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EXPLORING THE OPTICAL AND ELECTRICAL CHARACTERISTICS OF MgO/SiC-H_2O NANOFLUIDS FOR THERMAL ENERGY STORAGE[†]

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Heat is transferred to the storage medium during the charging phase of thermal energy storage (TES), and then released during the discharging phase. It may be used for industrial operations like metallurgical transformations or solar power facilities. Heat is stored in materials that alter temperature, phase, or chemical composition in sensible, latent, and thermochemical media, respectively. Optimal heat storage has a long history. This study investigates the optical and electrical properties of MgO/SiC-H_2O nanofluids for applications including thermal energy storage. Results indicate that when MgO/SiC NP concentrations were raised to 1.2 gm/L, absorbance rose by approximately 66.9% and transmittance by about 54%. Additionally, the increase in MgO/SiC NP concentration will raise absorbance, which indicates improved nanofluid dispersion. Additionally, when MgO/SiC nanoparticle concentrations approach 1.2 gm/L, the electrical conductivity of nanofluids increases by roughly 49.2%, and the melting time reduces as the concentration of MgO/SiC nanoparticles rises.
Keywords: *Optical characteristics; electrical characteristics; nanofluid; energy storage*
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1. INTRODUCTION

The enhanced thermal conductivity for a nanofluid containing copper in pump oil caused initial interest in nanofluids as potential heat transfer fluids to spike, but this interest was later dashed after numerous research groups tested a variety of available combinations of fluids and nanoparticles, primarily at room temperature. The bulk of the tests were done on water-based fluids, which are among nature's finest at heat transmission because they have a good balance of high thermal conductivity and low viscosity. The narrow temperature range of operation, high vapor pressure, and strong corrosiveness of water are some drawbacks [1–5]. By processing and creating materials with average crystallite sizes below 100 nm, or nanomaterials, nanotechnology opens up a new field of study. Quantum dots, carbon nanotubes, nanocomposites, and nanocrystalline materials are only a few examples of the variety of substances that fall under the umbrella term "nanomaterials" [6]. Chemical heat, latent heat, and sensible heat are the three components that make up the thermal energy storage. Storage of thermal energy at the temperature of the solid-to-liquid phase transition is the foundation of latent heat storage systems. This ability's essential function is to choose an exact (PCM) for a precise application based primarily on the temperature of that material's melting range (change of phase) (PCM). Because of the right characteristics of paraffin, such as stability, noncorrosiveness, and nontoxicity, it may be regarded as a great alternative for PCM use. The low heat conductivity of paraffin is a drawback to utilizing it as PCM. According to definitions given by experts [7-12], thermal energy storage is the temporary storing of thermal energy at any temperature (i.e., both low and high).

New kind of nanocomposites created by Hazim et al. [13] might be regarded promising materials for a variety of electrical and optical applications, including solar cells, sensors, electronics gates, transistors, lenses, lasers, etc. Different quantities of polymethylmethacrylate (PMMA), aluminum oxide (Al_2O_3) nanoparticles, and silver (Ag) nanoparticles were used to create the nanocomposites. An outline of the development of the usage of nanofluids in several applications was provided by Tawfik [14]. In accordance with this contribution, further research on the fundamentals and applications of nanofluids is urgently needed in order to comprehend the physical processes involved in employing nanofluids and to investigate many facets of their uses. Rasheed et al [15] thorough comparison of hybrid nanofluids and traditional forms of nanofluids provided a thorough grasp of the benefits of the latter. According to the findings that have been made public, hybrid nanofluids with improved thermal characteristics hold out hope for improved solar thermal PV/T system performance.

Verma and others [16] presented a clear and succinct review that concentrated on the mechanism and function of the optical characteristics of nanomaterials in enhancing absorptance or extinction coefficients from the solar spectrum. Polyvinyl alcohol (PVA), polyethylene oxide (PEO), and copper oxide (CuO) nanocomposites were created by Hashim et al. [17] and their structural and optical characteristics for use as humidity sensors were explored. Several studies on nanocomposites of SiC doped organic material to utilize in many applications such as biomedical, electronics and sensors [18-27]. In this research, MgO/SiC-H_2O nanofluids are prepared, and their optical and electrical characteristics are studied for applications in thermal energy storage.

