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NANOFLUIDS OF PEG/MgO/SiC-H_2O AS EXCELLENT HEAT TRANSFER MEDIUM: SYNTHESIS, PROPERTIES AND APPLICATION†

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Today, one of the most significant and widely used engineering fields is heat transfer science. Saving energy and increasing efficiency are crucial given the need for energy management. Numerous sectors, including the cooling of machinery in power plants, the car industry, electronic equipment, and heat exchangers, heavily rely on fluid heat transfer. Improved design and functionality of thermal systems are made possible by increased heat transfer rate by fluids. This study presents the production, characteristics, and potential uses of PEG/MgO/SiC-H_2O nanofluids as superior heat transfer media. Results indicate that when the quantity of MgO/SiC nanoparticles increased, the melting time reduced. Additionally, when the MgO/SiC NP concentration increased from 3 to 12 weight percent after 15 minutes, the reduction in melting time reached 65.5%. Additionally, when the concentration of MgO/SiC NPs was increased from 3 weight percent to 12 weight percent at photon wavelength (λ=400 nm), the electrical conductivity of PEG/MgO/SiC-H_2O nanofluids increased by about 30.6%. At the same time, the absorbance increased by about 66.4% and the transmittance decreased by 58.8%.
Keywords: *Heat transfer; applications; nanofluids; saving energy; energy management*
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1. INTRODUCTION

Nanofluids have a lot of promise in a variety of disciplines, including solar applications where they can boost solar water heaters' heat-transfer coefficients or increase the capacity of thermal energy storage systems, and refrigeration where they can boost refrigeration systems' efficiency. Nanofluids have a lot of promise, but they aren't often used as refrigerants or heat-transfer fluids (HTFs). However, during the last ten years, the application of nanofluids in solar heat collectors has gained popularity [1-7]. One of the biggest obstacles to efficient heating or cooling is creating ideal operating conditions. These systems' primary function is to accelerate the pace of heat or cold transmission via the use of cutting-edge working fluids. However, when the use of transfer fluids is taken into account, a number of important operating and maintenance requirements must be satisfied. The two categories of criteria known as physicochemical and thermal properties define heat transfer fluids (HTFs), which are extensively employed in several industrial and consumer applications. The most crucial physicochemical variables are kinematic viscosity, flash point, and pour point. The flow in the system is determined by viscosity, and to guarantee that temperature gradients between the heat carrier and the heat transfer surface are sufficiently minimal, a turbulent flow that has a Reynolds number exceeding 2100 in linear channels with circular cross sections must be present [8–14].

Current developments in the research of nanofluids, including manufacturing techniques, the mechanism of stability evaluation, stability enhancement procedures, thermophysical characteristics, and characterization of nanofluids, were described by Ouabouch et al. in their article [15]. Additionally, the variables affecting thermophysical characteristics were investigated. The evolution of the correlations utilized to forecast the thermophysical characteristics of the dispersion was reported by Ali et al. [16]. Additionally, it evaluates how these sophisticated working fluids affect nuclear reactor systems, air conditioning and refrigeration systems, and parabolic trough solar collectors. The existing scientific knowledge gap is then presented to establish future research trajectories. The poor thermal conductivity of the CuO/water nanofluid, which was caused by the spherical form of the CuO nanoparticles, was addressed by Nfawa et al. [17] by adding a tiny quantity of magnesium oxide (MgO) nanoparticles to the nanofluid. The thermal conductivity of a novel CuO-MgO/water hybrid nanofluid has been investigated at various volume concentrations (0.125-1.25%) of 80 % CuO and 20% MgO nanoparticles suspended in water at various ranges of temperatures from 25 to 50°C. The production, stability, and thermal conductivity of the MWCNTs-SiC/Water-EG hybrid nanofluid were examined by Kakavandi and Akbari [18]. The nanoparticles were characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM) techniques. DLS test was used to track nanofluid stability. The DLS data showed that nanoparticles were present in the nanofluid. SiC and its nanocomposites are important in fields of sensors, biomedical and electronics [19-29]. The synthesis, characteristics, and uses of PEG/MgO/SiC-H_2O nanofluids as superior heat transfer medium is discussed in this work.

