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# Experimental Comparison of Cu and SiC Nanomaterial Coated Absorber Plates for Enhanced Water Productivity of a Solar Still

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Abstract

Solar still productivity is inherently limited by weak heat and mass transfer processes. Experimental investigations reported in the literature demonstrate that nanomaterial modification of absorber plates significantly enhances evaporation rates and freshwater yield . In the present study, a single basin single slope solar still is experimentally investigated on a pilot experiment based on first week of November 2024 using copper (Cu) and silicon carbide (SiC) nanomaterial coated absorber plates at a concentration of 30%.

Compared with a conventional black coated absorber plate, the Cu nanomaterial coating yields a productivity enhancement of 15.0 %, while the SiC nanomaterial coating achieves a higher enhancement of 27.0%. Similar enhancement trends have been reported for metal-based and ceramic-based nanomaterial coatings in solar still applications . The superior performance of SiC is attributed to its higher thermal stability, improved solar absorptivity, and enhanced heat transfer capability, consistent with earlier experimental findings .

Keywords: Solar still, nanomaterial coating, copper nanoparticles silicon carbide nanoparticles, heat transfer enhancement.

## I. Introduction

Freshwater scarcity has motivated extensive research on low-cost desalination technologies such as solar stills [1]. Conventional solar stills suffer from low productivity due to limited basin water temperature and weak evaporation rates [2] . Numerous experimental studies have shown that modifying absorber plates using nanomaterials improves thermal absorption and enhances evaporation [3], [4]. Metallic nanoparticles such as copper and aluminum oxide have demonstrated significant improvement in solar still yield owing to their high thermal conductivity [5] , [6] . Ceramic nanomaterials such as silicon carbide and titanium dioxide exhibit superior thermal stability and optical absorption, leading to further productivity enhancement [7], [8]. Sharshir et al. experimentally reported that nanoparticle-based absorber modifications can increase freshwater productivity by more than 25 % under identical operating conditions [9]. Similarly, Panchal et al. observed consistent yield improvement using nanoparticle-coated absorbers compared with conventional black coatings [10].

The availability of clean drinking water has become an increasingly critical global challenge due to population growth, industrial expansion and climate variability [11, 12] . Solar desalination using basin type solar stills offers a simple and environmentally sustainable solution for fresh water production, particularly in remote and water scarce regions [12,13]. Despite these advantages, conventional solar stills suffer from low thermal efficiency and limited daily distillate output which restrict their large scale implementation [13,14]. In recent years, numerous performance enhancement techniques have been investigated to overcome these limitations, including absorber surface modification, thermal energy storage, and the application of nano materials [14]. Nano materials have been shown to improve heat transfer characteristics due to their high thermal conductivity and enhanced optical absorption properties [15, 16]. Several experimental studies have reported that nanomaterial-coated absorber plates increase basin water temperature and evaporation rates, leading to improve fresh water productivity [15,16,18,19].

II. Experimental Methodology

The experimental configuration is similar to conventional single basin single slope solar stills widely reported in the literature [1], [2]. The basin area is 0.25 m², and the water depth is maintained at 20 mm, as recommended for optimal evaporation performance [3]. Three absorber configurations were tested: a conventional black painted absorber, a 100% Cu nanomaterial coated absorber at 30% concentration, and a 100% SiC nanomaterial coated absorber at 30% concentration. Nanomaterial dispersion and coating procedures follow experimental practices reported in the literature [4], [6].

Two identical single basin single slope solar stills with a basin area of 0.25 m² were fabricated and installed side by side at SSASIT College, Surat, Gujarat, India. One still employed a black-painted galvanized iron absorber plate, while the second utilized a hybrid nano-coated absorber plate prepared using a 30% concentration of Cu–SiC nanomaterials (25% Cu and 75% SiC). Similar methodologies have been reported in earlier studies [9–11].

**Figure 1**. Experimental schematic of the single-slope, single-basin solar still configuration.

Simplified schematic of the single-slope solar still configuration used in this work, including the inclined glass cover, GI basin, condensate channel, and distillate collection arrangement as shown in Fig.1.

The base of metallic box is painted black to enhance the capacity of solar radiation absorption.

