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PHYSICAL PHENOMENON OF Al_2o_3 and SiO_2NANOFLUID ON TOP OF STEEPCOVER SHEET BY APPLYING LAPLACE ADOMIAN DECOMPOSITION METHOD

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ABSTRACT

The present paper discussed the transmission of convective heat from the condensed boundary layer flow over a vertical linear stretching board of viscous Nanofluids such as Al_2o_3in water and SiO_2in water nanofluids. As mentioned above, various physical parameters are measured at various volume fractions for both nanofluids. By way of similarity transformations, the acceleration and power boundary layer solutions, non-linear Laplace transform equations, are reduced to ordinary differential equations that are non-linear. Using the Laplace adomian decomposition method, the underlying non-linear regular formulas of Variations were resolved by the highly efficient. This research analyses nanofluid heat transfer's efficacy in cooldown of plastic and rubber mats.

Keywords: nanofluids, nanoparticles, boundary layer equations, stretching sheet, laplace adomian decomposition method.

INTRODUCTION

Balanced nanomaterials (1-100nm) embedded in traditional liquids such as water, oil or ethylene glycol are nanofluids. In large-scale industries such as in enormouschemical, food, oil, paper industries nanofluids are widely used, and also it is much helpful in many medical fields includes cancer treatment, targeted drug delivery systems, laser-based surgery, and cooling of the equipment etc. Silver and Titanium oxide, boundary layer flow Nanofluids are numerically analysed over vertical stretching sheet [1]. Investigation on Al_2o_3 nanoparticles for nanofluid Applications - A Review is studied [2]. The passage of a nanofluid boundary layer exponentially stretching sheet is studied [3]. In the presence of thermal emissions, a nanofluid's turbulent boundary layer flow is calculated across an extended sheet with unpredictable fluid properties. [4] In the applied magnetic field with convective heat transfer, Cu-water nanofluid movement induced by a vertical stretching layer is displayed. [5] The flow and heat transfer of boundary layers over a non-linear stretching sheet embedded in a porous medium with nanoparticles of partial fluid suspension are discussed [6]. Magnetohydrodynamics was numerically solved by the flow of a nanofluid's boundary layer and heat transfer across a sheet of non-isothermal stretching [7]. It investigates the motion of the MHD boundary layer of a nanofluid second-grade over convective boundary state stretching [8]. It addresses the presence of thermal radiation and partial slip over a non-linear stretching wall with section [9] of Heat exchange motion of MHD boundary layer nanofluid. With non-uniform producing or absorbing heat [10], it investigates the slipping stream and thermal transfer of nanofluids from the boundary layer of the MHD past a vertical stretching sheet. A nanofluid feature of MHD boundary layer flow and heat transmission across a sheet for stretching is discussed [11]. Flow and heat transfer to Sisko-nanofluid through a non-linear stretching sheet is numerically solved [12]. A power-law nanofluid flow with convective boundary conditions past a vertical stretching layer is being studied [14]. Advanced research on nanofluid flow problems via the Adomian approach is discussed [15]. The motion of equilibrium points using the Laplace Adomian decomposition method over a stretching layer with Newtonian heating studied [16]. Using the modified Laplace decomposition method, analytical solutions to the fractional Navier-Stokes equation are discussed [17]. An innovative Laplace decomposition technique for non-linear stretching sheet issues is investigated in the presence of MHD and slip situations in [18]. The Laplace Adomian decomposition method is numerically investigated for the multidimensional time-fractional model of the Navier-Stokes equation [19]. A comparative research on the stability in generalised pantograph equations of the Laplace-adomian algorithm and computational methods is experimentally resolved [20]. Movement and the release of energy with slip flow in a laminar boundary layer is addressed [21].