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2. MATERIALS AND METHODS

Silicon carbide and magnesium oxide nanoparticles (MgO NPs) were the materials employed in this study (SiC NPs). The nanofluids were made using MgO/SiC NPs at varied concentrations of 0.3 gm/L, 0.6 gm/L, 0.9 gm/L, and 1.2 gm/L. Researchers looked at the optical and electrical characteristics of MgO/SiC-H_2O nanofluids. Shimadzu's UV-18000A double beam spectrophotometer is used to test the optical characteristics of MgO/SiC-H_2O nanofluids from 200 to 1000 nm. Analyzing the MgO/SiC-H_2O nanofluids' melting properties throughout the heating process is part of the thermal energy storage. The MgO/SiC-H_2O nanofluids, whose temperature can be adjusted from 40°C to 100°C with a stirrer, were utilized as the heat transfer fluid. A digital device was used to monitor the temperature of the nanofluids while they were being heated.

3. RESULTS AND DISCUSSION

Figures 1 and 2 show, at various concentrations of MgO/SiC NPs, the absorbance and transmittance spectra of MgO/SiC-H_2O nanofluids with photon wavelength. By increasing the concentration of MgO/SiC NPs to 1.2gm/L, these figures showed that the absorbance rose by approximately 66.9% and the transmittance reduced by around 54%. The MgO/SiC-H_2O nanofluids have a greater absorption at UV spectrum, making them potentially useful in a variety of renewable energy areas, including solar collectors, energy storage, and heating and cooling systems. Increased absorbance, which corresponds to enhanced nanofluid dispersion, will be caused by an increase in MgO/SiC NP concentration [28].

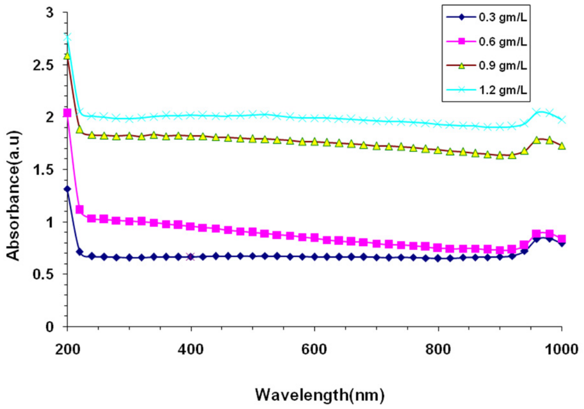

Figure 1. Absorbance spectra of MgO/SiC-H_2O nanofluids with photon wavelength for different concentrations of MgO/SiC NPs.

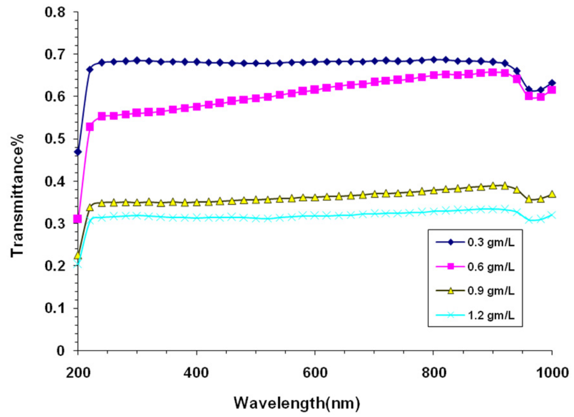

Figure 2. Transmittance spectra of MgO/SiC-H_2O nanofluids with photon wavelength for different concentrations of MgO/SiC NPs

The association between MgO/SiC NP concentrations and electrical conductivity of MgO/SiC-H_2O nanofluids is shown in Fig. 3. Due to an increase in the quantity of charge carriers[29,30], the electrical conductivity of nanofluids increases by roughly 49.2% when the concentration of MgO/SiC NPs reaches 1.2 gm/L.

The melting curves of the MgO/SiC-H_2O nanofluids are shown in Fig. 4. As the quantities of MgO/SiC nanoparticles increase, the melting time reduces. Due to improved thermal conductivity, MgO/SiC-H_2O nanofluids may melt more quickly in energy storage applications, increasing heat transmission [31–39]. When the concentration of MgO/SiC NPs increases from 0.3 gm/L to 1.2 gm/L within 15 min, the gain in melting time reaches 45%. As a result of this behavior, MgO/SiC-H_2O nanofluids may be thought of as a key for heating and cooling systems.

