Impact of Porosity and Trihybrid Nanofluid on the Transient Thermal Performance of Inclined Dovetail Fin with Emphasis on Internal Heat Generation.

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1. INTRODUCTION & OBJECTIVE

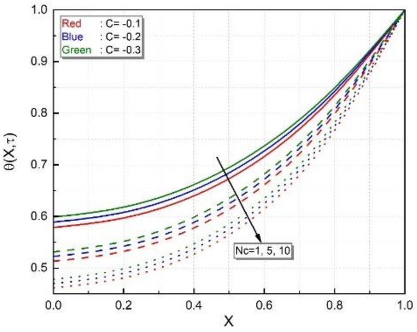
Numerous methods are employed to study the improvement of heat movement, and using fins to scrutinize heat transfer characteristics stands out as a particularly effective technique. Motivated by this functionality, the current study focuses on examining the transient thermal performance of a dovetail fin structure that is completely immersed in a trihybrid nanofluid. The medium of the fin is porous, with Darcy's law utilized to model the interactions between fluid and the solid. The trihybrid nanofluid is formulated by combining $MWCNT, Ag$, and Cu nanoparticles with the hybrid base fluid $C_2H_6O_2 - H_2O$. The resulting nonlinear partial differential equation has been transformed into a non-dimensional form and numerically tackled with the Finite Difference Method (FDM). The study visually and verbally outlines the influence of various aspects, such as tip tapering, dimensionless time, angle of inclination, full wet condition, porosity, internal heat generation, ambient temperature and other relevant parameters on the thermal profile of the fin. As a primary finding, the trihybrid nanofluid shows enhanced thermal responsiveness compared to mono and binary hybrid nanofluid. Additionally, the thermal dispersion increases with higher negative values of the fin taper ratio. These discoveries have significant implications for enhancing heat transfer in industrial applications.

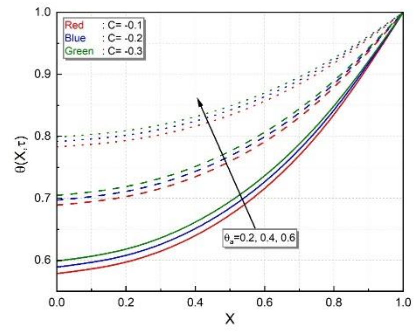
A fin is an extension or surface that juts out from an object and plays a vital role in transferring heat to or from the object to which it's attached. They are widely used in numerous devices, including radiators, heat exchangers, compressors, air coolers, and refrigerators. The design of fin structures is adaptable and often customized to fit the particular needs of an application. Typically, a fin's geometry might be longitudinal, radial or resemble a spine. The utilization of fins to improve heat transfer has attracted significant attention from researchers because of its long-lasting and broad application possibilities. Various types of fin problems and their applications have been methodically gathered and recorded by Kraus et al. [1], providing an essential reference in this specialized field.

In the realm of heat transfer, porous materials have gained significant attention for their potential in enhancing efficiency. Kiwan [2] explored the effects of porous materials on fin efficiency, while Khan and Aziz [3] analyzed the benefits of functionally graded materials for heat transmission. Recent advancements have also delved into the transient heat transfer dynamics, with Darvishi et al. [4] and Aziz and Bouaziz [5] contributing key findings on temperature-dependent thermal conductivity and heat generation. Nanofluids, particularly trihybrid compositions, have emerged as promising cooling agents, as demonstrated by Adnan [44]. Despite extensive research, the unexplored domain lies in the intersection of unsteady dovetail fins and trihybrid nanofluids. The present study bridges this gap, investigating the thermal behavior of a dovetail fin immersed in a specific trihybrid nanofluid, leveraging the Finite Difference Method (FDM) for in-depth analysis.

