Straight Rectangular Fin: Heat Flow and Efficiency

Heat flow, fin efficiency and effectiveness of a straight rectangular fin with a convective tip, from thickness, length, conductivity and convection coefficient.

Method: Incropera; DeWitt; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Fin thickness	2.0000	mm
Fin length (base to tip)	30.000	mm
Fin width	100.00	mm
Fin conductivity	200.00	W/(m·K)
Convection coefficient	50.000	W/(m²·K)
Base minus fluid temperature	60.000	K

Calculated results

Parameter	Value	Unit
Fin parameter √(hP/(kA_c))	15.969	1/m
Heat flow from the fin	17.551	W
Fin efficiency	92.569	%
Fin effectiveness (vs no fin)	29.252	

Notes for this case

- One-dimensional fin with uniform h; m in 1/m. Effectiveness above about 2 justifies a fin.

Formula and method

$$q_f = \sqrt{hPkA_c}\,\theta_b \frac{\sinh mL + (h/mk)\cosh mL}{\cosh mL + (h/mk)\sinh mL}, \quad m = \sqrt{\frac{hP}{kA_c}}$$

$$q_f = \sqrt{hPkA_c}\,\theta_b \frac{\tanh mL + h/(mk)}{1 + (h/mk)\tanh mL}, \quad \eta_f = \frac{q_f}{hA_f\theta_b}, \quad \varepsilon_f = \frac{q_f}{hA_c\theta_b}$$

$$A_c = wt, \quad P = 2(w+t), \quad A_f = PL + A_c$$

Variables

t	Fin thickness	m
L	Fin length (base to tip)	m
w	Fin width	m
k	Fin conductivity	W/(m·K)
h	Convection coefficient	W/(m²·K)
θ_b	Base minus fluid temperature	K
m	Fin parameter √(hP/(kA_c))	1/m
A_c	Fin cross-section w t	m²
P	Fin perimeter 2(w + t)	m
A_f	Fin surface including the tip	m²
q_f	Heat flow from the fin	W

η_f	Fin efficiency	-
ε_f	Fin effectiveness (vs no fin)	-

Method and standards

Fin equation with a convective tip.

Assumptions and limits

- Uniform h, steady state.
- Efficiency and effectiveness do not depend on θ_b and are given also when θ_b = 0 (no heat flow). The tanh form of the solution is used, so long or thin fins do not overflow.

References

- Incropera
- DeWitt
- Bergman and Lavine
- Fundamentals of Heat and Mass Transfer
- ch. 3 (fin with convective tip, Table 3.4)

Report details

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This calculator online

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