

MAXIMIZING OF SOLAR ABSORPTION BY (TiO₂-WATER) NANOFLUID WITH GLASS MIXTURE

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ABSTRACT

Suspensions of nanoparticles (i.e., particles with diameters < 100 nm) in liquids, termed nanofluids, show remarkable thermal and optical property changes from the base liquid at low particle loadings. Recent studies also indicate that selected nanofluids may improve the efficiency of direct absorption solar thermal collectors. Nanofluids are prepared by dispersing and stably suspending nanometer sized solid particles in conventional heat transfer fluids. Past researches have shown that a very small amount of suspending nanoparticles have the potential to enhance the thermo physical, transport and radiative properties of the base fluid.

At this research adding very small quantities of nano particle (TiO₂) to pure water with different weights percent ranged 0.1, 0.2, 0.3 and 0.4wt.%, we found that the best weight percent is 0.2 that gave more heat absorbed. Then adding glass impurities ranged 10, 20 and 30wt.% to the nanofluid in order to enhancing the absorbed heat so energy storage. The best glass weights percent is 0.3.

KEYWORDS: Glass Impurities, Energy Storage, Enhancement Absorbed Heat, Solar Energy

INTRODUCTION

Nanofluids, or suspensions of nanoparticles in liquids, have been studied for at least 15 years and have shown promise to enhance a wide range of liquid properties. Generally, nanofluids are formed by dispersing nanometer-sized particles (1-100 nm) or droplets into HTFs. Nanoparticles have unique properties, such as large surface area to volume ratio, dimension-dependent physical properties, and lower kinetic energy, which can be exploited by the nanofluids.

At the same time, the large surface area make nanoparticles better and more stably dispersed in base fluids. Compared with micro-fluids or milli-fluids, nanofluids stay more stable, so nanofluids are promising for practical applications without causing problems mentioned above. Nanofluids well keep the fluidic properties of the base fluids, behave like pure liquids and incur little penalty in pressure drop due to the fact that the dispersed phase (nanoparticles) are extremely tiny, which can be very stably suspended in fluids with or even without the help of surfactants[1].

Nanotechnology provides new area of research to process and produce materials with average crystallite sizes below 100 nm called nanomaterial. The term "Nano materials" encompasses a wide range of materials including Nano crystalline materials, Nano composites, carbon nanotubes and quantum dots[2].

Very high thermal conductivity and extreme stability have always been desired for heat transfer fluids with particles. Fluids having this important combination of features did not exist till the advent of Nano fluids. Nano fluid technology could make the process more energy efficient and cost effective. These Nano fluids could be used in a wide range of industrial applications. Demand for ultra-high-performance cooling in electronics has been increasing, and

conventional enhanced surface techniques have reached their limit with regard to improving heat transfer. Since nanoparticles are relatively much smaller than the diameter of micro channel flow passages, smooth-flowing Nano fluids could provide the solution. Since Nano fluids can flow in micro channels without clogging, they would be suitable coolants. These could enhance cooling of MEMS under extreme heat flux conditions [3].

Specific heat capacity of solvents can also be enhanced by doping with nanoparticles. Nelson et al. [4] reported that the specific heat capacity of polyalphaolefin was enhanced by 50% on addition of ex-foliated graphite nanoparticles at 0.6% concentration by weight. Shin and Banerjee [5] synthesized molten salt-based silica nanofluid and observed 26% enhanced specific heat capacity for 1% weight concentration. Thermal energy storage _TES_ systems at high temperatures are required to improve the operational efficiencies and reliability of solar thermal energy conversion systems.

The materials that are compatible for these applications—such as alkali-nitrates, alkalicarbonates, and alkali-chlorides _as well as their eutectics_—have very low specific heat capacities, usually less than 2 J/g While, to compare, the specific heat of water is 4.2 J/g K at room temperature.

