ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jan164

Investigation of Cooling Effects of Aluminum Oxide, Copper Oxide Nanofluid S and Water on the Polyethylene Stretching Sheets

Falana, A.[1]; Adeboje, T. B.[2]

[1]Department of Mechanical Engineering, University of Ibadan, Ibadan

[2]Department of Mechanical Engineering, Adeseun Ogundoyin Polytechnic, Eruwa, Ibadan,

Corresponding Author: Adeboje, T. B.

Publication Date: 2026/01/21

Abstract: This paper showcased the cooling effects of Aluminum oxide (AONF), Copper Oxide (CONF) Nanofluids and water (H_2O)on polyethylene stretching sheets for good surface finish and aesthetic look. The AONF had superfine structure when compared to CONF. The cooling effect of the NFs on SS with inner diameter of 10 mm, initial Die Temperature (DT) of 212℃ and stretching velocity of 1.42 m/s was determined by measuring the transient temperature TT for 50 minutes at 10 minutes interval The experimental results for the peak temperature and heat properties for AONF CONF and water were: 57.5 and 60.3 and 64.5℃, 1.01kg/m^3, 0.601 poise, 1.93x10^{-4} mol/dm^3 and 0.60 $wm^{-1}K^{-1}$ and 1kg/m^3, 0.95poise, 0.00 mol/dm^3 and 0.6 $wm^{-1}K^{-1}$, respectively. The values obtained indicate the efficient effect of optimum heat and heat transfer of Aluminum oxide (AONF) and Copper Oxide (CONF) Nanofluids and water(H_2O) on the stretching sheets. The aluminum oxide and coper oxide nanoparticles base- fluids revealed improved cooling characteristics on the polyethylene stretching sheets with minimal defects in comparison with water. The stretching sheets cooled with aluminum nanofluid exhibited the best cooling characteristics.

Keywords: *Functionality, Cooling Effect, Heat Properties, Nanofluid, Stretching Sheet.*

How to Cite: Falana, A.; Adeboje, T. B. (2026) Investigation of Cooling Effects of Aluminum Oxide, Copper Oxide Nanofluid S and Water on the Polyethylene Stretching Sheets. *International Journal of Innovative Science and Research Technology*, 11(1), 1254-1258. https://doi.org/10.38124/ijisrt/26jan164

I. INTRODUCTION

Enhancing surface texture, appearance, and mechanical qualities, polyethylene stretching sheets are cooled in nanofluid. Poorly cooled stretching sheets are a sign of flaws that compromise the quality and surface finish of the products. As a result, stretching sheets require adequate cooling, and precise information regarding the ideal cooling characteristics. The applications span various fields, including: cooling systems for metallic plates, material handling conveyors, Aerodynamic extrusion condensation processes, paper production, glass blowing, metal spinning, plastic film drawing, and polymer extrusion. Eastman *et al*. (2009) found copper particles increased thermal conductivity in ethylene glycol base fluids. for materials with unique properties. Advanced techniques now enable precise control over size, shape, composition, and surface properties. Traditional methods like vapor deposition are complemented by liquid-phase approaches such as sol-gel and hydrothermal methods, allowing for tailored nanoparticle production. Chavda *et al*. (2015) investigated the CuO/water nanofluid friction factor. Brownian motion should be incorporated into the velocity formula. Other researchers, such as Fekry *et al*. (2016), Chamkha and Ismael (2014), investigated thermo physical properties in nanofluids within rectangular porous channels. Awua *et al* (2024) mentioned the morphological study confirmed that the FTB particles are of spherical shape and have the average particle size is 26 nm, Oxides of calcium and silicon were Chaya and Joy deep (2025) synthesised a cost-effective Ag and Au-h-BN(NP) substrate for efficient SERS applications. Uncertainty analysis showed that dosage of PDAC-ZnO-NPs was the most influential parameter, while input parameters had negligible effects (Kareem *et al*.,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jan164

2025). Systematic analysis of surface morphology, purity, and chemical bonding confirmed the substrate's quality. Its SERS efficacy, tested with R6G, showed notable spectral reproducibility and effectiveness. Izzat *et al. (2025*). Nanofluids significantly improve thermal conductivity, viscosity, and heat transfer coefficients, making them superior to conventional fluids in applications such as heat exchangers, electronics cooling, PV/T systems, CSP technologies, and geothermal heat recovery.