Mathematical Implementation

The present study of the laminar boundary layer flow of nanofluids through the vertical structure board of an immiscible fluid velocity, in which it has been situated in the direction of constant velocity and is represented by U, and the temperature is represented by T. Usage of nanofluid mass, energy and momentum equation preservation theory-based Prandtl boundary layer equations

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \tag{1}$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=v_{Nf}\frac{\partial^2 u}{\partial y^2} \tag{2}$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\frac{K_{Nf}}{\rho_{Nf}(C_P)_{Nf}}\left(\frac{\partial^2 T}{\partial y^2}\right) \tag{3}$$

Here u and v are indeed the elements of velocity in the dimensions x and y, respectively. A kinematic viscosity is a v(Nf),$(C_p)_{Nf}$ is a basic thermal conductivity of heat K_{Nf}, and ρ_{Nf} is the nanofluid density, according to the boundary condition

$$y = 0, u = u_w = 0, v = 0,\ T = T_w + ax, \quad (4)$$
$$y \to \infty, u \to o, T \to T_\infty.$$

$Al_2o_3$and SiO_2Nanofluids:

The density, thermal power, and dynamic viscosity of the nanofluids are given by the volume fraction of the nanoparticles.

$$\rho_{Nf} = (1-\emptyset)\rho_b + \rho_s \quad (6)$$

The nanofluid's heat capacitance is given by

$$(C_P)_{Nf} = (1-\emptyset)(C_P)_b + \emptyset(C_P)_s \quad (7)$$

The nanofluid's dynamic viscosity is calculated by (Brinkman 1952)

$$\mu_{Nf} = \frac{\mu_b}{(1-\emptyset)^{2.5}} \quad (8)$$

$$K_{Nf} = \frac{K_s+(n-1)K_b-(n-1)(K_b-K_s)\emptyset}{K_s+(n-1)K_b+(K_b-K_s)\emptyset}(K_b) \quad (9)$$

The dimensionless factors are implemented

$$\Psi(x,y) = (av_{Nf})^{1/2}xf(\eta), \eta = y\left(\frac{a}{v_{Nf}}\right)^{1/2}, \theta = \frac{T-T_\infty}{T_w-T_\infty} \quad (10)$$

Where $u = \frac{\partial\Psi}{\partial y}$, $v = -\frac{\partial\Psi}{\partial x}$and $\Psi(x,y)$ is stream function, η is similarity variable. (11)

The velocity components are

$$u = axf'(\eta), v = -(av_{Nf})^{1/2}f(\eta) \quad (12)$$

By using the boundary conditions, the transformed momentum and energy equation equations is possible to write as

$$f''' - (1-\emptyset)^{2.5}\left(1-\emptyset+\emptyset\frac{\rho_s}{\rho_b}\right)\left(f'^2 - ff''\right) + \lambda\theta(1-\emptyset)^{2.5}\left(1-\emptyset+\emptyset\frac{\rho\gamma_s}{\rho\gamma_b}\right) = 0 \quad (13)$$

$$\frac{1}{Pr_{Nf}}\frac{K_{Nf}}{K_b}\theta'' + \left(1-\emptyset+\emptyset\frac{\rho_s}{\rho_b}\right)\left(1-\emptyset+\emptyset\frac{(\rho C_p)_s}{(\rho C_p)_b}\right)f\theta' = 0 \quad (14)$$

$$\eta = 0, y = 0, f = 0, f' = 1, \theta = 1 \quad (16)$$
$$\eta \to \infty, y \to \infty f' = 0, \theta = 0.$$

The kinematic viscosity v_{Nf}, Prandtl number (Pr), and thermal diffusivity α_{Nf} of the nanofluid are given by,

$$v_{Nf} = \frac{\mu_{Nf}}{\alpha_{Nf}} \quad (17)$$

$$(Pr)_{Nf} = \frac{\mu_{Nf(C_p)_{Nf}}}{K_{Nf}} \quad (18)$$

$$\alpha_{Nf} = \frac{K_{Nf}}{\rho_{Nf(C_p)_{Nf}}} \quad (19)$$

Where $\lambda = \frac{g\rho\gamma_b}{\rho f\alpha^2}$, $Pr = \frac{\vartheta_b}{\alpha_b}$.

