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Nomenclature

Parameters:

A_{b}	Base area of the fin (individual fin in case of an array), m^2
A_s	Heat transfer surface area of the fins (individual fin in case of an array), m^2
A_{sp}	Primary cylinder base area for fin inter-spacing of a heat transfer module, m^2
Bi	Biot number based on the convective heat transfer coefficient at fin-side, $hr_{\mathrm{b}}/k_{\mathrm{a}}$
Bi_{s}	Biot number based on the step surface convective heat transfer coefficient, $h_{\mathrm{s}}r_{\mathrm{b}}/k_{\mathrm{a}}$
E	Young's modulus, Pa
f_i	Objective functions; $i = 1$ to 5
g	Acceleration due to gravity, $\mathrm{m/s}^2$
h	Convective heat transfer coefficient, $\mathrm{W/m^2K}$
h_{s}	Convective heat transfer coefficient on step surface, $\mathrm{W/m^2K}$
k	Thermal conductivity of the fin material, W/mK
k_{a}	Thermal conductivity of the fin material at ambient temperature, W/mK
m	Total number of control points of the B-spline curve
N	Total number of computational grid
n_{fin}	Number of fins
P_i	Control points of the B-spline curve
Ra	Rayleigh number
r	Radial coordinate for the entire fin, m
r_b	Inner radius of the fin, m
r_o	Outer radius of the fin, m

r_1 Radius of the fin at the point of step change in thickness (in case of stepped fin), m

s_b Fin inter-spacing at base, m

s_m Mean fin inter-spacing, m

T Local temperature in the radial direction within the fin (in case of continuously varying thickness fin), K

T_b Temperature at the base of the fin, K

T_{film} Mean film temperature ($= \frac{T_b+T_\infty}{2}$), K

T_1 Local temperature in the radial direction within the first step of the fin (in case of stepped fin), K

T_2 Local temperature in the radial direction within the second step of the fin (in case of stepped fin), K

T_∞ Ambient temperature, K

t Half thickness of the fin, m

t_b Half thickness of the fin at base (in case of continuously varying thickness fin), m

t_o Half thickness of the fin at tip (in case of continuously varying thickness fin), m

t_1 Half-thickness of the first step of the fin (in case of stepped fin), m

t_2 Half-thickness of the second step of the fin (in case of stepped fin), m

u Radial displacement, m

W Length of the primary cylinder, m

y_s Thickness ratio; t_2/t_1

Subscript

max Maximum

min Minimum

n Computational grid point number

Superscript

$*$	Optimum

Greek symbols

α_e	Linear coefficient of thermal expansion of fin material, K^{-1}
α_s	Thermal diffusivity, m/s^2
β	Parameter describing the variation of thermal conductivity, K^{-1}
β_e	Thermal expansion coefficient of surrounding fluid, i.e. air, K^{-1}
ϵ	Emissivity of the fin material
$\bar{\theta}$	Temperature distribution
ν	Poisson's ratio
ν_s	Kinematic viscosity, m/s^2
ξ	Fin aspect ratio; $\xi = \frac{t_1}{r_b}$
σ	Boltzmann constant, 5.67×10^{-8} W/m^2K^4
σ_r	Radial thermal stress, Pa
σ_θ	Circumferential thermal stress, Pa

Abbreviations

HSDM	Hybrid spline difference method
NSGA II	Nondominant sorting genetic algorithm II