NOMENCLATURE

Special symbols used in certain equations are explained in the text.

$a$ coefficient

$\alpha_i$ thickness of tube, (m)

$A$ coefficient

$A_\phi$ area of the tube surface, (m$^2$)

$b$ coefficient or exponent

$B$ exponent

$c$ coefficient or exponent

$c_p$ specific heat of fluid, (kcal/(kg)(°C))

$d$ diameter of cylinder, (m)

$d_e$ characteristic dimension:

- height of the plate or vertical cylinder, $L$ (m);
- diameter of the horizontal cylinder, $A$ (m);
- major axis of the imaginary ellipse obtained by cutting an inclined cylinder by means of a vertical plane, $A/\cos \alpha$ (m);
- side of the square plate, $L$ (m);
- diameter of the circular plate, $L$ (m).

$E$ potential drop across the circuit, (volts); complete elliptical integral of the second kind corresponding to $\alpha$.

$F$ function of

$g$ local gravitational acceleration, (m/sec$^2$) or (cm/sec$^2$)

$g_o$ standard value of gravitational acceleration, (m/sec$^2$) or (cm/sec$^2$)

$Gr$ $\alpha \beta \Delta t \phi^2 \rho \alpha / \mu^2$, average Grashof number based on characteristic dimension $d_o$ (dimensionless)

$Gr_v$ $\alpha \beta \rho \phi^2 \rho \alpha / (\rho \mu c_p D^2)$, modified Grashof number, (dimensionless)

$h$ heat transfer coefficient, (kcal/(hr)(m$^2$)(°C))


average heat transfer coefficient due to convection, (kcal/hr)(m²)(°C))
h(x)
function of eccentricity of ellipse
f
a function as defined in Chapter 2.
k
thermal conductivity of fluid, (kcal/(hr)(m)(°C))
K
function of eccentricity of ellipse
L
height of the surface; cumulated section length; side of the square plate; diameter of the circular plate, (m)
m
coefficient; or number of sets of variables
n
exponent; or degrees of equation
Nu
h d²/k, average Nusselt number based on characteristic dimension d² (dimensionless)
p
atmospheric pressure, (mm Hg)
Pr
µ/k, Prandtl number, (dimensionless)
q
heat input, (kcal/hr)
q_c
convective heat transfer, (kcal/hr)
q_R
heat loss by radiation, (kcal/hr)
q_w
wall convective heat flux, (kcal/(hr)(m²))
r
statistical correlation coefficient
S
sum of squares of deviations
t
temperature, (°C)
T
temperature; temperature within the boundary layer, (°K)
T∞
(T - T∞)/T∞, temperature characteristic, (dimensionless)
U
fluid velocity in x-direction, (m/hr); overall heat transfer coefficient, (kcal/(hr)(m²)(°C))
U₁
velocity function, (m/hr)
x
x-coordinate; distance along surface measured from leading edge (m); a function of X and α as defined in Chapter 2.
X
horizontal distance from reference plane, (m)
\( y \)  
\( y \) - coordinate

\( y_c \)  
characteristic length defined as one half of the length of the periphery of a section obtained by cutting a horizontal or vertical cylinder by means of a vertical plane, (m)

\( z \)  
compressibility factor

Greek letters

\( \alpha \)  
cylinder inclination with horizontal, (degrees)

\( \beta \)  
coefficient of volumetric expansion of fluid, (°C\(^{-1}\))

\( \delta \)  
hydrodynamic and thermal boundary layer thickness, (m)

\( \Delta t \)  
\( (T_y - T_\infty) \), temperature difference between surface and fluid, (°C)

\( \epsilon \)  
emissivity of the ellipse; emissivity of surface

\( \theta \)  
plate inclination with the vertical, (degrees); plus sign and minus sign denotes hot side facing upward and downward, respectively.

\( \Delta \)  
ratio of heat transfer from an inclined cylinder to that from a horizontal cylinder of same \( L \) and \( d \), (dimensionless)

\( \mu \)  
viscosity of fluid, (kg/(m)(hr))

\( \xi \)  
a dummy variable; or a function as defined in Chapter 1.

\( \rho \)  
density of the fluid, (kg/m\(^3\))

\( \phi \)  
a function as defined in Chapter 1.

\( \Phi \)  
a function as defined in Chapter 2.

Subscripts

1  
ambient fluid

2  
surface of tube or section

air  
of air

Cu  
of copper

\( d \)  
based on characteristic dimension \( d \)
\( q/\cos \alpha \) based on characteristic dimension \( q/\cos \alpha \)

\( E q/\cos \alpha \) based on characteristic dimension \( E q/\cos \alpha \)

- \( i \) inside
- \( L \) based on characteristic dimension \( L \)
- \( a \) integrated mean value of temperature dependent properties
- \( o \) outside
- \( r \) at room temperature
- \( R \) radiation
- \( t \) at temperature \( t^\circ C \)
- \( w \) wall conditions
- \( w_{\text{water}} \) of water
- \( x \) local value based on \( x \) as characteristic dimension
- \( \infty \) ambient conditions; outside the boundary layer