Table 1: $\theta(X)$ values when $Nc = 0, Nr = 0, M^2 = 1, C = 0, Q = 0, \epsilon_g = 0, \tau = 90^0, t = 5, \theta_a = 0, \psi = 0, p = 0$

X	**G. Domairry**			**Error**	
	HAM	ADM	Present work	Error of HAM	Error of ADM
0	0.648047	0.648055	0.648054	7E-6	1E-6
0.2	0.661073	0.661059	0.661058	1.5E-5	1E-6
0.4	0.700664	0.700594	0.700593	7.1E-5	1E-6
0.6	0.768378	0.768246	0.768245	1.33E-4	1E-6
0.8	0.866873	0.866731	0.866730	1.43E-4	1E-6
1	1	1	1	0000000	00000





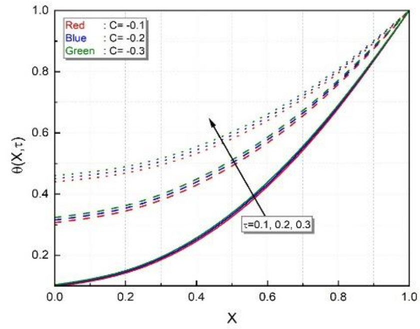
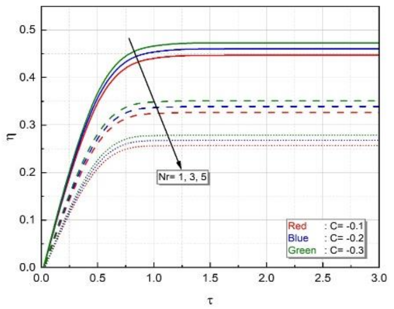
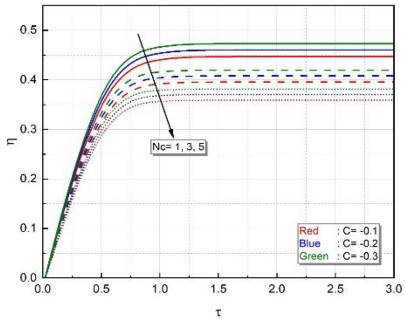


Figure 1: Variation of $\theta(X)$ for diverse Nc.

Figure 2: Variation of $\theta(X)$ for diverse θ_a.

Figure 3: Variation of $\theta(X)$ for diverse τ.





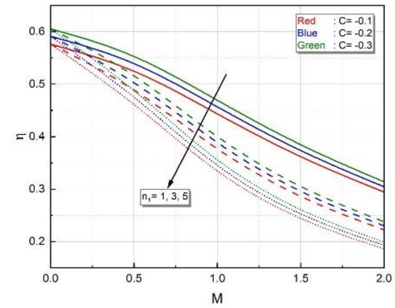


Figure 4: Efficiency η for diverse Nr

Figure 5: Efficiency η for diverse Nc.

Figure 6: Efficiency η for diverse M and n_1

2. RESULTS & HIGHLIGHTS OF IMPOINTANT POINTS

The study embarked on a numerical analysis of the transient thermal performance of a porous dovetail fin under a fully wet condition, immersed in a trihybrid nanofluid MWCNT,Ag,Cu-(C_2 H_6 O_2-H_2 O). This intricate examination also delved into the nuances of internal heat generation and its interplay with convective heat transfer, especially when the fin is subjected to radiative heat dissipation. Key insights from this research highlight the profound influence of convective parameters on the fin's heat transfer rate. It was observed that as the ambient temperature rises, the unsteady thermal profile of the fin also escalates. This elevation in the thermal profile, however, leads to a notable reduction in the heat transfer rate. As dimensionless time progresses, a distinct increase in the fin's thermal profile is evident, which eventually culminates in a steady state. This stabilization in the thermal landscape of the fin becomes particularly pronounced over extended periods. Furthermore, both convective and radiative parameters emerge as critical determinants affecting the fin's efficiency. Intriguingly, efficiency sees an upward trajectory with the progression in dimensionless time, ultimately plateauing as the system reaches its steady state. This stabilization underscores the fin's adaptability and resilience in varying thermal environments.

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