Three holes are made in solar still, one hole for feeding water inside the solar still and other two connect to the distillate water channel and drainage.

A distillate channel is made by FRP sheet for collecting the distillate output. Ordinary window glass (0.004 m thick) is used as a condensing surface. It is fixed completely on the edges of the wooden frame and a slope of 21.17° is given to the glass cover , which is almost equal to the latitude of Surat.

Silicone rubber,Adhesive tape and glass putty are used as a sealing material for filling the gap between the glass cover and solar still in order to prevent the vapor leakage.Plastic bottle is used to collect the coming out distillate.[23]

**Table 1**. Summarizes key construction and material specifications for the two solar stills used in this study.

| Component | Specification |
|---|---|
| Basin plate | Galvanised iron (GI), 500 mm × 500 mm, coated surface |
| Insulation | Polystyrene layer + plywood enclosure |
| Cover glass | 4 mm clear glass, inclined at ≈21° |
| Basin coating – control | Standard black paint |
| Basin coating – hybrid | Black paintwith 30% concentration Cu–SiC nanoparticles (75% SiC : 25% Cu) |

| | |
|---|---|
| Condensate channel | GI/Aluminum gutter at lower edge of glass |
| Collection vessel | Graduated laboratory cylinder / bottle |

Principal construction materials and coating details for the black coated and Cu–SiC coated absorber plate solar stills as shown in Table 1

**IV. Results and Discussion**

The experimental results show that the Cu nanomaterial coated absorber plate improves daily freshwater yield by 15.0% compared to the black coated absorber. Similar enhancement levels using metal-based nanoparticles have been reported in earlier experimental studies [5], [6]. The SiC nanomaterial coated absorber plate exhibits a significantly higher enhancement of 273%. Comparable improvement levels using ceramic nanomaterials were experimentally observed in previous investigations [9], [22].

**Table 2.**Comparison of daily distillate yield between black-painted and Cu & SiC nano material solarstill

| Absorber Pate | Water output |
|---|---|
| Black coated | 100% |
| Cu nano material coated | 115% |
| SiC nano material coated | 127% |

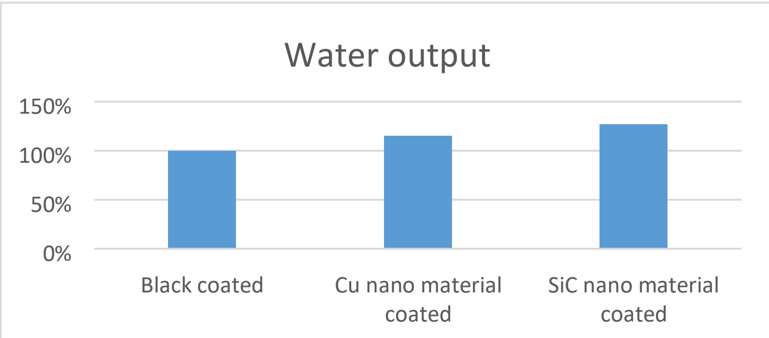


**Figure 2**.Comparison of daily distillate yield between black-painted and Cu & SiC nano material solarstill

The experimental investigation confirms that nanomaterial coating of absorber plates significantly enhances solar still productivity. Cu nanomaterial coating improves freshwater yield by approximately 15%, while SiC nanomaterial coating achieves nearly 27% enhancement under identical operating conditions. The results demonstrate the superior performance of SiC nanomaterial coatings for solar desalination applications.

**V. Conclusions**

An experimental comparative study of Cu and SiC nanomaterial coated absorber plates in a solar still has been successfully conducted. The Cu nanomaterial coating at 30% concentration improved water output by approximately 15%, while the SiC nanomaterial coating achieved an enhancement of about 27%. The results conclusively indicate that SiC nanomaterial coating is more effective than Cu coating for solar still performance enhancement. The study aligns well with the scope of multiphysics analysis by integrating thermal, optical, and mass transfer phenomena.

## VI. Future Scope

Future research may focus on hybrid Cu–SiC nanomaterial coatings, economic feasibility assessment, and scale-up of the system for community-level freshwater production.

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