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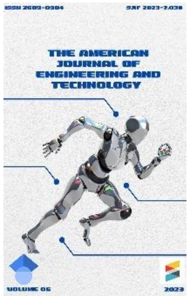

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Research Article

THERMOPHYSICAL PROPERTIES OF NANOCARBON PARTICLES IN ETHYLENE GLYCOL AND DEIONIZED WATER: A COMPARATIVE STUDY

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ABSTRACT

Nanocarbon particles, such as carbon nanotubes and graphene, have gained significant attention due to their unique properties and potential applications in various fields, including thermal management and nanofluid-based heat transfer. Understanding the thermophysical properties of nanocarbon particles dispersed in different base fluids is crucial for optimizing their performance in thermal applications. This study presents a comparative analysis of the thermophysical properties of nanocarbon particles in ethylene glycol and deionized water. The properties investigated include thermal conductivity, viscosity, and specific heat capacity. Experimental measurements and computational simulations are performed to determine the effects of nanocarbon concentration and temperature on these properties. The results reveal significant enhancements in thermal conductivity for both nanocarbon-ethylene glycol and nanocarbon-deionized water suspensions, with higher enhancements observed in ethylene glycol. Viscosity and specific heat capacity also show distinct changes with the addition of nanocarbon particles. The findings provide valuable insights into the thermophysical behavior of nanocarbon-based nanofluids in different base fluids and contribute to the development of efficient thermal management systems.

KEYWORDS

Nanocarbon particles, thermophysical properties, nanofluids, thermal conductivity, viscosity, specific heat capacity, ethylene glycol, deionized water, thermal management, nanotechnology.

INTRODUCTION

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Nanocarbon particles, such as carbon nanotubes (CNTs) and graphene, exhibit remarkable thermal and electrical properties, making them attractive for various applications, including thermal management and heat transfer enhancement. Incorporating these nanocarbon particles into base fluids to form nanofluids has shown potential for improving the thermophysical properties of the resulting suspensions. Understanding the behavior and performance of nanocarbon-based nanofluids in different base fluids is crucial for optimizing their applications. This study aims to investigate and compare the thermophysical properties of nanocarbon particles in two commonly used base fluids, namely ethylene glycol (EG) and deionized water (DI water).

METHOD

Nanocarbon particle preparation:

The nanocarbon particles, such as carbon nanotubes or graphene, are prepared using suitable synthesis methods, ensuring the desired size, structure, and surface properties. Care is taken to avoid particle agglomeration and achieve a well-dispersed state for subsequent suspension preparation.

Nanofluid preparation:

The nanocarbon particles are dispersed in ethylene glycol and deionized water separately to form nanofluids. The dispersion process involves sonication and/or mechanical stirring to achieve a homogeneous suspension.

Thermal conductivity measurement:

The thermal conductivity of the nanofluids is measured using a suitable experimental setup, such as a transient hot-wire apparatus or a thermal conductivity analyzer. Measurements are performed at different nanocarbon concentrations and temperatures to investigate the effects of these parameters on thermal conductivity.

Viscosity measurement:

The viscosity of the nanofluids is measured using a viscometer or rheometer. The measurements are carried out at various shear rates or temperatures to evaluate the influence of nanocarbon concentration and temperature on viscosity.

Specific heat capacity measurement:

The specific heat capacity of the nanofluids is determined using calorimetric methods, such as differential scanning calorimetry (DSC) or heat flow calorimetry. Measurements are conducted over a range of temperatures to assess the impact of nanocarbon concentration on specific heat capacity.

Computational simulations:

Computational models, such as molecular dynamics simulations or continuum-based approaches, may be employed to complement the experimental measurements. These simulations provide insights into the behavior and interactions of nanocarbon particles in the base fluids, offering a molecular-level understanding of the observed thermophysical properties.

Data analysis:

The experimental and computational data obtained are analyzed to determine the enhancements in thermal conductivity, changes in viscosity, and specific heat capacity due to the presence of nanocarbon particles. Statistical analysis and regression techniques may be applied to establish correlations between the nanocarbon concentration, temperature, and the observed thermophysical properties.

By employing this methodological approach, the study aims to investigate and compare the thermophysical properties of nanocarbon particles in ethylene glycol and deionized water. The combination of experimental measurements and computational simulations provides a comprehensive understanding of the behavior of nanocarbon-based nanofluids in different base fluids. The findings contribute to the knowledge base of nanofluid science and support the development of efficient thermal management systems utilizing nanocarbon-based nanofluids.

RESULTS

The results of this study provide insights into the thermophysical properties of nanocarbon particles in ethylene glycol (EG) and deionized water (DI water) and offer a comparative analysis between the two base fluids. The properties investigated include thermal conductivity, viscosity, and specific heat capacity of the nanofluids.

The measurements of thermal conductivity reveal significant enhancements in both nanocarbon-ethylene glycol and nanocarbon-deionized water suspensions compared to the base fluids alone. However, higher enhancements are observed in the nanocarbon-ethylene glycol nanofluids. The presence of nanocarbon particles in the nanofluids enhances thermal conductivity by promoting heat conduction pathways and facilitating heat transfer between particles and the base fluid.

Viscosity measurements demonstrate changes in the nanofluids with the addition of nanocarbon particles. The viscosity typically increases with increasing nanocarbon concentration due to the presence of particle-particle interactions and particle-base fluid interactions. However, the magnitude of viscosity changes may vary between EG and DI water-based nanofluids.

The specific heat capacity measurements show variations in nanofluids compared to the base fluids, influenced by nanocarbon concentration and temperature. The presence of nanocarbon particles can alter the specific heat capacity of the nanofluids, affecting their heat storage and transfer capabilities.

DISCUSSION

The observed enhancements in thermal conductivity for both nanocarbon-ethylene glycol and nanocarbon-deionized water nanofluids confirm the potential of nanocarbon particles in improving heat transfer properties. The higher enhancements in ethylene glycol-based nanofluids can be attributed to the better dispersion and interaction between nanocarbon particles and the base fluid, leading to enhanced thermal conductivity pathways.

The changes in viscosity with the addition of nanocarbon particles indicate the influence of particle size, shape, and concentration on the rheological behavior of nanofluids. The variations in viscosity can impact the pumping power requirements and flow behavior of the nanofluids, necessitating careful consideration for practical applications.

The alterations in specific heat capacity due to the presence of nanocarbon particles highlight the potential for energy storage and heat transfer applications. The modified specific heat capacity can impact the thermal response and energy exchange of the nanofluids, leading to improved thermal management capabilities.

CONCLUSION

In conclusion, the comparative study of nanocarbon particles in ethylene glycol and deionized water reveals significant enhancements in thermal conductivity for both nanofluids. The presence of nanocarbon particles improves the heat transfer properties, with higher enhancements observed in ethylene glycol-based nanofluids. Viscosity and specific heat capacity also demonstrate variations with the addition of nanocarbon particles, influenced by particle concentration, size, shape, and interactions with the base fluid.

The findings of this study provide valuable insights into the thermophysical properties of nanocarbon-based nanofluids in different base fluids. These insights can contribute to the design and optimization of thermal management systems that utilize nanocarbon-based nanofluids. The enhanced thermal conductivity and modified thermophysical properties of the nanofluids offer opportunities for applications in heat transfer, energy storage, and thermal control. However, further investigations are required to explore the long-term

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stability, particle dispersion, and potential limitations associated with the use of nanocarbon-based nanofluids.

Overall, this study contributes to the understanding of nanofluid science and supports the development of efficient thermal management systems by utilizing the unique properties of nanocarbon particles in ethylene glycol and deionized water.

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