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Synergizing environmental and technological advances: Discarded transmission oil and paraffin wax as a phase change material for energy storage in solar distillation as a step towards sustainability

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ABSTRACT

The increasing demand for water desalination technologies in coastal areas with high seawater levels but limited freshwater resources calls for innovative solutions. This research delves into the effectiveness of a new double-slope solar still with bottom fins (DSSS-BF) and a groundbreaking Composite Energy Storage Material (CESM). This study addresses productivity challenges in traditional solar stills, focusing on cost-effectiveness and adaptability. This investigation also aligns with the Sustainable Development Goals (SDGs) and utilizes eco-friendly materials such as discarded transmission oil, presenting a unique waste-to-energy approach. This research offers a sustainable and efficient energy storage material by repurposing discarded automotive transmission oil as an energy storage medium by mixing various volume proportions in paraffin wax. Experimental findings demonstrate that the CESM composed of 80 % wax and 20 % oil shows a striking 35.34 % boost in thermal conductivity compared to pure paraffin wax. Moreover, incorporating a finned absorber basin into the energy storage material significantly improves heat transfer, water evaporation, and production of safe drinking water, outperforming traditional solar stills. The DSSS-BF-CESM shows a significant increase in water and absorber temperatures compared to CSS, leading to high productivity. The DSSS-BF-CESM displays an impressive 46.57 % increase in productivity over conventional solar stills, directly contributing towards Sustainable Development Goals (SDGs) 6 and 7. Moreover, a careful examination of the economics reveals that the DSSS-BF-CESM had a 16.67 % decrease in CPL and a 15.38 % decrease in the payback period compared to CSS. This extensive research further promotes the development of solar desalination technology and highlights its viability in addressing both water scarcity and sustainability concerns.

1. Introduction

The global challenge of clean water scarcity has become increasingly pronounced due to surging population growth and the adverse impacts of climate change. International data indicates that less than 70 % of the global populace can access adequate freshwater resources within the coming decade. Among the various renewable energy alternatives, solar power is paramount for electricity generation, water desalination, air and water heating, drying, and solar-powered cooking. Water desalination is a pivotal solution for providing safe drinking water, an indispensable necessity for all life forms. Solar desalination, in particular, has garnered significant attention due to its ecological benefits and

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