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Research Paper

Boron nitride (BN) nanofluids as cooling agent in thermal management system (TMS)

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HIGHLIGHTS

- The physical properties of BN nanofluids with and without surfactant is compared.
- Higher thermal performance of boron nanofluids containing no surfactant is shown.
- BN nanofluids containing no surfactants shows high stability.
- Surfactant less BN nanofluids shows high thermal conductivity.
- Surfactant less BN nanofluid can be used as a cooling agent.

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ABSTRACT

This study reports the synthesis of boron nitride (BN) nanofluids as a cooling agent which contains deionized water as a base fluid via two-step method. A comparative study for BN synthesis has been conducted with (cetrimonium bromide, sodium dodecyl sulfate and polysorbate 80) and without surfactant at room temperature (~25 ± 1 °C) to understand the stability of BN as cooling agent by maintaining 0.001–0.1 vol% concentration. Performance of BN in thermal management system is also studied by determining thermal conductivity, specific heat capacity, and its rheological properties. BN suspension without surfactant shows highest stability (zeta potential value, 30–40 mV) compared to the BN suspension prepared with surfactant. The rheological experiment shows that viscosity increases with increase in BN nanofluids concentration (vol%), due to increase in nanoparticles. The synthesized BN nanofluids without surfactant shows an increase in thermal conductivity by 16.08% at a higher concentration (0.10% v/v), whereas a decrease of 13.95% in Prandlt number is observed at room temperature at a lower concentration of 0.0037% (v/v), indicating excellent thermal properties of the synthesized BN nanofluids as a cooling agent.

1. Introduction

The process 'cooling' is one of the most vital challenges for many industries. An extensive amount of research and development have been reported on industrial heat transfer requirements. But the most important point is the advances in cooling proficiency which is still inadequate as the conventional cooling agents have poor heat transfer properties [1,2]. Cooling agents, like, water, engine oil, are one of the most important requirements in many industries but, inherently low thermal conductivity is a major limitation in developing energy proficient heat transfer fluids. By increasing thermal conductivity of a heat transferring fluid, heat transfer in thermal management systems can be enhanced, capital costs can be minimized. Even, energy conversion and efficiencies can also be improved. Nanofillers and nanofluids, are a new class of heat transfer fluids, which are synthesized by suspending ultrafine (nanometer range) metallic or non-metallic particles in traditional cooling fluids, have revealed great improvement in thermal conductivity, viscosity, thermal diffusivity, and convective heat transfer coefficients [3].

This section mainly covers the literature review for synthesis of BN nanofluids and their thermal properties. In recent past years, nanofluids have attracted more and more attention as a cooling agent but some significant issues have been found for a two-phase system like the stability of nanofluids and the functionality of the surfactants under high temperature.

The use of surfactants, such as, CTAB, SDS and Tween 80 for enhancing the stability of nanoparticles in fluids have already been discussed [4,5]. Two-step method is the most economical

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