Performance study and analysis of Al_2O_3 Nanofluid under different flow conditions

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This article has been updated

Abstract

Efficient heat transfer is crucial in many industrial applications, yet traditional fluids often fall short in meeting the increasing thermal management demands. This study aims to address this problem by investigating the performance of Al_2O_3 nanofluids under various flow conditions to enhance heat transfer rates. The purpose of this research is to analyze how different concentrations of Al_2O_3 nanoparticles and varying Reynolds

numbers affect the thermal performance of the nanofluids. To achieve this, a series of experiments were conducted using a convective heat transfer setup. Al_2O_3 nanoparticles were dispersed in a base fluid at concentrations ranging from 0.1% to 1.0% by volume. The experiments were carried out under different flow conditions, characterized by Reynolds numbers varying from 1,000 to 10,000. The key performance indicators measured included heat flux, Nusselt number, and pressure drop. The results demonstrated a significant enhancement in heat transfer rates with the addition of Al_2O_3 nanoparticles. Specifically, an increase in nanoparticle concentration led to higher thermal conductivity and improved convective heat transfer. Additionally, higher Reynolds numbers resulted in greater turbulence, further augmenting the heat transfer performance. The optimal combination of nanoparticle concentration and Reynolds number yielded a substantial increase in the Nusselt number and heat flux compared to the base fluid. Heat conduction, which is the transfer of heat energy, is widely used in many home and industrial settings. It has been a crucial area of study since ancient times. This research studied the efficiency of Al_2O_3 nano fluid in facilitating effective heat transmission in several sectors, including pigmenting, dying, and evaporators. During the test phase, a fluid flow study was conducted under different flow conditions, both with and without the presence of a twisted tape insert. The investigation revealed that the heat flux for demineralized water rose from 1256 W/m^2 to 1358 W/m^2, while for nano fluid at a lower Reynolds number of 5000, it climbed from 3075 W/m^2 to 4737 W/m^2. Insert was seen with the increase in wall temperature. The inclusion of inserts in the test section resulted in a significant enhancement in the average heat transfer rate. Specifically, the heat transfer rate reached 1487 W for the nano fluid and 966 W for demineralized water at a Reynolds number of 25000. The overall heat transfer coefficient increased by 39.3% for demineralized water with inserts at a Reynolds number of 25000. Even at a lower Reynolds number of 50000, the use of demineralized water in conjunction with an insert resulted in a higher heat transfer coefficient.

Highlights

- It was investigated how Al_2O_3 affected the efficiency of heat transmission when a specifically made twisted tape insert was present.
- By lowering the creation of a static boundary layer in the center, the fluid flow direction was altered by the twisted tape inserts, raising the wall temperature.

- The Reynolds number was used to analyze the experimental data, including heat flow, average heat transfer, and total heat transfer coefficient.
- A presentation of the relationship between the Reynolds and Nusselt numbers was made.
- By altering the test fluid flow channel, the heat transfer rate might be increased by around 25% even without the use of the nano fluid.

Data availability

The data avaialble with me and ready to share if needed.

Change history

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Ethics declarations

Competing interests

The authors declare no competing interests.

Additional information

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The original online version of this article was revised: The author name ‘E. Balaji’ was incorrectly written as ‘E. Balaj’. The original article has been corrected.

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