Retraction

Retraction: MHD Darcy-Forchheimer hybrid nanofluid flow past a nonlinear stretching surface: Numerical study (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012042)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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MHD Darcy-Forchheimer hybrid nanofluid flow past a nonlinear stretching surface: Numerical study.

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Abstract. Numerical simulation of hybrid nanoliquid over a power law velocity stretching sheet with darcy forchheimer model is presented in this article. Similarity variable approach is applied to convert governing partial differential equations into ordinary differential equation then solved by shooting method. Impact of distinct flow parameters on momentum, energy and concentration profile is shown in graphs and heat transfer rate for two different hybrid nanofluid models(\textit{Ag Fe}_3\textit{O}_4/\textit{H}_2\textit{O} and \textit{Ag MOS}_2/\textit{H}_2\textit{O}) computed and tabulated. Heat transfer rate is more in silver-iron oxide combination as compared to silver-molybdenum disulfide.

1. Introduction
Recent developments in nanotechnology is driving the technical community into new direction in almost all engineering sectors. Heat removal from surface plays pivotal role in many industrial processes such as cooling of electromechanical devices, dealing with boiling temperature in power plants , managing heat transport in pharmaceutical industries, etc. Thermal conductivity is one of the influencing factor in achieving desired heat removal rate. But conventional fluids like water ,oils are having low thermal conductivity as compared to solids. Combining the features of liquids -solid particles \cite{1} introduced engineered fluid which is well-known as nanofluid. Hybrid nanofluids are extended version of nanofluids in which more than one type of nano powder can be used to prepare nanofluid. \cite{2} studied Cu- \textit{Al}_2\textit{O}_3/\textit{H}_2\textit{O} fluid flow over a stretching sheet with suction. This study shows that nano particle volume fraction is crucial in achieving desired efficiency in heat transfer rate. \cite{3} examined the influence of Brownian motion, thermoporosis on hybrid liquid flow over an unsteady stretching surface. Their results portrays that these two important nanofluid parameters namely thermoporosis, Brownian motion are reducing heat exchange rate, \cite{4} discussed suction ,magnetic field effects on moving surface with copper-allumina nano particles. The authors identified dual solution for suction parameter and proved that hybrid nano fluid is dominating nanofluid in terms of heat transfer. \cite{5} scrutinized thermophysical characteristics of EO-TC4/Nicr mixture with radiation effect. Magnetohydrodynamic (MHD) is one of the branch in fluid mechanics which describes the magnetic characteristics of electrically conducting fluids.
particle suspension into electrically conducting fluid has got wide range of application in medical [6] material processing [7] and many other industries. Electrical and magnetic fields are very much useful to control fluid flows which is the major requirement in many nanofluid flow problems. [8] explored to Fe5o4 forced laminar flow and their results proves that heat transfer can be enhanced under magnetic field. In another study by [9] shows the impact of electrical field on MHD fluid. The Darcy-law which proportionally relates velocity and pressure gradients is not suitable for higher velocity fluid flow problems. But many advance fluid flow problems comes under high velocity models so Forchhiemer non-linear term will be added to analyze the fluid flow in porous media with high reynolds number. Hybrid nanoliquid flow over a curved stretching surface is examined by [10] with uniform heat source, radiation effects. This study conveys that blade shaped nano particle optimizes the temperature whereas brick shaped nanoparticles shows the lowest temperature. Three dimensional flow past a vertical sheet is examined by [11] with 50% -50% water and ethylene glycol combination. Their outcomes shows that radiation, shape factor improves nusselt number and this rate of enhancement is more in case of hybrid nanofluid. [12] considered temperature based viscosity model to examine the thermal behavior of Mos2 Sio2 nano particles with base fluid as ethylene glycol.

