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Enhancing thermal conductivity of water/CeO₂-MWCNTs hybrid nanofluid: experimental insights and artificial neural network modeling

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Overview

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Abstract

Water/CeO₂-MWCNTs hybrid (NF) is a novel type of NF that has potential applications in heat transfer and thermal energy storage. However, the thermal conductivity (ThC) of this NF is not well understood. In this study, we aim to estimate the stability and investigate the ThC of water/CeO₂-MWCNTs hybrid NF experimentally. We prepared the NF by dispersing CeO₂-MWCNTs nanoparticles in deionized water using ultrasonication spanning 5–30 min. We measured the ThC of the NF at different temperatures and concentrations using a transient hot-wire method. Assessment of hybrid NF stability involved measurements of zeta potential and particle size distribution through dynamic light scattering (DLS). Meanwhile, ThC assessments were conducted across different solid volume fractions ($0.007 \leq \text{SVF} \leq 0.112\%$) and temperatures (20–50 °C). Results underscored the hybrid NF's impressive stability and notably enhanced ThC. Longer sonication times, particularly at 30 min, positively impacted both stability and ThC. SVF and temperature also exerted substantial effects, with the most significant enhancement occurring at 0.112% SVF and 50 °C. To forecast the hybrid NF's ThC, a novel correlation and artificial neural network model were developed with a commendable level of accuracy (R-squared = 0.9918 and maximum deviation of 0.438%). We compared our results with similar hybrid NFs reported in the literature and discussed the possible mechanisms of ThC enhancement. Our study provides new insights into the thermal behavior of water/CeO₂-MWCNTs hybrid NF and its potential application in thermal engineering systems.

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