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Solar energy storage and release application of water - phase change material - (SnO_2-TaC) and (SnO_2–SiC) nanoparticles system

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ABSTRACT

The thermal energy storage and release application of water- phase change material - (SnO_2-TaC) and (SnO_2–SiC) nanoparticles system has been investigated for cooling and heating applications. The water - polyethylene glycolwith (SnO_2-TaC) and (SnO_2–SiC) nanoparticles have been used. The results showed that the melting and solidification times for storage and release of thermal energy of water - polyethylene glycoldecrease with increase in (SnO_2-TaC) and (SnO_2–SiC) nanoparticles concentrations. The melting and solidification times decrease with increasing of TaC nanoparticles concentrations to water-polyethylene glycol/SnO_2 nanofluid and SiC nanoparticles concentrations to water-polyethylene glycol/SnO_2 nanofluid.

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1. INTRODUCTION

The extensively used thermal energy storage materials are phase change materials (PCMs) because of their ability of storing and releasing considerable amounts of energy (thermal) during the processes of phase change melting and solidification. Because of environmental regards and ascent of fossil fuels cost, PCMs are attractive increasingly spirited for many applications such as, battery thermal management, electronic cooling, buildings space heating and cooling. In the current study, a cylindrical geometry is selected as it is considered most favorable for heat exchangers, due to its acceptable efficiency in a low volume. The disadvantage of PCMs is low thermal conductivity, which decreases rates of melting and solidification [1]. Phase change materials and thermal energy storage become increasingly substantial subjects during the last two decades for purposes of heating and cooling. When there is delay in time between generating energy and energy demand, a great solution is thermal energy storage. There are three ways to store thermal energy which are sensible, latent, and chemical options. The important norm to choose a PCMs for a specific application is its phase change temperature. Also, other important parameters should also be possessed into account, including high latent heat and thermal conductivity values, in addition tocycling stability [2]. PCMs can be classified into organic and inorganic materials. The phase changes that result in absorbing heat involve conversions from solid to liquid, liquid to vapor, and solid to solid. The change from liquid to solid tends to be prioritized, given energy during the changes of transformation and minimal volumetric. PCMs should also have preferred properties such as: economic, thermophysical, chemical, kinetic end environmental feasibility to be used in passive LHTES systems. Other type of PCMs called organic PCMs which can be classified asparaffin and non-paraffin synthesis, like alcohols, fatty acids, glycols and esters [3]. Improved heat transfer techniques in solar energy systems leads to better performance. Among many improvement techniques in heat transfer, using of nanofluids as working fluids in solar collector systems, water heaters, cooling systems, solar still and solar cells [4].

2. MATERIALS AND METHODS

The water/polyethylene glycol (PEG) with (tin oxide(SnO_2)–tantalum carbide (TaC)) and (tin oxide(SnO_2)–silicon carbide (SiC))nanoparticlessystems were prepared for thermal energy storage and release by nanofluidswith different concentrations of nanoparticles are water-polyethylene glycol/$(SnO_2)_{0.05-x}$ - TaC_x nanoparticles and water-polyethylene glycol/$(SnO_2)_{0.05-x}$-SiC_x nanoparticles, where x=0.005, 0.01 and 0.015) where SiC and TaC nanoparticles were added each one to $SnO_2$with concentrations are (10, 20, and 30) wt.%. The (SnO_2-TaC) and (SnO_2-SiC) nanoparticles were added to water with concentration (1.67×10^{-3} g/mL). The melting and solidification processes during heating and cooling present thermal energy storage and release. Digital device was used to measure the temperature during the heating and cooling processes.

3. RESULTS AND DISCUSSION

The heat transfer of water/PEG with (SnO_2-TaC) and (SnO_2- SiC) nanoparticles nanofluids was investigated during the processes of melting and solidification as shown in Figure 1 to Figure 4. The time of melting and solidification decreases with increasing of (SnO_2-TaC) and (SnO_2- SiC) nanoparticles concentrations. Effective dispersion of (SnO_2-TaC) and (SnO_2-SiC) nanoparticles into base fluid were accelerated the conductive heat transfer during the process of melting and solidification where the nanoparticles form a paths network inside the nanofluids. The water/PEGwith (SnO_2-TaC) and (SnO_2- SiC) nanoparticles nanofluids could be considered efficient for solar water heating system due to their characteristics of enhanced heat transfer [5-12].

