FINAL PROJECT

THE EFFECT OF U-BENDS ON THE HEAT TRANSFER COEFFICIENT OF NANOFLUIDS

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ABSTRACT

Conventional coolants such as water are limited by low thermal conductivity, making it difficult to meet the cooling demands of increasingly compact, high-power thermal systems. Nanofluids offer a promising solution by enhancing heat transfer performance, but how this enhancement behaves when the fluid flows through a sharp curvature, instead of a straight path, is still not well understood. This study numerically investigates the effect of a 180° U-bend on the convective heat transfer coefficient of an Al_2O_3/water nanofluid (φ = 1.34%) using ANSYS Fluent, applying a two-phase Euler-Lagrange (Discrete Phase Model) approach with the SST k-ω turbulence model across Reynolds numbers ranging from 10,000 to 100,000. The heat transfer coefficient was extracted along four lines representing the outer, inner, and side walls of the bend, and the results were validated against an established empirical correlation, showing good agreement with a maximum deviation of less than 5%. The results show that heat transfer is distributed unevenly around the bend at every Reynolds number tested: the outer wall experiences a sharp, localized peak caused by centrifugal force pushing the flow directly against its surface, and this peak grows much faster than the general increase caused by Reynolds number alone. The inner wall consistently shows the lowest values, while the side walls show a more moderate and balanced increase. Nanoparticle concentration data further reveal that particles increasingly migrate toward the outer wall as Reynolds number rises, confirming that this heat transfer peak is caused by real particle movement, not simply by faster flow. Overall, these findings show that bend geometry determines where heat transfer enhancement occurs, while Reynolds number determines how strong that enhancement becomes providing useful guidance for designing more effective U-bend nanofluid heat exchangers.

Keywords: Nanofluids, Reynolds Number, U-bend, Heat Transfer Coefficient, CFD, Al_2O_3.