Paper 263

Experimental Study and Thermal Efficiency Analysis of Solar Thermal-Driven Devices for Seawater Desalination

With the increasing scarcity of freshwater resources worldwide, seawater desalination has become a vital solution for addressing water shortages. Conventional desalination technologies, such as multi-stage flash (MSF) and reverse osmosis (RO), although well-established, are associated with high energy consumption and environmental impacts. Solar thermal technology, as a renewable and environmentally friendly energy source, offers an efficient solution for driving seawater desalination. Solar thermal-driven desalination devices can provide freshwater while significantly reducing energy consumption, offering sustainable water supply solutions for remote and energy-limited regions.

The performance of solar thermal-driven desalination systems depends primarily on solar thermal absorption efficiency, heat transfer efficiency, and freshwater production efficiency. In practice, factors such as the design of solar collectors, heat exchanger configuration, brine circulation, and operating conditions significantly affect thermal efficiency and water output. Therefore, experimental investigation and thermal efficiency analysis of solar thermal desalination devices are essential for optimizing system design and enhancing energy utilization.

By constructing experimental setups and performing system performance tests, key parameters such as collector temperature distribution, heat transfer efficiency, and freshwater yield can be obtained. Thermal efficiency analysis allows evaluation of system performance under varying solar irradiance, operating temperatures, and brine flow rates, providing data support for device design and operational optimization. Additionally, experimental results serve as references for validating theoretical models and numerical simulations, promoting the engineering application of solar thermal desalination technologies.

This study aims to conduct experimental research and thermal efficiency analysis of solar thermal-driven devices for seawater desalination. The research focuses on system construction, solar collector performance testing, heat transfer and freshwater yield analysis, and evaluation of operating parameters on system performance. The findings are expected to provide theoretical guidance and practical reference for the

design of high-efficiency, sustainable solar thermal desalination devices, facilitating their deployment in water-scarce regions.