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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_b/k_a
Bi_s	Biot number based on the step surface convective heat transfer coefficient, $h_s r_b / k_a$
E	Young's modulus, Pa
f_i	Objective functions; $i = 1$ to 5
g	Acceleration due to gravity, m/s^2
h	Convective heat transfer coefficient, W/m^2K
h_s	Convective heat transfer coefficient on step surface, 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, $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$
 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