Solution Procedure:

By using laplace adomian decomposition method.

$$f''' - A\left(f'^2 - ff''\right) + \lambda\theta(1-\emptyset)^{2.5} + B = 0(20)$$
$$C\theta'' + Df\theta' = 0(21)$$

Where $A = (1-\emptyset)^{2.5}\left(1-\emptyset+\emptyset\frac{\rho_s}{\rho_b}\right)$, $B = \lambda\theta(1-\emptyset)^{2.5}\left(1-\emptyset+\emptyset\frac{\rho\gamma_s}{\rho\gamma_b}\right)$

$C = \frac{1}{Pr_{Nf}}\frac{K_{Nf}}{K_b}$, $D = \left(1-\emptyset+\emptyset\frac{\rho_s}{\rho_b}\right)\left(1-\emptyset+\emptyset\frac{(\rho C_p)_s}{(\rho C_p)_b}\right)$.

Taking laplace transformation on the above equation

$$L[f'''] - AL\left[f'^2 - ff''\right] + BL[1] = 0 \quad (22)$$

By using boundary conditions

$$L[f] = \frac{1}{s^2} + \frac{\alpha}{s^3} + \frac{A}{s^3}L\left[f'^2 - ff''\right] - \frac{B}{s^4} \quad (23)$$

Taking inverse laplace on both sides,

$$f = \eta + \frac{\alpha\eta^2}{2} - B\frac{\eta^3}{3!} + L^{-1}\left[\frac{A}{s^3}L\left[f'^2 - ff''\right]\right] \quad (24)$$

Assume $f_0 = \eta + \frac{\alpha\eta^2}{2}$, $f_1 = B\frac{\eta^3}{3!}$.

The general term is given by

$$f_{n+1}(\eta) = L^{-1}\left[\frac{A}{s^3}L\left[f'^2 - ff''\right]\right]$$
$$f_{n+1}(\eta) = L^{-1}\left[\frac{A}{s^3}L[A_n - B_n]\right] \quad (25)$$

Where A_n and B_n are the adomian polynomials given by

$A_0 = f_0'^2$, $B_0 = f_0f_0''$

$A_1 = 2f_0'f_1'$,$B_1 = f_0f_1'' + f_1f_0''$

$A_2 = 2f_0'f_2' + f_0'^2$,$B_2 = f_0f_2'' + f_1f_1'' + f_2f_0''$……

And $f(\eta) = f_0 + f_1 + f_2 + f_3 + f_4 + \ldots\ldots\ldots\ldots\ldots\ldots$

$$f_0 = \eta + \frac{\alpha\eta^2}{2!}.$$

$$f_1 = (A-B)\frac{\eta^3}{3!} + \frac{A\alpha\eta^4}{4!} + \frac{A\alpha^2\eta^5}{5!}.$$

$$f_2 = (A^2 - 2AB)\frac{\alpha\eta^6}{6!} - \frac{A^2\alpha^2\eta^7}{7!} - \frac{A^2\alpha^3\eta^8}{8!}\ldots\ldots\ldots\ldots\ldots\ldots$$

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$$f(\eta) == \eta + \frac{\alpha\eta^2}{2!} + (A-B)\frac{\eta^3}{3!} + \frac{A\alpha\eta^4}{4!} + \frac{A\alpha^2\eta^5}{5!} + (A^2-2AB)\frac{\alpha\eta^6}{6!} - \frac{A^2\alpha^2\eta^7}{7!} - \frac{A^2\alpha^3\eta^8}{8!} \quad (26)$$

By using equation (2)

$$C\theta'' + Df\theta' = 0$$
$$\theta'' = -\frac{D}{C}f\theta' \quad (27)$$

Taking laplace transform on both sides

$$L[\theta''] = -\frac{D}{C}L[f\theta'] \quad (28)$$

$$L[\theta] = \frac{1}{s} + \frac{\beta}{s^2} - \frac{D}{cs^2}L[f\theta'] \quad (29)$$

Taking inverse laplace transform

$$\theta = 1 + \beta\eta - \frac{D}{c}L^{-1}\left[\frac{1}{s^2}L[f\theta']\right] \quad (30)$$