In this study radiation and dissipation effects are taken into account and proved that viscosity parameter reduces momentum, nusselt number increases with heat source. Mixed convection 3D hybrid nanomaterial characteristics was reviewed by [13]. In this study comparative report of hybrid nanofluid and nanofluid for enhancing heat exchange rate was presented. In another study [14] scrutinized to Mos2/C2H6O2 H2O hybrid nanomaterial characteristics with non-fourier heat flux model. [15] presented Darcy Forchhiemer relation with Mos2 Sio2 nano materials. The main aim of this study is to compare thermal behaviour of two (Ag Fe3O4 and Ag MOS2) hybrid nanomaterials for enhancing heat transfer.

2. Problem formulation

Consider a two-dimensional steady, laminar flow induced by stretching sheet. The stretching surface is taken in x-axis direction and y-axis is considered as normal to stretching surface. Uniform transverse magnetic field is applied in y-axis direction. With these assumptions the fluid flow model is expressed as follows:

\[
\frac{\partial u}{\partial x} - \frac{\partial v}{\partial y} = 0
\]  

(1)

\[
u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = \nu \frac{\partial^2 u}{\partial y^2} - \frac{\sigma_{nf} B_d (x) x^{-1} u}{\rho_{nf}} + \frac{\nu_{nf}}{\sqrt{k}} u'^2 + \frac{\nu_{nf}}{\sqrt{k}} u'^2
\]  

(2)

\[
u \frac{\partial \tau}{\partial x} + v \frac{\partial \tau}{\partial y} = \alpha_{nf} \frac{\partial^2 \tau}{\partial y^2} + \tau \left[ D_B \frac{\partial \alpha_c}{\partial y} + \frac{\partial \tau}{\partial y} \right]^2
\]  

(3)

\[
u \frac{\partial C}{\partial x} + v \frac{\partial C}{\partial y} = D_{nf} \frac{\partial^2 C}{\partial y^2} + D_{nf} \frac{\partial^2 C}{\partial y^2}
\]  

(4)

and boundary conditions are:

\[u = U_w = a x^n, v = 0, T = T_w, C = C_w \text{ at } y = 0\]

(5)

\[u = 0, v = 0, T = T_\infty, C = C_\infty \text{ at } y \to \infty\]

Introducing similarity transformation

\[
\frac{\rho_k}{\rho_k} = f'(\eta), \eta = y \left(\frac{2x^2}{2v}\right)^n, v = x^2 \left[(n + 1)f(\eta) + (n - 1)\eta f'(\eta)\right] \left(\frac{2v}{x^{n+1}}\right)^{n+2}
\]

(6)

\[
T(\eta) = T_\infty + \theta(\eta) (T_w - T_\infty), C(\eta) = C_\infty + \phi(\eta) (C_w - C_\infty)
\]

The flow governing equation (2)-(4) reduces to the following form

\[f'''' + A_1 A_2 \left(\frac{2n}{n+2} f''\right) - A_2 A_3 M f' - \lambda f' - F_c (f')^2 = 0\]

(7)
\[
\theta'' + \frac{k_{hf}}{Pr} \theta' + A_4 f \theta' + \dot{N} b \theta' \phi' + N t \theta t^2 = 0
\]

(8)

\[
\phi'' + L e f \phi' + \frac{N^2}{N b} \phi'' = 0
\]

(9)

Non-dimensional forms of Boundary conditions (5) are

\[
\left[ \begin{array}{c}
 f(\eta) \\
 f'(\eta) \\
 \theta(\eta) \\
 \phi(\eta)
\end{array} \right] = \left[ \begin{array}{c}
 0 \\
 1 \\
 1 \\
 1
\end{array} \right] \text{ at } \eta = 0
\]

(10)

\[
\left[ \begin{array}{c}
 f'(\eta) \\
 \theta(\eta) \\
 \phi(\eta)
\end{array} \right] = \left[ \begin{array}{c}
 0 \\
 0 \\
 0
\end{array} \right] \text{ as } \eta \to \infty
\]

Here M denotes magnetic parameter is forchheimer term,Pr is Prandtl number, Nt indicates thermoporosis parameter,Nb is Brownian motion term.