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2. MATERIALS AND METHODS

The following materials were employed in this study: polyethylene glycol (PEG), magnesium oxide nanoparticles (MgO NPs), and silicon carbide nanoparticles (SiC NPs). In 50 ml of distilled water, 1 g of PEG was dissolved. The PEG/MgO/SiC-H_2O nanofluids were created using MgO/SiC NPs at concentrations of 3%, 6%, 9%, and 12%. PEG/MgO/SiC-H_2O nanofluids' optical and electrical properties were investigated. Using a double beam spectrophotometer (Shimadzu, UV-18000A) with a 200–1100 nm wavelength range, the optical characteristics of PEG/MgO/SiC-H_2O nanofluids were examined. The analysis of the PEG/MgO/SiC-H_2O nanofluids' melting properties throughout the heating process is part of the thermal energy storage. PEG/MgO/SiC-H_2O nanofluids, whose temperature can be adjusted from 35°C to 100°C with a stirrer, were utilized as the heat transfer fluid. A digital device was used to measure the temperature of the nanofluids as they heated.

3.RESULTS AND DISCUSSION

Figures 1 and 2 show, at different concentrations of MgO/SiC NPs, the behavior of the absorbance and transmittance spectra of PEG/MgO/SiC-H_2O nanofluids with photon wavelength. According to the figures, increasing the concentration of MgO/SiC NPs from 3 weight percent to 12 weight percent at photon wavelengths (λ=400nm) resulted in an increase in absorbance of approximately 66.4% and a decrease in transmittance of 58.8%. This behavior can be useful in solar collectors, heating and cooling systems. MgO/SiC NP concentration increases will result in higher absorbance, which indicates improved nanofluid dispersion [30].

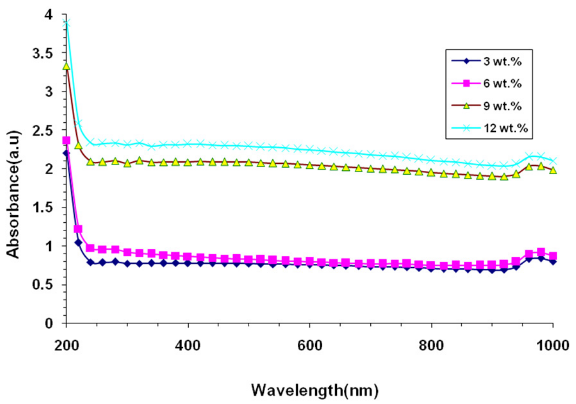

Figure 1. Behavior of absorbance spectra of PEG/MgO/SiC-H_2O nanofluids with photon wavelength for various concentrations of MgO/SiC NPs

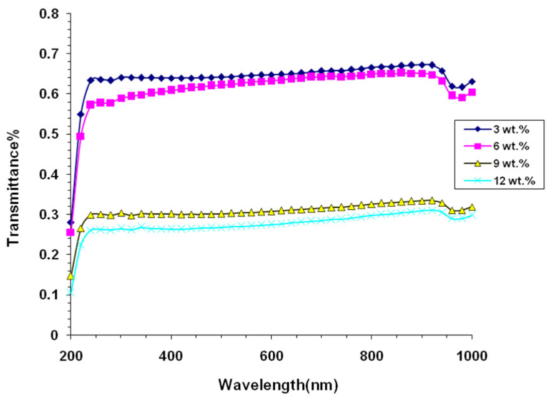

Figure 2. Behavior of transmittance spectra of PEG/MgO/SiC-H_2O nanofluids with photon wavelength for various concentrations of MgO/SiC NPs

The electrical conductivity (EC) of PEG/MgO/SiC-H_2O nanofluids varies with concentrations of MgO/SiC NPs, as shown in Fig. 3. When the concentration of MgO/SiC NPs rose to 12 weight percent, the electrical conductivity of PEG/MgO/SiC-H_2O nanofluids improved by roughly 30.6%. The rationale is that the electrical conductivity of the nanofluids depends significantly on the surface charges of nanoparticles [31].

The melting curves of PEG/MgO/SiC-H_2O nanofluids are shown in Fig. 4. As the concentration of MgO/SiC nanoparticles increased, the melting time decreased. PEG/MgO/SiC-H_2O nanofluids' decreased melting time for energy storage is connected to improved thermal conductivity, which increases heat transfer[32–39]. When the amount of MgO/SiC NPs increases from 3 weight percent to 12 weight percent within 15 minutes, the melting time is reduced by 65.5%, making the PEG/MgO/SiC-H_2O nanofluids beneficial in a variety of heating and cooling sectors.