Assume $\theta_0 = 1 + \beta\eta$

$$\theta_{n+1} = -\frac{D}{c}L^{-1}\left[\frac{1}{s^2}L[f\theta']\right] \quad (31)$$

$$\theta_{n+1} = -\frac{D}{c}L^{-1}\left[\frac{1}{s^2}L[A_n]\right] \quad (32)$$

$$\theta_1 = -\frac{D}{c}\left[\frac{\beta\eta^3}{3!} + \frac{\alpha\beta\eta^4}{4!}\right]$$
$$\theta_2 = -\frac{D}{c}\left[\frac{\beta\eta^2}{2!} + \frac{\alpha\eta^3}{3!}\right] \ldots\ldots\ldots\ldots..$$
$$\theta(\eta) = 1 + \beta\eta - \frac{D}{c}\left[\frac{\beta\eta^2}{2!} + (\alpha+\beta)\frac{\eta^3}{3!} + \frac{\alpha\beta\eta^4}{4!}\right] \quad (33)$$

Table-1. Density, particular thermal permittivity, values of water heat conductivity, Al_2o_3 and SiO_2.

	ρ(Kg/m^3)	C_p($J/Kg.K$)	K(W/m.K)
Water	1000.52	4181.8	0.597
Al_2o_3	3970	765	40
SiO_2	2200	703	1.2

Table-2. Nanofluids' thermal physical characteristics Al_2o_3 water.

Φ	ρ_{Nf}	$(C_P)_{Nf}$	μ_{Nf}	K_{Nf}	$(Pr)_{Nf}$	$v_{Nf} \times 10^6$	$\alpha_{Nf} \times 10^6$
0.00	1000.52	4181.8	0.001002	0.613	7.02	1.0015	0.1427
0.01		4142.33	0.001027	0.6150	6.92	0.9375	0.1355
0.02	1190.51	4102.86	0.001053	0.6334	6.82	0.8845	0.1297
0.03	1285.50	4063.40	0.001081	0.6520	6.74	0.8409	0.1248
0.04	1380.50	4023.93	0.001109	0.6713	6.65	0.8033	0.1208
0.05	1475.49	3984.46	0.001139	0.6908	6.57	0.7719	0.1175
0.06	1570.49	3944.99	0.001169	0.7108	6.49	0.7443	0.1147
0.07	1665.48	3905.52	0.001201	0.7312	6.41	0.7211	0.1124
0.08	1760.48	3866.06	0.001234	0.7520	6.34	0.7009	0.1105
0.09	1855.47	3826.59	0.001268	0.7733	6.27	0.6834	0.1089

As the volume fraction grows, the capacitance, Prandtl, v_{Nf}, α_{Nf} decreases, but the reverse trend is obtained from the above table for density, dynamic viscosity, thermal conductivity.

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Table-3. SiO_2 Water nanofluids' thermal physical properties.

Φ	ρ_{Nf}	$(C_P)_{Nf}$	μ_{Nf}	K_{Nf}	$(Pr)_{Nf}$	$v_{Nf} \times 10^6$	$\alpha_{Nf} \times 10^6$
0.00	1000.52	4181.80	0.001002	0.597	7.02	1.0015	0.1427
0.01	1183.71	4141.26	0.001027	0.6150	6.92	0.8676	0.1255
0.02	1366.91	4100.72	0.001053	0.6333	6.82	0.7704	0.1130
0.03	1550.10	4060.19	0.001081	0.6521	6.74	0.6974	0.1036
0.04	1733.30	4019.65	0.001109	0.6712	6.64	0.6398	0.0963
0.05	1916.49	3979.11	0.001139	0.6907	6.56	0.5943	0.0957
0.06	2099.69	3938.57	0.001169	0.7106	6.48	0.5567	0.0859
0.07	2282.88	3898.03	0.001201	0.7310	6.40	0.5261	0.0822
0.08	2466.08	3857.50	0.001234	0.7518	6.33	0.5004	0.0790
0.09	2649.27	3816.96	0.001268	0.7730	6.26	0.4786	0.0764

As the volume fraction increases from the table above, the capacitance, prandtl, v_{Nf}, α_{Nf} decreases, however, for density, dynamic viscosity and thermal conductivity, the reversed pattern is acquired.

