M = \sqrt{hPKA_c}\,\theta_b = \sqrt{h(2t+2w)K(t \times w)}\,\theta_b$

$= \sqrt{100\,(2w)\,180 \times 1 \times 10^{-3} \times w}\ (100-25) = 450\ w$

$mL_c = 33.3 \times 10.5 \times 10^{-3}$

$= 0.35$

$m = \sqrt{\frac{hP}{KA_c}} = \sqrt{\frac{100 \times 2w}{180 \times 1 \times 10^{-3} \times w}}$

$= 33.3\ m^{-1}$

$q_f = 450\ w \tanh 0.35$

$q_{f/w} = 450 \tanh 0.35 = 151.4\ W/m$

$\eta_f = \frac{q_f}{q_{max}}$

$= \frac{151.4}{157.5} = 0.96\ (96\%)$

$q_{max} = hA\theta_b$

$= h\left[2(L \times w) + t \times w\right](T_b - T_\infty)$

$= 100\left[2(0.01\,w) + 0.001w\right](100-25)$

$\frac{q_{max}}{w} = 157.5\ W/m$