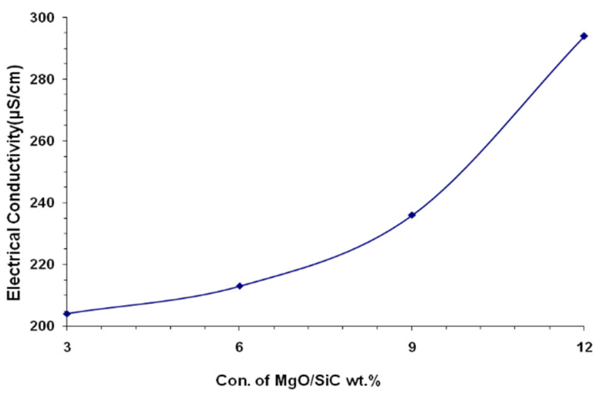

Figure 3. Variation of electrical conductivity (EC) of PEG/MgO/SiC-H_2O nanofluids with concentrations of MgO/SiC NPs

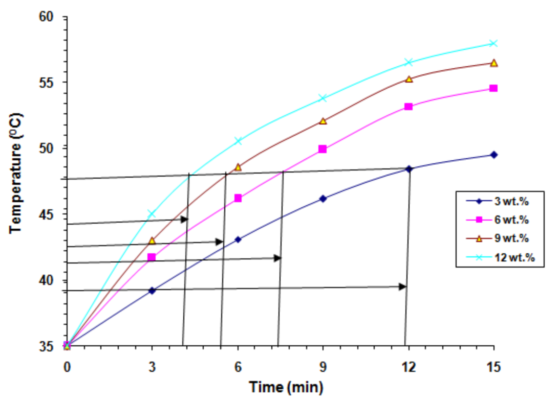

Figure 4. Melting curves of PEG/MgO/SiC-H_2O nanofluids

4.CONCLUSIONS

The category of HTFs that is now increasing and evolving the fastest is nanofluids. Their advantageous qualities include the variety of base fluids and integrated nanoparticles, which results in a composition that can be adjusted based on the need. From this research, the following findings might be made:

1. As the quantities of MgO/SiC nanoparticles increased, the melting time reduced.
2. When the MgO/SiC NP concentration increased from 3 weight percent to 12 weight percent after 15 minutes, the reduction in melting time reached 65.5%.
3. When the concentration of MgO/SiC NPs rose to 12 weight percent, the electrical conductivity of PEG/MgO/SiC-H_2O nanofluids improved by around 30.6%.
4. The concentration of MgO/SiC NPs was raised from 3 weight percent to 12 weight percent at photon wavelength (λ=400nm), resulting in an increase in absorbance of about 66.4% and a reduction in transmittance of 58.8%.

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НАНОРІДИНИ PEG/MgO/SiC-H_2O ЯК ЧУДОВЕ ТЕПЛОПЕРЕДАЮЧЕ СЕРЕДОВИЩЕ: СИНТЕЗ, ВЛАСТИВОСТІ ТА ЗАСТОСУВАННЯ

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Сьогодні однією з найбільш значущих і широко використовуваних галузей техніки є наука про теплообмін. З огляду на потребу в енергоменеджменті економія енергії та підвищення ефективності є надзвичайно важливими. Численні сектори, включаючи охолодження машин на електростанціях, автомобільну промисловість, електронне обладнання та теплообмінники, значною мірою покладаються на теплообмін рідиною. Покращений дизайн і функціональність теплових систем стали можливими завдяки підвищеній швидкості теплопередачі рідинами. У цьому дослідженні представлено виробництво, характеристики та потенційне використання нанофлюїдів PEG/MgO/SiC-H_2O як кращого теплообмінного середовища. Результати показують, що коли кількість наночастинок MgO/SiC збільшується, час плавлення зменшується. Крім того, коли концентрація MgO/SiC NP збільшилася з 3 до 12 масових відсотків через 15 хвилин, скорочення часу плавлення досягає 65,5%. Крім того, коли концентрація наночастинок MgO/SiC була збільшена з 3 вагових відсотків до 12 вагових відсотків на довжині хвилі λ=400 нм, електропровідність нанофлюїдів PEG/MgO/SiC H_2O зросла приблизно на 30,6 %. У той же час поглинання зросло приблизно на 66,4 %, а пропускна здатність зменшилася на 58,8 %.

Ключові слова: *теплообмін; застосування; нанофлюїди; енергозбереження; енергоменеджмент*