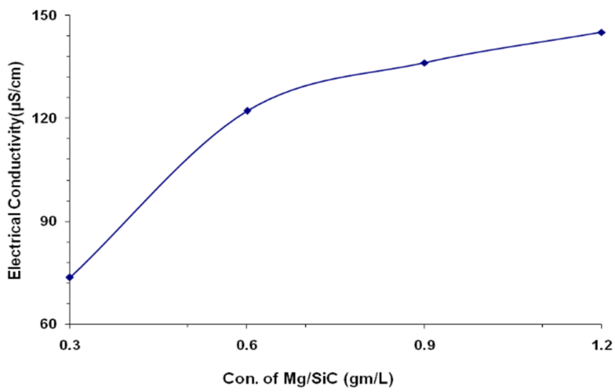

Figure 3. Behavior of electrical conductivity of MgO/SiC-H_2O nanofluids with concentrations of MgO/SiC NPs.

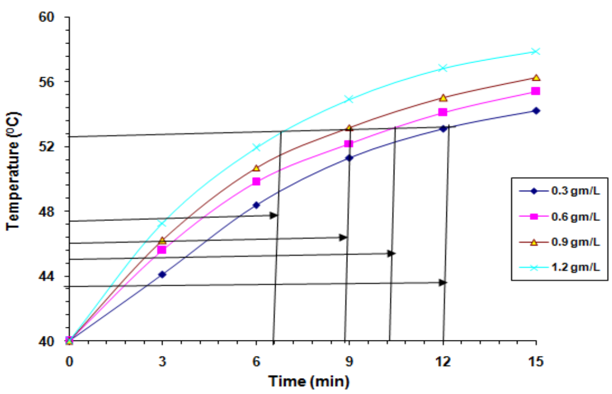

Figure 4. Melting curves of MgO/SiC-H_2O nanofluids

4. CONCLUSION

This study examines the optical and electrical properties of MgO/SiC-H_2O nanofluids for applications in thermal energy storage. This research allows us to reach the following conclusions:

1. When the concentration of MgO/SiC NPs was raised to 1.2 gm/L, the absorbance rose by approximately 66.9% and the transmittance by about 54%.
2. As the MgO/SiC NP concentration increases, the absorbance rises, indicating improved nanofluid dispersion.
3. When the concentration of MgO/SiC NPs increased to 1.2 gm/L, the electrical conductivity of nanofluids increased by roughly 49.2%.
4. As the concentration of MgO/SiC nanoparticles increases, the melting time reduces.
5. When the concentration of MgO/SiC NPs increases from 0.3 gm/L to 1.2 gm/L after 15 minutes, the gain in melting time reaches 45%.

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ДОСЛІДЖЕННЯ ОПТИЧНИХ ТА ЕЛЕКТРИЧНИХ ХАРАКТЕРИСТИК НАНОРІДИНИ MgO/SiC-H_2O ДЛЯ ЗБЕРІГАННЯ ТЕПЛОВОЇ ЕНЕРГІЇ

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Тепло передається накопичувальному середовищу під час фази зарядки накопичувача теплової енергії (TES), а потім виділяється під час фази розрядки. Його можна використовувати для промислових операцій, таких як металургійні перетворення або сонячні електростанції. Тепло зберігається в матеріалах, які змінюють температуру, фазу або хімічний склад відповідно у чутливому, латентному та термохімічному середовищах. Оптимальне зберігання тепла має довгу історію. У цьому дослідженні описано дослідження оптичних і електричних властивостей нанофлюїдів MgO/SiC-H_2O для застосувань, включаючи зберігання теплової енергії. Результати показують, що коли концентрації MgO/SiC NP були підвищені до 1,2 г/л, абсорбція зросла приблизно на 66,9 %, а пропускна здатність приблизно на 54 %. Крім того, збільшення концентрації наночастинок MgO/SiC збільшить поглинання, що вказує на покращену дисперсію нанофлюїдів. Також, коли концентрації наночастинок MgO/SiC наближаються до 1,2 г/л, електропровідність нанофлюїдів збільшується приблизно на 49,2 %, а час плавлення скорочується зі збільшенням концентрації наночастинок MgO/SiC.

Ключові слова: *оптичні характеристики; електричні характеристики; нанорідина; накопичення енергії*