It has been shown that nanoparticles with higher thermal conductivity than their surrounding liquid can increase the effective thermal conductivity of suspension. For example, a small amount (<1% volume fraction) of Cu nanoparticles or carbon nanotubes dispersed in water or oil was reported to increase the inherently poor thermal conductivity of the liquid by 74% and 150% [6, 7].

Specific heat capacity of solvents can also be enhanced by doping with nanoparticles. Nelson et al. [8] reported that the specific heat capacity of polyalphaolefin was enhanced by 50% on addition of ex-foliated graphite nanoparticles at 0.6% concentration by weight. Shin and Banerjee [9] synthesized molten salt-based silica nanofluid and observed 26% enhanced specific heat capacity for 1% weight concentration.

In this work we will use glass impurities that is available everywhere with nanofluid (TiO₂-water) to enhancement thermal energy storage.

RESULTS AND DISCUSSIONS

Results were obtained for the present work in the purpose of enhancement of solar energy storage by mixture of nanofluid (TiO₂-water) with glass impurities ranged 10, 20 and 30wt.% were compared with the case of nanofluid alone (0.1, 0.2, 0.3 and 0.4 wt.%).

Figure 1 represent variation of nanofluid temperature with losing time (without adding glass impurities), we can see that all nanofluid weight percent's gave less in absorbing and releasing solar heat than the case of pure water.

In order to make an increasing in absorbing solar heat we add glass impurities with weights percent of 10 wt.% as in figure 2, 20 wt.% as in figure 3 and 30 wt.% as in figure 4. From figures we can see that the best case is of figure 4 which is 30 wt.% of glass impurities, this because of the enhancing of reflection to the solar radiation which lead to increase the solar heat absorbed by the mixture.

CONCLUSIONS

Our research gave us the following conclusions:

- Adding glass impurities can enhancement heat absorbing.
- Increasing the glass impurities weights percent increase amount of solar heat absorbed.

- The best nanofluid weight percent is 0.2%. which gave the largest heat absorbed.
- Solar heat absorbed decreases with time.

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APPENDICES

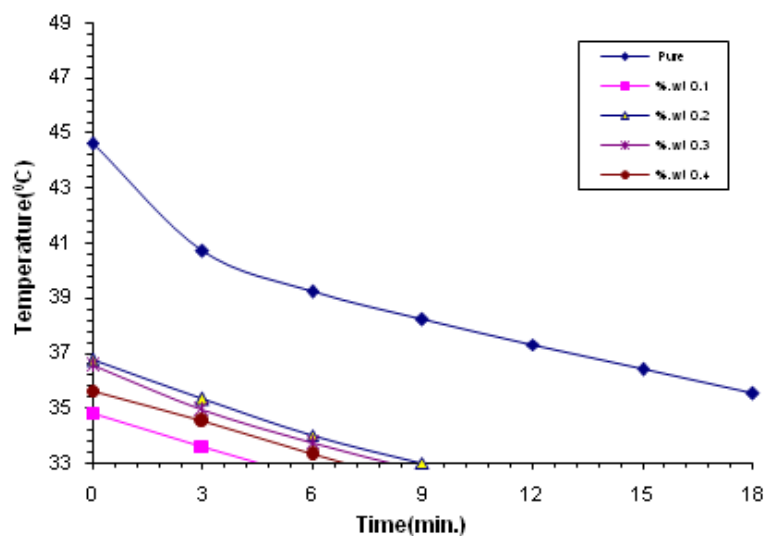


Figure 1: Variation of Nanofluid (TiO₂-Water) Temperature with Losing Time without Glass Impurities

