Optimizing Charging and Discharging Time for Solar Portable Immersion Heater Using Scheffler Concentrator and Phase Change Material.

Varad Vichare[1], Anita Nene[1], and Ashish Utage[1]

[1]MIT World Peace University Faculty for Engineering and Technology

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Abstract

Thermal energy storage systems (TES) have emerged as a vital solution for addressing the gap between energy supply and demand. While research on solar energy storage has primarily focused on flat-plate collectors, limited work has been done to explore the potential of Scheffler solar concentrators. This study proposes an innovative approach to thermal energy storage using a Scheffler solar concentrator and phase change material (PCM) to address the energy needs of rural areas with limited access to electricity. Real-time design and testing were conducted using paraffin wax as the PCM, and CFD analysis was performed using the ANSYS Fluent software to determine the optimal charging and discharging times. The results indicated that the required charging time was 17 min according to the CFD analysis, while the experimental results yielded a charging time of 18 min. The results demonstrated that the proposed approach is a feasible and effective solution for meeting the energy demands of rural communities. The charging time was optimized using the response surface method, yielding an optimal charging time of 20.5 min and an optimal discharging time of 26.2 min. Overall, these findings highlight the potential of utilizing Scheffler solar concentrators and PCMs for sustainable and reliable thermal energy storage.

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