Development of a Non-Tracking Solar Thermal Concentrator Using the Simultaneous Multi-Surface Design Method

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The main issue associated with solar power is its high costs, caused by the expensive tracking systems required for solar energy systems to remain efficient. Furthermore, current solar concentrators have been shown to be intrinsically flawed, resulting in huge opportunities to improve on current technology by developing a non-tracking concentrator that can accept indirect sunlight while offering higher levels of energy efficiency. The simultaneous multi-surface design method, along with other principles of optics, is used to develop this novel concentrator. The design method is applied to create a point-by-point calculation of two surfaces that redirect light from varying angles to an absorber. Information gained from the design of one surface facilitates the design of the other, until the entire concentrator is established. Three phases of testing were conducted, a computer simulation, a controlled environment test, and a sunlight implementation test. Simulation data validated the concentrator design by proving its ability to concentrate indirect sunlight. Temperature data indicated that the designed concentrator vastly outperformed the parabolic concentrator in wide angular deviations and had the capability to reach higher temperatures than a parabolic trough under direct sunlight. These results strongly support the fact that the designed concentrator can outperform tracking parabolic troughs while remaining stationary. Calculations from experimental data revealed a theoretical efficiency of 20.9%. Further cost analysis based on the data suggests that using this non-tracking system will allow for a significantly lower cost per watt than traditional solar power systems, offering an exciting alternative that outpaces current solar energy systems.

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