Furthermore, Xu and Pop (2014) and Mushtaq *et al*. (2014) proffered the magnitudes of buoyancy in nanofluids, considering factors like Prandtl number and boundary layer dynamics. Research by Bondareva *et al*. (2015) examined heat transfer characteristics in static base fluids. Falana *et al*. (2016) explored the effects of strong injection, finding that it generates a suction force that reduces drag and affects temperature distribution within the thermal boundary layer. Later, Falana *et al*. (2018) reported that strong injection and suction have distinct effects on local skin friction, with implications for various applications. Getting nanofluids with good suspension stability is especially crucial. Preparation techniques, such as one-step (Kumar *et al*., 2016) or two-step.nanoparticles and nanofluids development is done simultaneously in one-step method, which includes stirring the nanosize particles straight in the base solution. determine dynamic viscosity causes thermal conductivity to rise as the volume fraction does. Buoyance, which is the ratio of Grashof to the square of Reynolds number, is one of the measures affecting magneto-hydrodynamic convective heat transfer, more noticeable buoyancy effect. Abu-Nada *et al*. (2010) published a study in the International Journal of Thermal Sciences, examining how varying nanofluid properties (thermal conductivity, viscosity, density, and specific heat capacity) affect natural convection heat transfer within an enclosure. In order to demonstrate how the magnetic, suction-injection, Brownian motion, thermophoretic, Prandtl, Eckert, and Lewis parameters affect the flow. According to Noghabadi *et al.* (2014), the Prandtl number determines the critical Reynolds number associated with the temperature profile. Bawoke and Birhanu (2023) reviewed nanomaterials, classifying them based on characteristics, synthesis methods, and applications. Unlike bulk materials, nanomaterials' properties (physical, chemical, electrical, optical, magnetic, and mechanical) are size-dependent.

