e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704103 |

Enhancing Productivity of Solar Stills Using Kevlar/Glass Hybrid Composites

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ABSTRACT: The abstract for the solar still basin comparing composite materials discusses the potential benefits and drawbacks of using composites in the construction of solar still basins. The aim is to determine which material provides the highest productivity and durability while maintaining cost-effectiveness. The results indicate that composite materials with a high thermal conductivity and low heat absorption are more efficient in converting solar energy into distilled water. Additionally, the durability of these materials ensures a longer lifespan for the solar still basin, making it a sustainable and reliable solution for water desalination. Solar stills made using hybrid composites offer a promising solution for sustainable water desalination and purification. The combination of different materials in these composites enhances the overall efficiency and durability of the solar stills. The research and development in this field have shown significant improvements in water production rates and energy efficiency compared to traditional solar stills.

KEYWORDS: Solar stills, Hybrid composites, Composites

I. INTRODUCTION

Composite materials are a type of material that is made up of two or more different substances. These substances, known as the matrix and the reinforcement, are combined to create a material that has unique properties and characteristics. The matrix is typically a polymer, such as epoxy or resin, that holds the reinforcement together. The reinforcement can be made up of a variety of materials, such as fibers, particles, or flakes. The combination of these different substances results in a composite material that is stronger, lighter, and more durable than the individual components on their own. A hybrid composite is a material that is formed by combining two or more different types of composites. It is designed to take advantage of the unique properties of each individual composite material in order to create a material with enhanced characteristics. Hybrid composites are commonly used in various industries, including aerospace, automotive, and construction. The integration of thermal storage systems, phase change materials, and advanced tracking mechanisms has further enhanced the efficiency and reliability of solar stills, enabling them to operate optimally even under suboptimal weather conditions. By incorporating intelligent control systems and automation, solar stills can adapt to changing environmental parameters and maximize water production while minimizing energy consumption. These technological advancements have made solar stills more versatile and adaptable to a wide range of operating conditions, making them a viable solution for decentralized water treatment and off-grid applications.

II. MATERIALS

Kevlar, a para-aramid fiber, is a strong, heat-resistant synthetic material developed by Stephanie Kwolek at DuPont in 1965. It is known for its high tensile strength, which is five times stronger than steel, and its low weight. Kevlar is typically spun into ropes or fabric sheets that can be used as an ingredient in composite material components. In terms of properties, Kevlar has a tensile strength of about 3,620 MPa (525,000 psi), a relative density of 1.44 (0.052 lb/in^3), and a high modulus of elasticity. It is resistant to heat, maintaining its strength down to cryogenic temperatures and slightly stronger at low temperatures. However, its strength reduces at higher temperatures, with a 10-20% reduction in tensile strength after 500 hours at 160°C (320°F) and a 50% reduction after 70 hours at 260°C (500°F).Glass fiber, also known as fiberglass, is a versatile material with a wide range of properties that make it suitable for various industrial applications. Some of the key properties of glass fiber include:High tensile strength: Glass fiber has a

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greater tensile strength than steel wire of the same diameter, at a lower weight.Dimensional stability: Glass fiber is not sensitive to variations in temperature and humidity, making it suitable for use in environments with extreme temperature and humidity fluctuations.High heat resistance: Glass fibers can retain 50% of their room temperature tensile strength at 370°C and 25% at 480°C.Good thermal conductivity: Glass fibers have a high ratio of surface area to weight, making them effective thermal insulators.Great fire resistance: Glass fiber is naturally incombustible and does not propagate or support a flame.Good chemical resistance: Glass fiber is highly resistant to attacks by most chemicals.Highly economical: Glass fiber is a cost-efficient choice compared to similar materials.

III. PROBLEM IDENTIFICATION

These factors are crucial in determining the overall performance and feasibility of the solar still system.

1. Material selection: The choice of materials for the composite solar basin plays a significant role in determining the system's performance. Natural fibers, such as banana fiber, have been used in the production of hybrid composites for their high mechanical and thermal properties, low cost, and low specific weight. The performance of the solar still system can be enhanced by using materials that are resistant to corrosion, UV degradation, and have high thermal conductivity.

2. Cost-effectiveness: The cost-effectiveness of the composite materials used in the construction of the solar basin is a crucial factor in determining the feasibility of the system. Hybrid composites made from natural and synthetic fibers have been shown to be cost-effective in generating drinking water, especially in desert regions and inaccessible areas. The use of low-cost energy storage materials, such as flat-plate solar thermal collectors, can also improve the productivity of the solar still system.

3. Efficiency: The efficiency of the composite materials used in the construction of the solar basin is a key factor in determining the overall performance of the solar still system. The use of v-corrugated basins, internal reflecting mirrors, and flat-plate solar collectors can enhance the performance of the solar still system by increasing the surface area of heat and mass transfer. The inclusion of phase change materials (PCMs) in the solar still system can also improve its efficiency by storing excess heat and releasing it when needed.