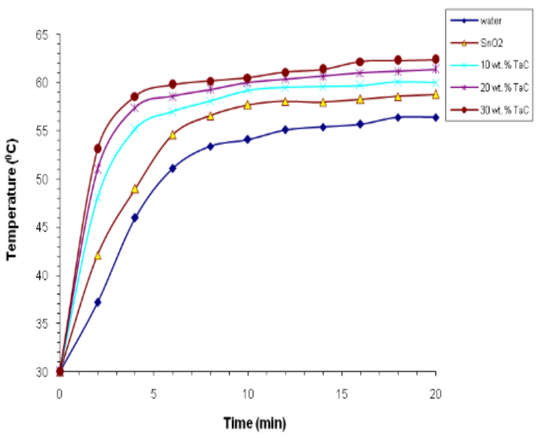

Figure 1. Melting curves of water/PEG-(SnO_2-TaC) nanofluids

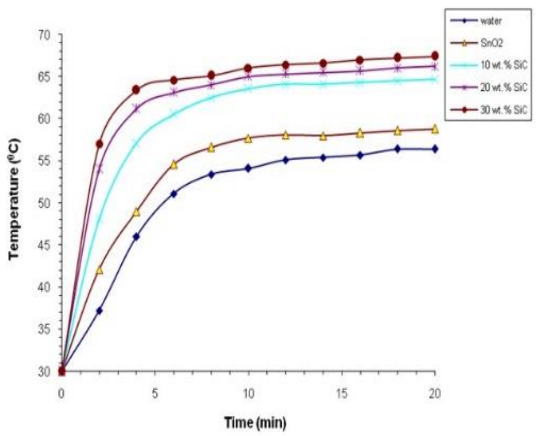

Figure 2. Melting curves of water/PEG-(SnO_2SiC) nanofluids

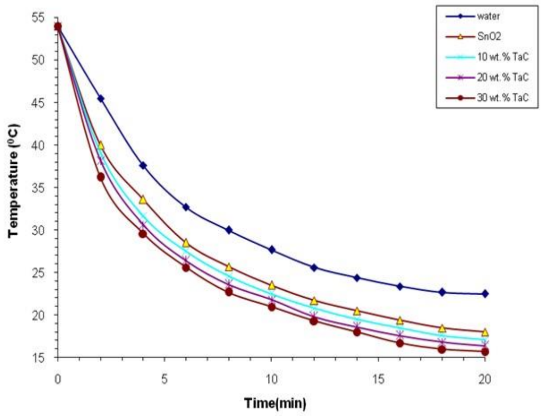

Figure 3. Solidification curves of water/PEG-(SnO_2-TaC) nanofluids

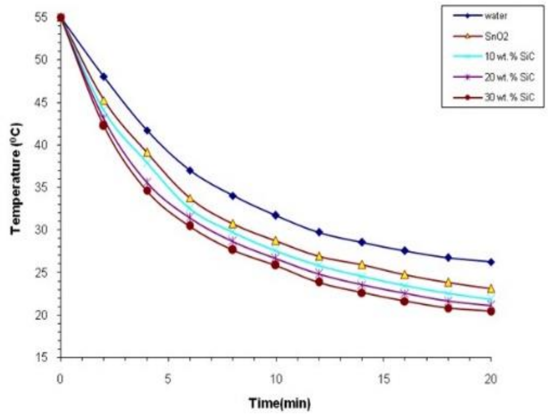

Figure 4. Solidification curves of water/PEG-(SnO_2-SiC) nanofluids

4. CONCLUSION

The water/PEG with (SnO_2-TaC) and (SnO_2-SiC) nanoparticles nanofluids have high efficiency for storage and release of thermal energy which can be used for heating-cooling of buildings, automobile engines, etc.The time of melting and solidification for storage and release of thermal energy applications are decreased with increase of the (SnO_2-TaC) and (SnO_2-SiC) nanoparticles concentrations.

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