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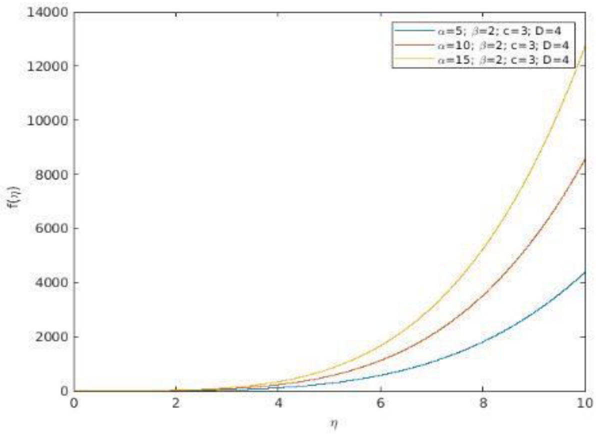

Figure-1. The outcome of tnanofluids'velocity profile oith different α values.

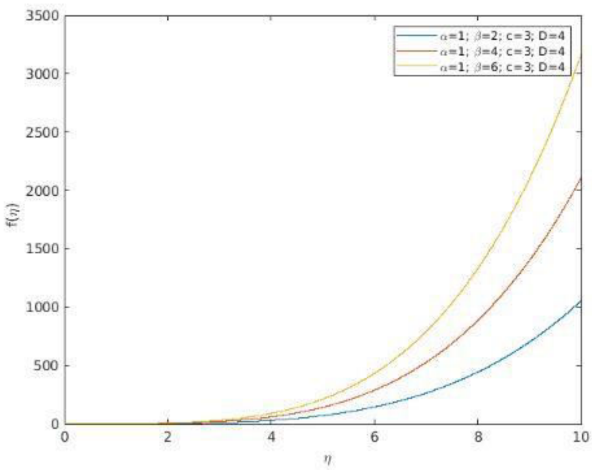

Figure-2. Results of the nanofluid velocity outline with various values of β.

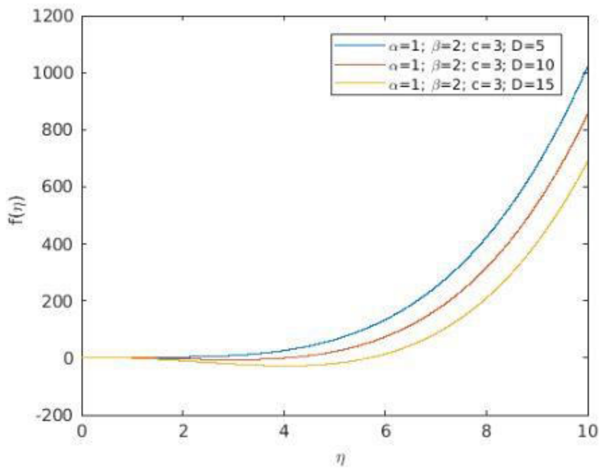

Figure-3. Products of the velocity profile of nanofluids with various D values.

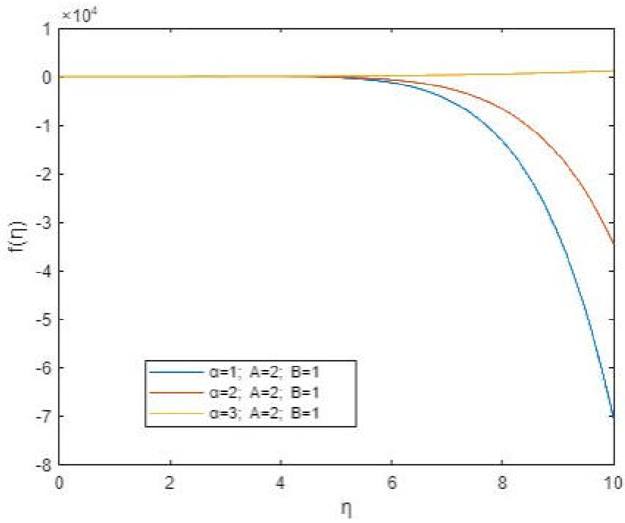

Figure-4. Velocity profile effects of nanofluids with various D values.

