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Thermohydraulic Performance of TiO_2–H_2O and TiO_2–NH_3–H_2O Nanofluids for Internal Forced Convection Cooling

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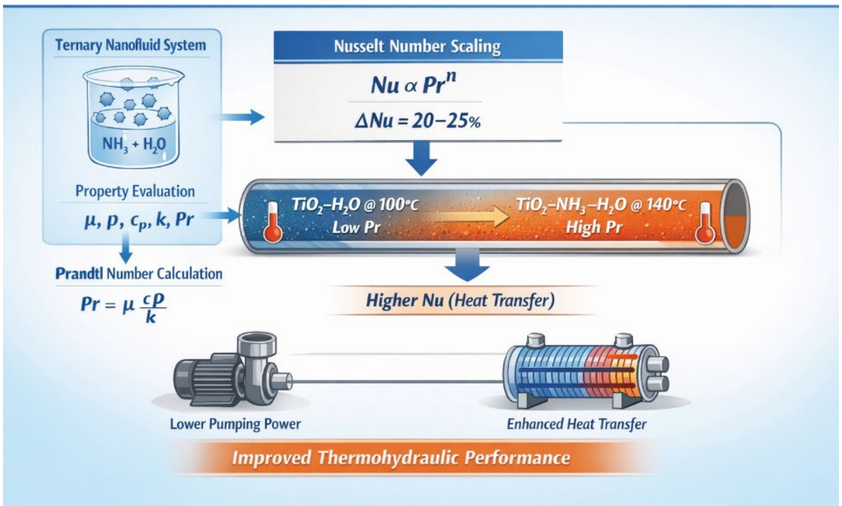
ABSTRACT

Nanofluids have been widely explored as advanced working fluids for enhancing convective heat transfer in internal cooling systems. Water-based nanofluids such as TiO_2–H_2O are extensively reported but are practically constrained to operating temperatures near 100 °C. Ammonia–water mixtures permit substantially higher operating temperatures and provide a basis for alternative nanofluid formulations. This study presents a comprehensive thermohydraulic comparison of TiO_2–H_2O and TiO_2–NH_3–H_2O nanofluids under internal forced-convection conditions. A structured property-evaluation framework is developed to determine effective thermophysical parameters of the ternary TiO_2–NH_3–H_2O system.



Prandtl-number trends are obtained from these data and used to isolate Nusselt-number enhancement at fixed Reynolds number using canonical turbulent correlations. The combined effects of heat transfer and pumping power are assessed, demonstrating that TiO_2–NH_3–H_2O nanofluids can provide superior thermohydraulic performance when higher operating temperatures are feasible. Across the operating conditions considered, TiO_2–NH_3–H_2O nanofluids exhibit a 20–25% increase in Nusselt number relative to TiO_2–H_2O at fixed Reynolds number.

KEY WORDS

Ternary nanofluid, Internal forced convection, Thermohydraulic optimization, Prandtl number, Property evaluation framework, Mixed base-fluid systems

BIOGRAPHY

Co-Presenter

Adjunct Professor Michael Akindeju is Chair of the Institution of Chemical Engineers (IChemE) Mining and Minerals Special Interest Group and a distinguished engineering leader whose expertise spans mineral processing, engineering biology, advanced process design, and innovation in complex industrial systems. He is Principal Consultant at MKPro Group, where he delivers high-impact solutions across biotechnology, energy, and manufacturing sectors, and Adjunct Professor at the Institute of Innovation, Science, and Sustainability, Federation University Australia.

A Fellow of both IChemE and the Royal Australian Chemical Institute (RACI), Chartered Engineer, and Registered Professional Engineer, Professor Akindeju is widely recognised for integrating scientific insight with practical engineering to drive sustainable, technology-enabled transformation. His work bridges industry and academia, with a strong commitment to strengthening sector capability, advancing research translation, and mentoring the next generation of engineers through his professional and educational contributions.

Co-Presenter

Dr. Apurv Kumar is a Senior Lecturer in Mechanical Engineering at Federation University Australia and an Adjunct Senior Research Fellow at Australian National University. His research focuses on solar thermal systems, thermochemical conversion of waste, and green hydrogen production, with expertise in high-temperature heat transfer and multiphase flow processes.

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