

Review on Thermal Performance Enhancement Using Inserts and Nanofluids in Spiral and Helical Coil Geometries

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Abstract –It was difficult to keep the engine cylinders from producing too much heat during the vehicle's development.

Engine failure from melting and damage is avoided by a cooling system. An automobile's performance is greatly impacted by its cooling system. Atomic number 13-based radiators are currently used by all automakers. The high engine power requirements are not met by the quality radiator, which only partially reduces the temperature. The purpose of this work is to use different nanofluids to examine the convective heat transfer constant of car radiators. Automobile radiators frequently utilize a mixture of ethylene glycol and water as engine fluid. Because f-MWCNT nanofluid had better thermal characteristics than DI water, it performed better despite having lower heat transfer rates. When it came to heat transport, nanofluid performed up to 40% better than DI.

Key Words: Nano fluids, Anyis, Radiator, Heat Exchange

1. INTRODUCTION

The cooling system and other associated systems in an automobile depend on the radiator's thermal performance. In terms of operations, pure mathematics, and aggregating value, this half has been neglected for many years. Numerous studies are carried out on extra parts including an oblong blade, plate, spherical tube, tier tube, elliptic tube, and spine balance in order to increase a radiator's effectiveness. Commercial cars frequently employ spine fin radiators.

Spine fin radiators transmit heat quickly, however because of its ambiguous fluid section, they may cause friction problems. Two geometric components make up the spine balancing radiator: complex stream sections for enhanced heat exchange and a notable scale difference between the radiator and balance component.

Since it affects cooling rates, improved heat transfer is essential for car performance.

Heat transfer rates could be increased by new developments and pushed liquids. The latter choice is the subject of the gift essay.

To achieve the required heat transfer, large and efficient heat transfer systems are needed for liquids with poor

heat transmission, such as ethanediol, water, motor oil, and refrigerants. Chemicals are occasionally added to fluids in an attempt to improve heat transmission. Nanofluids, a novel type of liquid, are the result of technological developments. Heat conduction between solids and fluids occurs in these liquids, which are fluid suspensions containing particles smaller than 100 nm. Floating alumina or non-metallic nanoparticles in heat transfer fluids produce nanofluids.

Compared to liquids that are frequently used for heat exchange and include micrometer-sized particles, nanofluids have better thermal properties. An investigation of the convective turbulent heat transfer characteristics of nanofluids (Al₂O₃-water) with 1-3 vol.% was carried out by Pak Associate in Nursing Cho. As volume fixation and Reynolds variety grow, so does the Nussle variety of nanofluids. Nan fluids, which suspend nanoparticles smaller than 100 nm in heat transfer liquids such water, oil, diesel, and ethanediol, were created by Veeranna Sridhara and Lakshmi Narayan Satapathy. Nanometer-sized solid particles, whether metallic or non-metallic, are suspended to develop novel heat transfer liquids.

Nanofluids based on corundum (Al₂O₃) show enhanced heat transfer, thickness, and conductivity. Thermal conductivity was increased for two to twelve months when Al₂O₃ nanoparticles with sizes ranging from 13 to 302 nm were introduced to create nanofluids. Because of their remarkable thermal characteristics, nano fluids are increasingly being used as heat transfer fluids in car cooling. According to recent assessments, nanofluids are better at transmitting heat.

This study uses a combination of water-based Al₂O₃ nanofluids as coolants to investigate the heat transmission characteristics of a spline fin car radiator. A comparison is made between the thermal performance of a vehicle radiator that uses traditional coolants and one that uses nanofluids.

The study looked at how thermal performance is impacted by the volume fraction of Al₂O₃ nanoparticles in base fluids and radiator size reduction.

2. Literature Review

[1].The effectiveness of thermal radiators as a heat source in dryer simulation design was investigated experimentally and numerically by Wiryanta and Adiaksa. The purpose of this study was to evaluate the

temperature performance of tube and fin car radiators using both computational and experimental techniques. A reservoir water tank, heater, pump for hot water circulation to radiators, and cooling fan were all part of the simulation design employed in the experiment. ANSYS Workbench was used to develop the geometry and mesh, and Fluent was used for post-processing. The results of the simulation agreed with the findings of the experiment. Based on experimental and computational analytical data, this research proposes methods to enhance radiator performance. Optimizing the cooling fan speed and hot water flow rate from the reservoir to the radiators is the first stage in optimizing the system design.

[2]. Results of "Heat Transfer Analysis in Light Passenger Car Radiators with Various Geometrical Configurations" by P. Natarajan The study's main objective is to develop and analyze single-phase convective heat transfer. This study investigates the effects of various geometric configurations on staggered fin and tube radiator performance.

Fins-tubes are used to demonstrate the heat-transmission technique, but it can also be applied to other geometrical arrangements. This study investigates the effects of various radiator tube geometrical designs on their performance. The investigation discovered that whereas oval tubes I and II had lower values, circular and oval tubes III had outlet temperatures and maximum velocities comparable to those of other oval tubes. Compared to a circular tube, oval tube-III has greater pressure.

[3]. Chidambara Kuttalam Kailasanathan and Sudalai Suresh Pungaiah carried out "Thermal Analysis and Optimization of Nano Coated Radiator Tubes Using Computational Fluid Dynamics and the Taguchi Method."

Three different coolant flow rates, coating thicknesses, and top surface coatings on radiator tubes were evaluated in this investigation. To condition the heat input for CFD, thermal analysis is carried out at three different temperatures.

CFD analysis with the Taguchi technique provide a simple and efficient method for process parameter optimization. The findings of the ANOVA were validated for the most significant item and showed 95% confidence. The radiators' aluminum core's copper nano-coating increases the efficiency of heat transfer. Heat is transferred by copper particles deposited on aluminum tubes in the heater core.

