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Experimental Testing and Analysis of Tubular Solar Still with Fins and Parabolic Concentrator Integrated with Thermal Energy Storage Unit

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Abstract

The solar still unit is used mainly to produce freshwater from salt water. The principal operation of the solar still unit depends mainly on the solar energy. Therefore, the solar still unit cannot work after the sunset as well as the productivity of such unit is very low. Enhancement techniques were adapted in this research to further extend the productivity and daily freshwater yield from the solar still unit. As the productivity of the solar still is usually low, enhancement techniques should be implemented to the solar still unit to achieve this goal. Many improvement methods can be implemented to improve the productivity of the solar still such as basin shape enhancement, condensation surface material, using solar reflectors, thermal storage units, etc. The enhanced condensation surface material of quartz glass was used in this research to enhance the productivity of solar stills. Additionally, an improved aluminum casting basin with built-in square fins was used to increase the heat transfer surface area of the basin and increase the evaporation rate and daily freshwater yield accordingly. Furthermore, passive thermal energy storage with phase-change material was integrated with the solar still to allow continuous production of freshwater at night as well. Paraffin wax with a 43 ℃ melting temperature and 250 KJ/kg latent heat capacity was used as a heat-storing medium. Paraffin has the property of storing heat during the daytime when solar heat is available and reusing it again at night in the absence of solar heat. The stored heat will be used to raise the temperature of the feed water before it is distilled in the solar still unit. The maximum overall productivity obtained from the system was 6.68 L/m2 per day, with 5.88 L/m2 per day during the daytime and 0.8 L/m2 per day during the nighttime. Maximum freshwater production efficiency and thermal efficiency obtained were 60.12% and 43.67% respectively.