IV. FABRICATION PROCESS

Hybrid composites made of Kevlar and glass fibers with an epoxy matrix can be manufactured using various methods, including hand lay-up, vacuum bag molding, and compression molding. The manufacturing process typically involves selecting the appropriate materials, preparing the fiber layers, applying the epoxy resin, and curing the composite. The hand lay-up process is a common method for manufacturing hybrid composites using Kevlar and glass fibers with an epoxy matrix. This process involves laying down the fiber layers in a specific order, such as starting with a layer of glass fiber to enhance impact energy absorption, followed by Kevlar fibers to optimize mechanical properties. The fiber layers are then impregnated with an epoxy resin mixture, and the composite is cured at room temperature or in an oven with controlled temperature and humidity conditions. Vacuum bag molding is another method used to manufacture hybrid composites using Kevlar and glass fibers with an epoxy matrix. This process involves placing the fiber layers and epoxy resin mixture in a vacuum bag and applying vacuum pressure to remove air bubbles and ensure proper impregnation of the fibers. The composite is then cured in an oven with controlled temperature and humidity conditions. In summary, hybrid composites made of Kevlar and glass fibers with an epoxy matrix can be manufactured using various methods, including hand lay-up, vacuum bag molding, and compression molding. The manufacturing process involves selecting the appropriate materials, preparing the fiber layers, applying the epoxy resin, and curing the composite to ensure proper bonding and optimized mechanical properties.

V. CONCLUSION

When the temperature inside a solar still increases, the rate of evaporation of water also increases, leading to a higher rate of water production. Therefore, a temperature increases of about 28% in a solar still is significant, as it suggests a substantial improvement in the efficiency of the water distillation process. When the temperature of the glass surface in a solar still increases, the rate of evaporation of water also increases, leading to a higher rate of water production. Therefore, a temperature increases of about 23% in the glass surface of a solar still is significant, as it suggests a

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substantial improvement in the efficiency of the water distillation process. The use of hybrid composites made of Kevlar and glass in the construction of solar stills has led to an increase in water production of approximately 43.6%.

Fig 1: Solar still using Hybrid Composite

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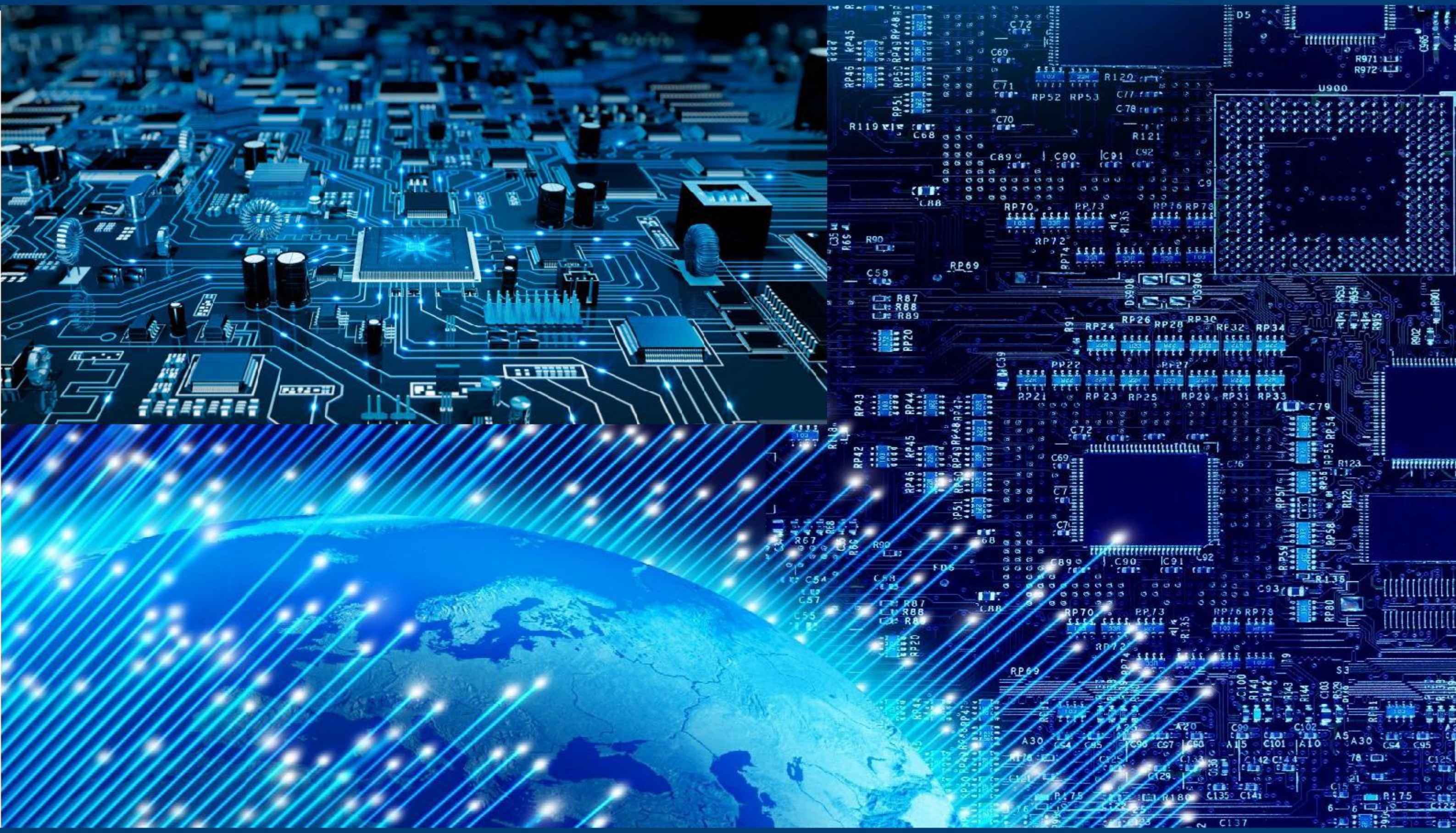

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