Copper-coated aluminum tube radiators can be used in place of standard aluminum radiators to cool the high-power engine for best performance while reducing the front portion of the vehicle. While the outside layer of copper coating is lighter than actual copper alloy radiators and free of rust, the inner layer of aluminum retains its usual properties.

[4]. C. Uma Maheswari, C. Suresh Reddy, C. Rajeshwara Reddy, A.T. Kiran Sai Naidu, C. Saradhi, and A. Chenna Kesavulu carried out "CFD ANALYSIS OF RADIATORS." The thermal and CFD analysis of car radiators is covered in this work. In MAT Lab, theoretical computations with different coolant mass flow rates were carried out.

For tube materials like copper, aluminum, and stainless steel, temperature distribution and heat transfer rates for different coolant velocities have been investigated. Copper was shown to have the highest heat transmission rate and efficiency after numerical results were compared.

They discovered that higher output temperatures result from raising the coolant mass flow rate. While aluminum performs better than stainless steel, copper produces the best results. Because copper resists corrosion, it is a perfect material for tubes.

Research Gap: They discussed stainless steel, copper, and aluminum radiator tubes. The radiator fins were left out of the CFD calculations.

5]. Dr. M.V.A. Raju and Sai Kiran.S. carried out "Modelling and Analysis of Louvred Fin Radiators with Nan fluids Using CFD."

This study performs CFD analysis on radiators without louvered fins at different mass flow rates using the ANSYS computational analysis tool. Radiators with and without louvered fins will be the subject of a CFD study. CFD is used for modeling and analysis.

Experimental results are in good agreement with computational results. A successful fluid flow and heat transfer study of car radiators (louvre fin) employing nanofluid was carried out to improve heat transmission.

This examination looks at variations in coolant and airflow directions in terms of pressure, temperature, and velocity. Higher cooling capacity results from increasing the mass flow rate of coolant and air. Cooling capacity grows with the temperature of the inlet coolant but falls with the temperature of the input air.

[6]. Abhishek Kumar and Kola David carried out "CFD and Heat Transfer Analysis of Automobile Radiators Using Helical Tubes."

The behavior of nanofluids mixed with base fluid water in helical and straight tube radiators is investigated in this work. CREO parametric software is used to model the radiators in three dimensions.

While thermal analysis is done in Ansys, CFD analysis is done on radiators for all fluids.

The radiators in this project are treated with a variety of fluids. Using CFD analysis, the study discovered that raising the mass flow intake results in greater heat transfer coefficient values. Aluminum oxide nanofluid transfers heat more quickly than other fluids. Copper alloys generate more heat flux than aluminum alloys, according to thermal analysis.

3. MATERIAL AND METHOD

3.1 THERMOPHYSICAL PROPERTIES OF NANOFLUID

Water (H₂O) and Al₂O₃ nanofluid solid particles were used in a variety of applications, including basic liquid fluids and nanofluid solid particles. Different concentrations of them were mixed together. For radiator agents, arrange the nanofluid substance. Heat transmission is significantly higher in nanofluids than in regular fluids. A number of nanofluid properties were investigated and applied to simulations.

3.2 Model Characteristics

The ANSYS Fluid Flow Fluent software suite was used for CFD simulation in this study. A review of the literature on theories pertaining to nanofluid analysis was the first step in this investigation.

Additionally, the Autodesk Artificer 2020 software suite is used to finish the construction of fluid pure mathematics.

The current style of the AN is referred to as radiator style. Planning and meshing were done with ANSYS software, and then Fluid Flow Fluent was utilized for modeling. Radiator planning is shown in Figure 1.



Fig 3.1 Radiators full view

3.3 Boundary Conditions

In this work, a temperature of 130°C and an intake velocity of 0.4 m/s are assumed. A change in fluid flow can be seen by calculating the Reynolds number. The assumption for viscous flow is k-epsilon realizable when the Reynolds number is between 3000 and 4000.

4 METHODOLOGIES

- Use Solid Works to create a radiator geometry.
- To prepare the model for flow analysis, export it to ANSYS Workbench.
- Using the Tetra element and the Skewness value to mesh geometry
- < 1 Describe the state of the wall
- Mesh the model and export it to Fluent
- Assigning Solid and Fluid Domains
- Characterizing the characteristics of fluids and solids
- Solid and Fluid Boundary Conditions
- Execute the iteration
- Results should be exported to CFD Post-Postprocessor.
- The entrance, fin surface, pipe outer surface, and outflow are all affected by post-process temperature.
- The coating material will undergo the same procedure.
- Compare the outcomes with and without coating.

Software technique was used to advance the project. In this case, ANSYS CFD is used for analysis and Solid Works is used for modeling.

4.1 DESIGN AND ANALYSIS

To make the analysis more useful, the radiators of a car that is currently on the road are used. Reverse engineering was used to learn the specifics of the radiators' geometry. The Gambit model was created after the dimensions of each radiator component were measured using appropriate measuring tools. Discrediting the fluid domain, simulating fluid flow with steady-state heat transfer, post-processing the data, and coming to appropriate conclusions.

5. CONCLUSIONS

The efficiency of a nanofluid composed of a mixture of water and Al₂O₃ for radiator cooling was investigated using computational fluid dynamics models. This study investigates the effects of nanoparticle concentration on fluid temperature and heat transmission at the radiator output. Heat transfer to the environment is increased by raising the concentration of nanoparticles in the working fluid while keeping the inlet temperature and velocity constant. Consequently, the working fluid's temperature decreased along the radiator pipe.

This phenomena is partly explained by the greater heat conductivity of nanofluids compared to water. It was demonstrated that adding 1% Al₂O₃ to the nanofluid worked well.

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