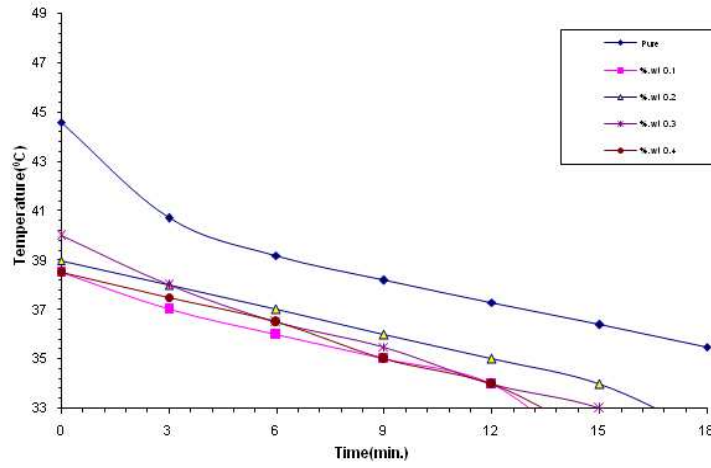


Figure 2: Variation of Nanofluid (TiO₂-Water) Temperature with Losing Time for Adding 10 wt.% of Glass Impurities

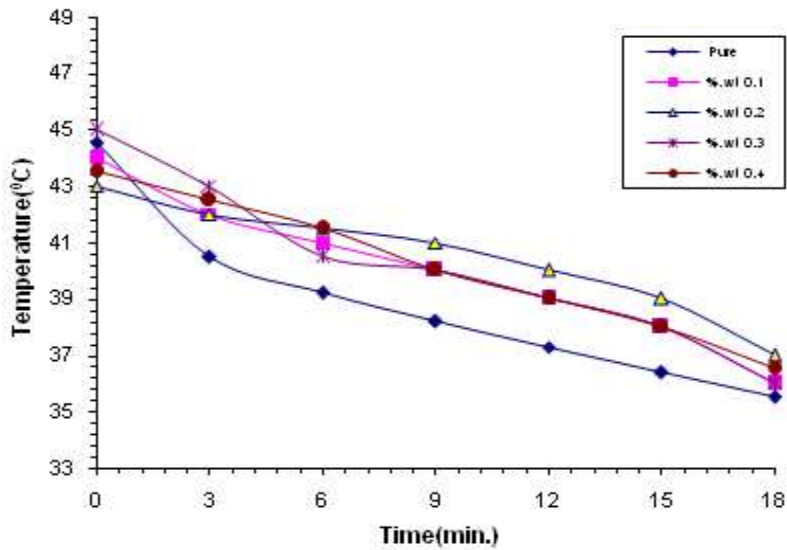


Figure 3: Variation of Nanofluid (TiO₂-Water) Temperature with Losing Time for Adding 20 wt.% of Glass Impurities

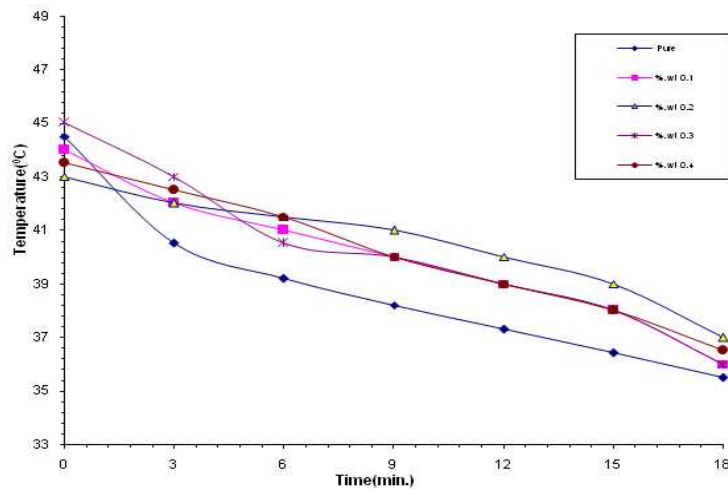


Figure 4: Variation of Nanofluid (TiO₂-Water) Temperature with Losing Time for Adding 30 wt.% of Glass Impurities