Using relations for nano fluid thermophysical properties from Devi et al [2]

\[
A_1 = \left[ 1 - \phi_{np2} \left( 1 - \phi_{np1} \right) + \phi_{np1} \left( \frac{\rho_{p1}}{\rho_f} \right) \right] + \phi_{np2} \left( \frac{\rho_{p2}}{\rho_f} \right)
\]

\[
A_2 = \left( 1 - \phi_{np2} \right)^{2.5} \left( 1 - \phi_{np1} \right)^{2.5}
\]

\[
A_3 = \left[ 1 - \phi_{np2} \left( 1 - \phi_{np1} \right) + \phi_{np1} \left( \frac{(\rho c_p)_{sl}}{(\rho c_p)_f} \right) \right] + \phi_{np2} \left( \frac{(\rho c_p)_{sl}}{(\rho c_p)_f} \right)
\]

Skin friction coefficient and Nusselt numbers can be computed as

\[
C_f = \frac{\frac{k_{hf}}{\rho_f u^2}}{\frac{\partial u}{\partial y}} \Bigg|_{y=0}
\]

and

\[
N_u = \frac{-\frac{k_{hf}}{\mu_f}}{\frac{\partial T}{\partial y}} \Bigg|_{y=0}
\]

Using equation (6) these two quantities in non-dimensional form

\[
C_f Re_x^{-1} = \frac{1}{A_1} f''(0)
\]

\[
N_u Re_x^{-1} = -\left( \frac{k_{hf}}{k_f} \right) \frac{n + 1}{2} \theta'(0)
\]
Figure 1. Magnetic field impact on velocity

Figure 2. Magnetic field impact on temperature behavior
Figure 3. Effect of porosity parameter on velocity

Figure 3 displays the porosity factor relation on velocity distribution. For higher values of porosity the momentum gets decreases due to frictional force. Figure 4 portrays that forchheimer number diminishes momentum distribution. This happens due to the fact that progressive values of the forchheimer number improves the influence of inertia factor on fluid motion as a result momentum decelerates. Figure 5 explores the consequences of forchheimer number on thermal distribution. It is clearly evident from this figure of forchheimer number enhances the temperature profile. Table 2 shows Computation of Nusselt number

Figure 4. Forchheimer number relation on Velocity
Figure 5. Impact of Forchheimer parameter on temperature

Table 2. Computation of Nusselt number

| M  | Nb  | Nt  | Fr | λ | $C_f Re_x^{-1}$ | $Nu Re_x^{-1}$ |
|----|-----|-----|----|---|----------------|----------------|
| 0.6|     |     |    |   | Ag – Fe$_3$O$_4$ | Ag – MO$_2$    |
| 1.0|     |     |    |   | 1.60363       | 1.60152       |
| 0.2|     |     |    |   | 1.87059       | 1.86878       |
| 0.3| 0.2 |     |    |   | 1.43651       | 1.43416       |
| 0.3| 0.3 |     |    |   | 1.43651       | 1.43416       |
| 0.6| 1.2 |     |    |   | 1.60363       | 1.60097       |
| 1.0| 0.5 |     |    |   | 1.78529       | 1.78220       |
| 1.0| 0.5 |     |    |   | 1.78930       | 1.78741       |

4. Conclusion
Thermal characteristics of two different hybrid nanofluid are analyzed in this study some of the important observations of this study are as follows:

- Forchheimer parameter accelerates velocity and temperature distribution in both hybrid nanofluid models.
- Nusselt number of $Ag – MO_2/H_2O, Ag-Fe_3O_4/H_2O$ for Brownian motion thermoporosis parameters shows an increasing trend.
- Porosity parameter decelerates the nusselt number in both hybrid nanofluid models.
- Skin friction increase for local inertia parameter for both hybrid nanofluid models.

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