II. EXPERIMENTAL SET-UP

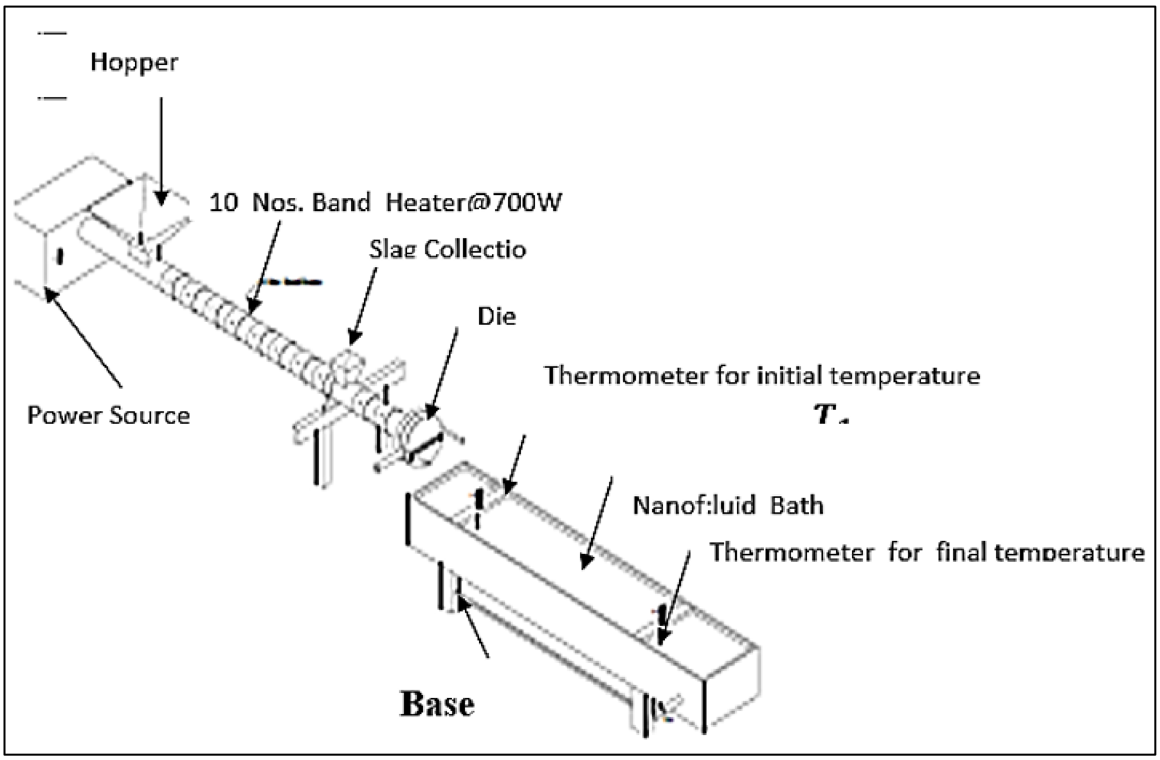

Fig 1 Experimental Set-Up
Source: Researcher, 2024

Die Temperature =2 12℃

Diameter of the Stretching Sheet =10mm
The velocity of stretching Sheet =1.41m/s
Depth of the cooling bath: =0.155m
Length of the cooling bath: =3.48m
Breath of the cooling bath =1.51m
Volume of the cooling bath =0.5804m^3

Initial cooling of water and nanoparticle base fluid were recorded using thermometer

Final cooling of water and nanoparticle base fluid were recorded using thermometer

$T_1 = Temperature$ at entrance
$T_2 = Temperature$ at Middle
$T_3 = Temperature$ at End of bath

The heat sourced was 212℃ and the transient temperature of the die was measured. Water was use as control sample for the transient temperature and was compared the transient temperature of both aluminum and copper oxides.The stretching sheet with the diameter of 10mm moved at the velocity 1.44 m/s and the volume of the bath was 0.5804m^3 in the cooling process. The corresponding transient die temperature was taken for both control sample , aluminum and copper oxide fluids.

III. RESULT AND DISCUSSION

Table 1: Temperature Dependent Cooling Evaluation (Experimental Control Water Base fluid Depth of: 0.155m

Time(10mins)	**Initial Temp℃ (T_1)**	**Mid- Temp℃(T_2)**	**Final Temp℃ (T_3)**
0.00	33,90	34.0	33,80
1,00	52.80	53.50	52.60
2.00	64.80	65.30	64.30
3.00	73.40	73.60	72.90
4.00	73.80	73.90	72.9
5.00	81.10	81.30	80.1
6.00	81.50	81.60	76.90

Table 2: Temperature Dependent Cooling Evaluation (CuONPs Copper Oxide Namofluid; Depth of 0.155m)

Time (10mins)	**Initial Temp℃ (T_1)**	**Mid- Temp℃(T_2)**	**Final Temp℃ (T_3)**
0.00	33.60	33.80	33.60
1,00	52.80	52.50	53.10
2.00	66.40	65.10	64.80
3.00	68.50	65.30	66.10
4.00	76.90	77.50	75.30
5.00	82.50	84.20	80.60

Table 2 contains the empirical result for copper oxide (CuO) temperature (Izzat *et al.*, 2025). When examined with respect to water, the result revealed a sharp improvement. It showed copper nanofluid reflections at temperatures ranging from 33.66 to 82.43 on average. The significantly increased thermal conductivity led to an improvement in the Brownian motion,Chung.(2001). CuO nanoparticles (CuONPs) exhibited enhanced thermal conductivity and Brownian motion in water, resulting in a 42% improvement in heat transfer, as reported by Abu and Bidius (2020). According to Peyghamberzadeh *et al.*, the significant cooling properties of CuONPs demonstrated a 4.1% increase in heat transfer, with a cooling temperature of 18.7 CuONPs compared to 19.5 for base fluid.

