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Experimental and Theoretical Aspects of Phase Change Materials in Solar Desalination

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Abstract

In this work, a solar still was designed and built to study the effect of using Phase Change Material (PCM) on the water temperature inside the still and its productivity defined as the amount of fresh water produced. For this purpose, Tricosane (paraffin wax) was used as PCM for different reasons including, low melting point of 45^{o}C which allows it to melt easily during the daytime, in addition, paraffin wax is affordable, safe and not toxic. The PCM was packed inside sealed copper tubes submerged under water inside the solar still. The number of PCM filled tubes was varied to achieve values of mass of PCM/mass of water, R, of 0, 0.17, 0.34 and 0.51. The experimental results showed that the temperature of both the water and the PCM increases as the sun rises till the melting point of the PCM is reached after which it remains constant till all the PCM melts. The temperature then rises to reach a maximum value after which it drops till the melting point is reached again. It remains constant at the melting point of the PCM until all of the PCM solidifies after which it drops. The length of the constant temperature zones is proportional to the amount of the PCM present. The experimental results showed that as the value of R increases, the daytime productivity decreases whereas the nighttime productivity increases resulting in a decrease in the overall unit productivity. During the night time, the average increase in the unit productivity during the months of April to August is 22.2%, 36.4%, and 50% for R equal to 0.17, 0.34 and 0.51 respectively. The effect of solar irradiation and ambient weather conditions was investigated by carrying the experiments in different months (April to August). The change in the temperature of the water and the PCM, as well as the unit productivity, was predicted theoretically by performing mass and energy balances. The effect of solar irradiation and the amount of PCM was studied. The theoretical results obtained confirmed those obtained experimentally.