Enhancing thermal efficiency in flat plate solar collectors through internal barrier optimization

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Abstract

This study investigates the impact of introducing horizontal barriers within the internal cavity of flat plate solar collectors on their thermal efficiency. The primary objective is to enhance thermal performance by reducing convective heat loss. An experimental test bench was constructed to evaluate five solar collectors under controlled conditions. One collector was unmodified as a reference, while the other four had 1 to 4 horizontal barriers inserted between the absorber plate and glass cover. Each collector's efficiency was assessed by measuring inlet and outlet water temperatures, incident solar radiation, ambient temperature, and water flow rate. Efficiency versus heat loss parameter curves were generated, and correction factors were applied to account for material and sensor differences. The collector with four barriers demonstrated the highest overall

thermal efficiency, achieving an efficiency improvement of up to 12 % compared to the reference collector. Specifically, the efficiency of the reference collector was around 70 %, while the collector with four barriers reached an efficiency of approximately 82 %. Introducing two barriers resulted in a 9 % increase in efficiency, bringing it to about 79 %. Conversely, the collector with three barriers showed a slight decrease in efficiency to 68 %. The barriers effectively reduced internal convective heat loss, enhancing the collector's ability to harness incident solar radiation. Inserting horizontal barriers within the internal cavity of flat plate solar collectors significantly improves thermal efficiency by reducing convective heat loss. The optimal configuration, based on this study, involves using four barriers. This method presents a straightforward yet effective approach to enhancing solar collector performance. Future research should focus on refining barrier design and placement for different collector sizes and geometries, potentially supporting broader adoption of solar thermal energy systems and contributing to sustainable energy solutions.

Author keywords

Convective heat transfer; Energy efficiency; Flat plate collectors; Solar energy; Thermal performance

Indexed keywords

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