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Mini Review

Solar Energy Harvesting (SEH) Using Nanofluid: A Crisp Outlook

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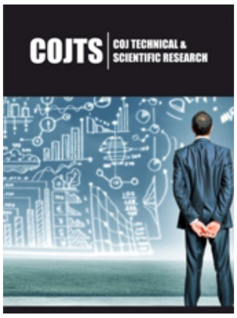

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Abstract

The most efficient means of creating and converting thermal energy are Solar Thermal Energy Harvesting Systems (STEHs) that use many sun collectors. Nanoparticles are ideal collectors of the sun's thermal energy. Research on solar thermal energy harvesting devices using nanoparticles is described. The thermal performance, heat transfer coefficient, and temperature range of mono and hybrid nanofluids in STEHs are investigated in this outlook.

Keywords: Thermal energy; Solar energy harvesting systems; Nanoparticle; Thermal performance

Introduction

The energy crisis is humanity's most common word. Rapid population and industrial growth may have exacerbated this problem. Ignoring this situation could cause another Covid-19-like calamity [1-3]. Conventional fossil fuels dominate energy, but their immediate wealth limits their availability. Hence, scientists and engineers worldwide are exploring solar, geothermal, wind, ocean, and tidal energy sources to replace traditional ones. Solar energy provides heat and electricity worldwide. Solar energy management. Sun thermal energy powers building conditioning, water desalination, steam generation, water heating, and more. Indian Saibaba Temple Prasadalaya Shirdi uses Solar Thermal Energy (STEHs). Heat transmission influences STEHs performance. Heat transmission capacity improves compact and efficient STEHs performance (Figure 1). Nanoparticles under 100nm were studied for decades. Richard Feynman invented nanotechnology in 1959. Scanning tunneling microscopy spotted the atomic cluster in 1981, developing nanotechnology. After 10 years, Iijima [4] discovered Carbon Nanotube (CNT), which outperformed conventional materials in thermal, chemical, and mechanical properties and introduced researchers to nanomaterial-based technologies [2].

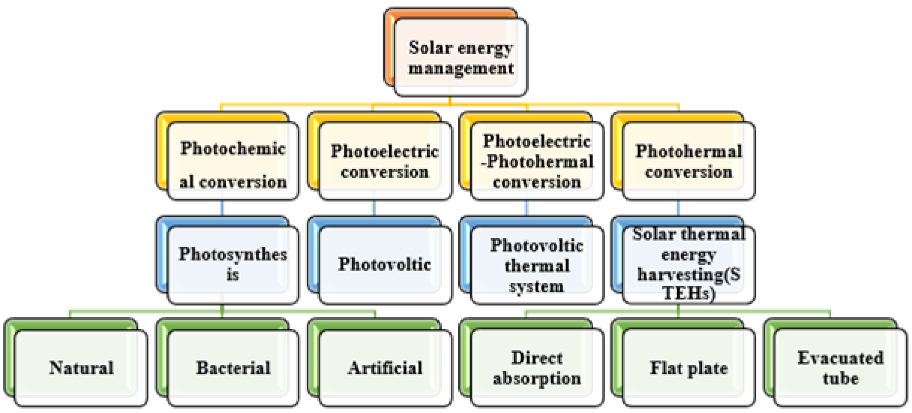

Figure 1: Sunlight uses management.

Some key points

a) Nanofluids lower STEH costs by reducing heat transfer area.

b) Absorption of energy and heat transmission capacity dependent on surface area, nanofluids have good surface area due to small nanoparticles.

c) Nanofluids have better thermal conductivity than working fluids.

d) Adding surfactant improves nanofluid stability across a large temperature gradient.

e) Nanofluids-based STEHs have a high HTC (convective heat transfer range), increasing efficiency.

f) Nanofluids have greater optical characteristics than base fluids, which enhances solar spectrum absorption.

SEHSs Application with Nanoparticles and Nanofluids

Below are current SPES applications used by researchers. These are flat plate, evacuated, and conical cylindrical solar collectors.

Solar collectors

Solar collectors gather sunlight to generate heat energy. Sunlight energy is collected by working fluid in collectors and converted into thermal energy. However, water (working fluid) is less efficient than nanoparticles/fluids [5-7].

Flat plate collector

Yousefi's [8] flat plate collector efficiency experiment with Al2O3. PSC. Particle volume fraction, flow rate, and surfactant affect collector efficiency. Water collector efficiency increased 28.3% throughout experiment. Moghadam [9] using CoU found 21.8% efficiency improvement over water-based collectors.

Evacuated tubes collector

Evacuated collectors outperform flat plate collectors. Several thermal ground investigations compare both performances. Research shows that evacuated collectors have good thermal efficiency at low cost and negligible heat losses. This works in humid and condensation weather. Evacuated SPESs are superior than flat plate collectors. Nanofluids improve collector performance. Tong [10] found a 4% thermal efficiency increase using MWCNT working fluid. Sabiha [11] found that SWCNT volume concentration changed from 0.05% vol. to 0.02% vol. significantly affected collector thermal performance.

Conical and cylindrical collector

Cylindrical collectors use thermosyphonic driving force to absorb solar light and produce heat. Cylindrical solar collector efficiency 85%. Goudarzi [12] found 25.6% efficiency improvement in cylindrical collectors using CuO-based nanofluids. Noghrehabadi [13] found a 62% thermal performance increase in conical collectors with SiO2 nano fluid.

Parabolic collator

A parabolic collator is a solar collector that uses a U-shaped trough to focus the sun's rays on a tiny heat sink filled with water, nano fluid, or both. The use of CNT as a working fluid increases efficiency by 4-7 percent, according to research by Kasaeian [14] Improved thermal performance was measured at 18-52% by Menbari [15].

Key Obstacles

Nanofluids important features generate ever-increasing interest in their use in SEHSs. Yet the major issue in this area is the wide variety of findings. The underlying physical mechanism behind the various nanofluids characteristics is poorly understood. Key obstacles in the study of nanofluids in SPESs were also explored here.

a) Nanofluids are expensive. Nanofluids demand precise and complex equipment. Nanofluids cost more with such equipment. This hinders SPES nanofluid use.

b) Van der Waals interactions make nanofluids homogeneous and stable. Nanofluids in SPESs are limited by nanoparticle aggregation at high temperatures. Surface modification, chemical, and physical particle treatment can decrease this issue.

c) Two-way nanofluid production. First, nanoparticles are created chemically/physically and then sonicated in the base fluid. Another method developed nanoparticles parallel to the base fluid. Ion exchange and instability affect both methods. Sometimes nanofluids are unsuitable for SPESs or produce poor results.

Conclusion

a) Nanofluids boost SPES performance.

b) SPES thermal performance depends on nanoparticle thermal conductivity and is often boosted with high volume factions.

c) Recent research trends are unclear on how particle size affects SPES thermal performance.

d) Nanofluid heat transport in SPESs requires additional theoretical and experimental work.

e) Nanofluid procurement costs and instability limited nanoparticle utilization in SPESs.

f) Based on review, we offer some future research directions to improve nanofluids as working fluids for solar radiation use in SPESs.

g) High-temperature nanofluid stability needs more research.

h) Hybrid nanofluids have many SPES applications.

i) Low-cost nanofluids production is another potential focus.

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