Table 3: Temperature Dependent Cooling Evaluation (AlO_3NPs Aluminum Oxide Namofluid; Depth of 0.155m)

Time(10mins)	Initial Temp℃ (T_1)	Mid- Temp℃ (T_2)	Final Temp℃ (T_3)
0.00	32.80	32.80	32.90
1,00	48.90	48.50	48.90
2.00	570	57.90	57.60
3.00	62.80	63.00	62.9
4.00	70.80	71.60	71.30
5.00	70.40	80.10	79.60

The effects of temperature on the cooling process of aluminum nanofluid () were shown in Tables 3. The recorded temperature was between 38.83- and 76.70-degrees Fahrenheit, which was the lowest and highest cooling temperature. Aluminum oxide particles enhance the heat transfer properties of nanofluids with increases in (Abu and Bodius, 2020). However, particle concentration is affected by temperature (Zhu *et al*., 2016). According to Table 4.2, this effect is most pronounced at ambient temperature. There is large disparity as a result of temperature of nanofluiod to water base fluid 15.70 to 19.5 differential with heat transfer enhancement of 19.4%

Table 4: Thermo Physical Properties of Nanoparticles –Base Fluids

S/N	Samples	Density Kg/m^3	Viscosity (ρ)	%φ $Volume$ Concentration	Specific Heat (ķ)JKg^{-1}K^{-1}	Thermal Conductivity $wm^{-1}K^{-1}$
1.	CuO oxide(initial)	1.0018	0.939	1.9987x10^{-5}	1.106x10^3	0.57903
2.	CuO oxide(final)	1.009	0.877	1.985x10^{-5}	1.0594x10^3	0.578875
3.	Al_2 O_3(initial)	1.0019	0.93	1.8836x10^{-5}	0.981x10^3	0.6001
4.	Al_2 O_3(final)	1.0011	0.873	1.8815x10^{-5}	1.004x10^3	0.600214
5.	*H2O*	0.7972	0.357	-	4.18	0.606

The effects of the nanofluids' thermo-physical properties on copper oxide (CuO) and aluminum oxide were shown on Table 4 . Heat transfer characteristics are significantly induced through temperature, with density increasing by 0.618% to 0.718%, Jahnavi and Ganesh (024). The effects of the temperature on the sample nanofluid were examined at the instance of the temperature before and after cooling process and were tagged as initial and final. Considering the values between the initial and the final for the cooling temperature. Peyghamberzadeh *et al*. (2011) found that nanofluids exhibited improved specific heat capacity, enhancing cooling system due to increase the drag.

IV. CONCLUSION

The experimental investigation has established both academic and industrial approach, and bridged the gap between theory and practice. Despite having little or no prior knowledge of nanofluids, respondents increased their knowledge sufficiently. The mathematical simulation's limitations are lessened and the gap is filled by empirical validation of the theoretical simulation. The cooling processes of CuO-NFs, and Al_2 O_3–NFs have been predicted and quantified in this study. Nanoparticle-based fluids made of copper oxide and aluminum oxide demonstrated improved cooling characteristics on stretching sheets with minimal defects in comparison with water. The aluminum oxide and copper oxide nanoparticle-based fluids showed improved cooling characteristics on stretching sheets with minimal defects in comparison with water. Th polyethylene e stretching sheet cooled with aluminum oxide nanofluid exhibited the best cooling characteristics.

REFERENCES

[1]. Abu-Nada E., 2009.Effects of variable viscosity and thermal con ductivity of Al2O3–water nanofluid on heat transfer enhance ment in natural convection. *International Journal Heat Fluid Flow* 30:679–690.
[2]. Awua, J. T,. Ibrahim, J. S, Krishna, S. J., Edeoja, A. O., A. Kuhe A. K.,. Sharifpu, M., S. Murshed, S. M., 2024. Synthesis, characterisation, physicochemical, and electricalproperties of natural (bio) nanofluids, Environ Prog Sustainable Energy.2024;43:e14397.wileyonlinelibrary.com/journal/ ephttps://doi.org/10.1002/ep.14397 DOI: 10.1002/ep.14397. *Vol. 55 page 642-648*
[3]. Bawoke M. and Birhanu A, 2023. Nanomaterials: An overview of synthesis, classification, characterisation, and applications. Nano Select 2023; 4:486–501.DOI: 10.1002/nano.202300038
[4]. Bondareva N. S., Sheremet, M. A. and Pop, I., 2015. Magnetic Field Effect on the UnsteadyNatural Convection in a Right-Angle Trapezoidal Cavity Filled with a Nanofluid. *International Journal of Numerical Methods for Heat & Fluid Flow*.25:1924-1946.
[5]. Chamkha, A. J., Ismael, M.A., 2014. Conjugate Heat Transfer in a Porous Cavity Filled with Nanofluidsand