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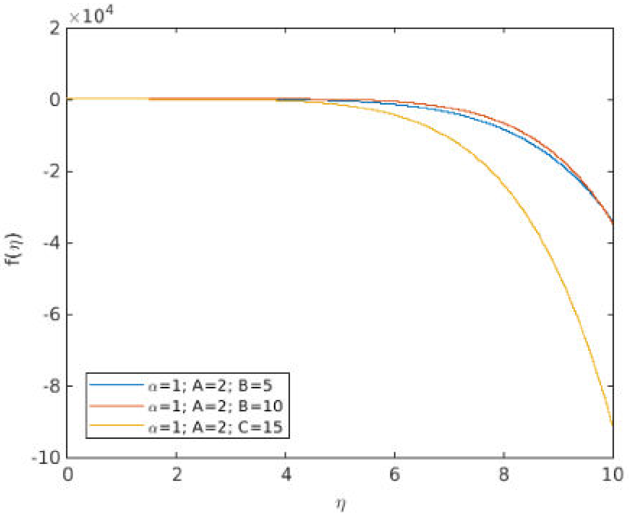

Figure-5. Temperature profile effects of nanofluids with different B values.

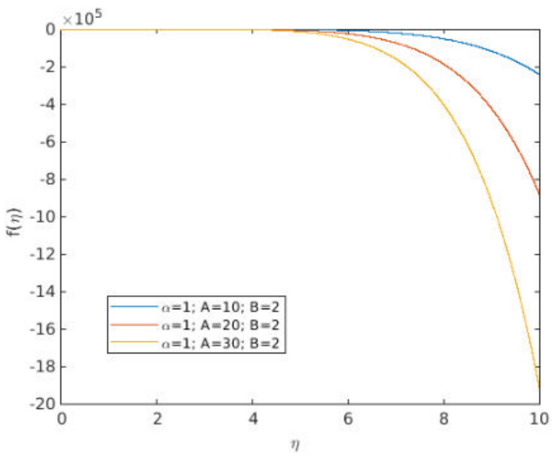

Figure-6. Temperature profile results of nanofluids with different A values.

RESULTS AND DISCUSSIONS

The transmission over a Vertical Stretching Sheet of thermal downside linked to bedded physical phenomenon flow of $Al_2o_3$and SiO_2nanofluids was studied. Table-2 shows The capacitance that, Prandtl, v_{Nf},α_{Nf} decreases once the quantity fraction increases, but the density, coefficient, thermal conduction reverse pattern is obtained. It is seen from table 3 that once the quantity fraction increases, the capacitance, Prandtl, v_{Nf}, α_{Nf}decreases, but the reverse pattern for density, coefficient, thermal conduction is obtained. For the various alpha values, the speed pattern for the nanofluid could be seen in Figure-1; once it increases, the rate profile will increase. The nanofluid rate profile is shown for different β values from Figure-2; once it increases, the rate profiles will rise From Figure-3, the nanofluid speed profile is seen for various D values, once it rises, The rate profiles are expected to rise through Figure-4 The temperature profile for the nanofluid is seen to be constant for A, B and thus the totally different alpha values will rise

o Once the heat profile increases, the nanofluid temperature profile is shown to be stable for an alpha, A and thus the completely different α values will increase.

The nanofluid temperature profile is shown in Table-6 for an alpha, B is stable, and thus the entirely different values of A will increase the temperature profile before it increases.

CONCLUSIONS

- There are nanofluids than their base fluids with superior temperature physical phenomenon and coolant properties.
- Via increasing the Prandtl spectrum, the temperature in each Al_2o_3 water and SiO_2 water nanofluid decreases.
- Like the changes in volume fraction, Al_2o_3 water and SiO_2water nanofluids change thermal physical phenomena and density. However, with an improvement in volume fraction, as an alternative Prandtl variety and warmth capacity decreases.
- In addition, volume fraction increases will elevate the constant of warmth transfer for each form of nanofluids.
- Increased viscousness would increase for each form of nanofluid inside the volume. Viscousness is constant at constant times for several kinds of nanofluids.

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