Supplementary Information

Double diffusive bio-peristaltic propulsion of hydromagnetic Casson fluid through a conduit under the influence of Hall current and thermal radiation

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$$B_1 = \frac{P_r N_b}{(1+P_r R_d)},\ B_2 = \frac{P_r N_t}{(1+P_r R_d)},\ B_3 = \frac{P_r N_{TC}}{(1+P_r R_d)},\ B_4 = \frac{P_r Q}{(1+P_r R_d)}, \qquad T_1 = \frac{1}{h}, \qquad T_2 = 0,$$

$$E_1 = \frac{1}{h}\ , E_2 = 0, N_1 = \frac{1}{h}, N_2 = 0, T_3 = \ -B_1 N_1 T_1 - \ B_2 T_1^2 - \ B_4, \qquad T_4 = \ -T_6 h,$$

$$T_5 = 0, T_6 = \frac{T_3}{2}, E_3 = 0,\ E_4 = 0, N_3 = 0, N_4 = 0, T_7 = -(B_1 N_1 T_3 + 2B_2 T_1 T_3)\ ,$$

$$T_8 = -(B_1 N_1 T_4 + B_1 N_3 T_1 + 2B_2 T_1 T_4),\ T_9 = \ -(T_{12} h^2 + T_{13} h), T_{10} = \frac{T_7}{2}, T_{11} = 0,$$

$$T_{12} = \frac{T_{10}}{3}, T_{13} = \frac{T_8}{2} E_5 = -C_1 T_3,\ E_6 = -E_8 h, \qquad E_7 = 0, E_8 = \frac{E_5}{2}, N_5 = -D_1 T_3, N_6 = -N_8 h,$$

$$N_7 = 0,\ N_8 = \tfrac{N_5}{2}, T_{14} = -(B_1 N_1 T_{10} + 2B_2 T_1 T_{10} + B_2 T_3^2),$$

$$T_{15} = -(B_1 N_1 T_8 + B_1 N_3 T_3 + B_1 T_1 N_5 + 2B_2 T_1 T_8 + 2B_2 T_3 T_4),$$

$$T_{16} = -(B_1 N_1 T_9 + B_1 N_3 T_4 + B_1 T_1 N_6 + 2B_2 T_1 T_9 + B_2 T_4^2 + E_5 B_3),$$

$$T_{17} = -(T_{21}h^3 + T_{22}h^2 + T_{23}h), T_{18} = \frac{T_{14}}{3}, T_{19} = \frac{T_{15}}{2}, T_{20} = 0, T_{21} = \frac{T_{18}}{4}, T_{22} = \frac{T_{19}}{3},$$

$$T_{23} = \frac{T_{16}}{2}, E_9 = -C_1T_{7,}E_{10} = -C_1T_{8,}E_{11} = -(E_{14}h^2 + E_{15}h), E_{12} = \frac{E_9}{2}, E_{13} = 0,$$

$$E_{14} = \frac{E_{12}}{3}, E_{15} = \frac{E_{10}}{2}, N_9 = -D_1T_{7,}N_{10} = -D_1T_8, N_{11} = -(N_{14}h^2 + N_{15}h), N_{12} = \frac{N_9}{2},$$

$N_{13} = 0, N_{14} = \frac{N_{12}}{3}, N_{15} = \frac{N_{10}}{2}, T_{24} = T_{12} + T_{22,}T_{25} = T_6 + T_{13} + T_{23,}$

$$T_{26} = T_1 + T_4 + T_9 + T_{17,}\ T_{27} = T_2 + T_5 + T_{11} + T_{20}, E_{16} = E_8 + E_{15},$$

$$E_{17} = E_1 + E_3 + E_6 + E_{11}, E_{18} = E_2 + E_4 + E_7 + E_{13},\ N_{16} = N_5 + N_8,$$

$N_{17} = N_1 + N_3 + N_6 + N_{11,}N_{18} = N_2 + N_4 + N_7 + N_{13}, A_{11} = -\frac{G_r}{b}, A_{12} = -\frac{G_c}{b},$

$$A_{13} = \frac{G_f}{b}, M_1^2 = \frac{M^2cos^2\theta}{(1+m^2)} + \frac{1}{K}, N^2 = \frac{M_1^2}{b}, A_{14} = 4A_{11}T_{21},$$

$$A_{15} = 3A_{11}T_{24} + 3A_{12}E_{14} + 3A_{13}N_{14}, A_{16} = 2A_{11}T_{25} + 2A_{12}E_{16} + 2A_{13}N_{16},$$

$$A_{17} = A_{11}T_{26} + A_{12}E_{17} + A_{13}N_{17}, A_1 = \frac{2A_3}{N^2}, A_{18} = -A_8(NhcoshNh - sinhNh)$$

$A_2 = -1 - (2A_3h + 3A_4h^2 + 4A_5h^3 + 5A_6h^4 + A_7N\ sinhNh + A_8N\ coshNh),$

$$A_3 = -\left(\frac{A_{17}}{2N^2} + \frac{A_{15}}{N}\right), A_4 = -\left(\frac{A_{16}}{6N^2} + \frac{A_{14}}{N^4}\right), A_5 = -\frac{A_{15}}{12N^2}, A_6 = -\frac{A_{14}}{20N^2}, A_7 = -\frac{2A_3}{N^2},$$

$A_8 = \frac{A_{18}}{(sinhNh - Nh\ coshNh)}$, $b = \left(1 + \frac{1}{\beta}\right)$.

Nomenclature

(X, Y): Cartesian coordinates

p: Pressure

D_B: Brownian motion coefficient

ρ_f: Fluid density

k: Thermal conductivity

M: Hartmann number

ρ_{f_0}: Fluid density at T_0

N_{CT}: Soret number

ρ_p: Nanoparticle mass density

N_t: Thermophoresis parameter

β_c :Volumetric solutal expansion

R_e: Reynolds number

$(\rho c)_p$: Heat capacity of nanoparticle

ϕ: Dimensionless solutal concentration

T: Temperature

ψ: Stream function

C: Solutal concentration

L_e: Lewis number

δ : Wave number

G_r: Thermal Grashof number

D_T: Thermophoretic coefficient

$(\rho c)_f$: Heat capacity of fluid

N_{TC}: Dufour parameter

Θ: Nanoparticle volume fraction

D_{TC}: Dufour diffusively

G_c: Solutal Grashof number

μ: Fluid viscosity

g: Acceleration due to gravity

T_1: Fluid temperature at upper wall

T_0: Fluid temperature at lower wall

C_1: Fluid concentration at upper wall

C_0: Fluid concentration at lower wall

D_s: Solutal diffusively

β_T: Volumetric thermal expansion

Da: Darcy number

L_n: Nanofluid Lewis number

D_{CT}: Soret diffusively

m: Hall parameter

Q: Heat source/sink parameter

β: Casson fluid parameter

χ: Dimensionless nanoparticle volume fraction

σ: Electrical conductivity

R_d:Thermal radiation

α: Angle of inclined magnetic field

N_b: Brownian motion parameter

P_r: Prandtl number

G_f: Nanoparticle Grashof number

θ: Dimensionless temperature