Heated by a Triangular Thick Wall, *International Journal of Thermal Sciences*, *67*, pp. 135-15

[6]. Chavda N. K., Patel, G. V., Bhadauria, M. R., and Makwana, M. N. 2015. Effect of Nanofluid on Friction Factor of Pipe and Pipe Fittings: Part II Effect of Copper Oxide Nanofluid. Int J Res Eng Technol 4:697–700.

[7]. Einstein, A., 2001Eine neue Bestimmung der Moleküldimensionen. Ann. Phys. 324, 289–306. doi:10.1002/andp.19063240204

[8]. Falana, A., Ojewale, O. A., Adeboje, T. B., 2016. Effect Brownian Motion and Thermophpresis on Nonlinearly Stretching Permeable Sheet in A Nanofluid, *International Journal of Advanced in Nanoparticles* (5) pp.123-134, Published Online. February 2016,Sci.http://www .Scrip.org/journal/anphttp:// dx.doi.org/ 10.42436anp.20`6.51014

[9]. Falana, A., Ojewale, O. A., Adeboje, T. B., 2018. Effect of Suction/Injection on Boundary Layer Flow and Heat Transfer Over A Nonlinearly Stretching Permeable Sheet in a Nanofluid, *Journal of Nigerian Association of Mathematical Physics*, 4, pp.117-124.

[10]. Fekry, M. H, Mahdy, M., Ramadan, A. M., Omima, A. and Abo, Z., 2016. Effects of Viscous Dissipation on Unsteady MHD Thermo Bioconvection Boundary Layer Flow of a Nanofluid Containing Gyrotactic Microorganisms along a Stretching Sheet. *World Journal of Mechanics*. 6:505-526.

[11]. Izzat. Wang X., Glulam R., Tao Su, Abdulsalam S. S., Muhammad, Y., M., Kamil A., 2025. Nanofluids for Advanced Applications: A Comprehensive Review on Preparation Methods, Properties, and Environmental Impact *CS Omeg*Cite this: *ACS Omega* 2025, 10, 6, 5251–5282C,https://doi.org/ 10.1021/ acsomega.4c10143

[12]. Kazeem K. S. , Idayat A. O., Kehinde A. B. , Monsuru O. D. c , Dauda O. A. a , Mujidat O. A Opeoluwa D. S., Temitope O. A., 2025. Zinc oxide-nanoparticle impregnated poultry droppings activated carbon for model oil desulfurisation: Experimental investigation and regression modelling with uncertainty quantification, Available online 17 April 2025 2949-8295/© 2025 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/bync-nd/4.0/).

[13]. Kumar, S. Sharma, M. Bala, A. Kumar, A Maithani. R. Sharma, T. SAlam, N.K. Gupta, M. S.., 2022, Enhanced heat transfer using oil-based nanofluid flow through conduits: a review Energies, 15 (22) pp. 1-28, 10.3390/en15228422.Sci., 124, pp. 187-195,

[14]. Mushtaq, A., 2014. Nonlinear Radiative Heat sTransfer in the Flow of Nanofluid Due to Solar Energy: A Numerical Study, *Journal of the Taiwan Institute of Chemical Engineers*, *45*, pp. 1176-1183

[15]. Noghabadi, A., 2014. Analyse of Fluid Flow and Heat Transfer of Nanofluidsover a Stretching Sheet near the Extrusion Slit, *Computers & Fluids*, *100*, pp.227-236

[16]. Xu, H., Pop, I., 2014. Fully Developed Mixed Convection Flow in a Horizontal Channel Filled by a Nanofluid Containing Both Nanoparticles and Gyrotactic Microorganisms, *European Journal of Mechanics B/Fluids*, *46*,pp. 37-45.