NOMENCLATURE

Roman

A	= Aspect ratio (l/b)
$\mathcal{A}$	= Coefficient matrix
A_f	=Flow area $\left\{\frac{\pi}{4}(d_o^2 - d_i^2)\right\}$
A_s	=Surface area of the annulus $(2\pi d_i L)$
b	= Annular gap (m)
$\mathcal{b}$	= RHS column vector of system of linear equations
C_p	= Specific heat (J Kg^{-1} K^{-1})
d	=Diameter of annulus(m)
$\mathcal{D}$	= Diagonal matrix
$\hat{e}_z$	= Unit vector
g	= Acceleration due to gravity (m s^{-2})
h	= Heat transfer coefficient (W $m^{-2}K^{-1}$)
H	= Upper Hessenberg matrix
I	= Current (Ampere)
k	= Thermal conductivity (W $m^{-1}K^{-1}$)
K_m	= m^{th} Krylov subspace
L	= Length (m)
$\mathcal{L}$	= Lower decomposed matrix by LU decomposition
m	= Circulation rate of test liquid (g s^{-1})
M	= Preconditioner matrix
p	= Pressure (Pascal)
q , q_w	= Heat flux (W/m^2)
r	= Radial distance (m)
R	= Non-dimensional Radial distance
RR	= Radius ratio $\left(\frac{r_o}{r_i}\right)$
T	= Temperature (°C)
u	= Radial velocity (m s^{-1})
$\vec{U}$	= Velocity vector
$\mathcal{u}$	= Upper decomposed matrix by LU decomposition

U = Non-dimensional radial velocity

v = Tangential velocity (m s^{-1})

V = Voltage (V)

$\mathcal{V}$ = Initial normalized residual

w = Axial velocity (m s^{-1})

W = Non-dimensional axial velocity

z = Axial distance (m)

Z = Non-dimensional axial distance

Greek

α = Thermal diffusivity

α_i = Coefficients of the characteristic polynomial

β = expansion coefficient (K^{-1})

θ = Non-dimensional temperature

$\emptyset$ = Azimuthal direction

τ = Non-dimensional time

ρ = Density (Kg m^{-3})

μ = Dynamic viscosity

ν = Kinematic Viscosity (m^2 s^{-1})

∂ = discrete

δ = change

λ = Eigen value

ω = SSOR relaxation factor

τ = Non-dimensional time

ε = computational space

$\in$ = iteration-error at current time-level

res = residual at current time-level

Dimensionless parameters

Gr = Modified Grashof Number $\left(\frac{g\beta|q_w|b^4}{k\nu^2}\right)$

Pe = Peclet Number $\left(\frac{U_{i,j}*\partial\varepsilon}{Pr*jac(i)}\right)$

	= Prandtl Number $\left(\frac{\nu}{\alpha}\right)$
Ra	= Rayleigh Number $\left(\frac{g\beta\|q_w\|b^4}{k\nu\alpha}\right)$
Nu	= Nusselt Number $\left(\frac{hb}{k}\right)$
Re	=Reynolds Number $\left(\frac{m_l b}{\mu A_f}\right)$

Subscripts and Superscripts

a	= ambient
h	= heated
i	= i^{th} coordinate direction
i	= Inlet/ inner
j	= j^{th} coordinate direction
l	= liquid
n	= Time level
o	= Outlet / outer
p	= Constant pressure
s	= surface
w	= wall
*	= Predicted value

Abbreviations

GMRES	= Generalized minimal residual
PDE	= Partial differential equation
RHS	= Right hand side
NS	= Navier-Stokes equations
SMAC	= Simplified Marker and Cell
SOR	= Successive over relaxation
SSOR	= Symmetric successive over relaxation
FH	= Full heating
PH	= Partial heating