EFFECT OF USING NANOFLUIDS AND PROVIDING VACUUM ON THE YIELD OF CORRUGATED WICK SOLAR STILL

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ABSTRACT

The performance of the corrugated wick solar still with internal reflectors, integrated with external condenser and using different types of nanomaterials is investigated and compared with conventional still under the same metallurgical conditions. The influences of saline water depth (1, 2, and 3 cm) on the corrugated wick solar still performance have been investigated.Experimentations obtained that the productivity of a corrugated wick still with reflectors when providing vacuum was about 180% higher than that of the conventional still. In addition, using the cuprous and aluminum oxides nanoparticles increases the yield of modified corrugated wick still solar still with reflectors when providing vacuum by about 285.10% and 254.88% respectively.

Keywords: Corrugated solar still; Wick solar still; Nanofluid; Aluminum oxide; Cuprous oxide

1 INTRODUCTION

Many attempts have been made to improve the performance of simple solar stills. The basin area of the still, free surface area of the water, depth of the water in the still and inlet water temperature are considered as the main factors affecting the productivity of the solar still. To increase the basin area, fins and corrugated absorbers [1] and wick [2,3] were used.The evaporation rate of brine water in the still can be faster for a good condensation condition. This can be achieved by providing vacuum inside the basin still [4] and integrating an external condenser with the solar still [5].The influence of using carbon nanotubes-water nanofluid on the distilled water productivity of a modified vacuum solar still was studied by Gnanadason et al. [6]. Kabeel et al. [7] studied the effects of using the cuprous and aluminum oxidesnanoparticles on the performance of a single basin solar still. The results showed that using the cuprous oxide nanoparticles, as well as the aluminum oxide nanoparticles, increased the distilled water productivity by about 133.64% and 93.87% and 125.0% and 88.97% with and without operating the vacuum fan respectively.

The function of this study is to combine between changing the basin liner to be corrugated, using double layer wick material, using internal reflecting mirrors, providing vacuum and using the cuprous and aluminum oxides nanoparticles and compare the performance of conventional single basin solar still with the modified solar still.

2 EXPERIMENTAL SET-UP

Two solar stills were designed and fabricated to study and compare the performance of the solar desalination systems. Fig. 1 shows a cross-sectional view of solar stills. The first one is a conventional still and the second is a modified still. The conventional still (a single basin) has a basin area of 0.5 m^2 (50 cm×100 cm).The modified still has the same specification and dimensions of conventional still except that the still base is not flat but has a corrugated form with a height of 50 mm.

3 RESULTS AND DISCUSSION

It is revealed from the resultsthat the basin water temperature of modified still is higher than that of conventional still but the glass temperature in modified still is less than that of conventional still.These differences in water and glass temperatures are because the combination of the reasons of increase in water temperature which is caused because of the particles of studied nanomaterial, vees surface of corrugated basin

liner, double layer wick material and reflecting mirrors. In addition to the reasons of decrease in glass temperature which is caused because of using the vacuum fan. Also, it can be observed that the fresh water productivity for modified still is greater than that of conventional type at all times.In addition, the results demonstrated that the distillate production of modified corrugated wick solar still with internal reflecting mirrorswhen integrating an external condenser only reached about 180% higher than that of conventional solar still. In addition, the productivity of modified corrugated wick solar still with internal reflecting mirrors when providing vacuum and using the cuprous oxide nanoparticles reached approximately 285.10% over the conventional still. Finally,the yield of modified corrugated wick solar still with internal reflectors when providing vacuum and using the aluminum oxide nanoparticles was greater than that of the conventional still byabout254.88%.

Fig. 2 shows a comparison between using corrugated absorber, reflecting mirrors, supplying wick material and integrating an external condenser at different depths of basin water with and without using nanofluids. It is seen from the figure that the more decrease in basin water depth, the more increase in productivity for all the three tested cases.

4 CONCLUSIONS

Integrating an external condenser with the corrugated wicksolar still with internal reflecting mirrors increases the amount of distilled water produced by about 180% compared with a conventional still, at a saline water depth of 1 cm. In addition, using the cuprous and aluminum oxides nanoparticles in the modified corrugated wick still with reflectors when providing vacuum increases the amount of distilled water produced by approximately285.10%and 254.88% compared to a conventional still respectively.

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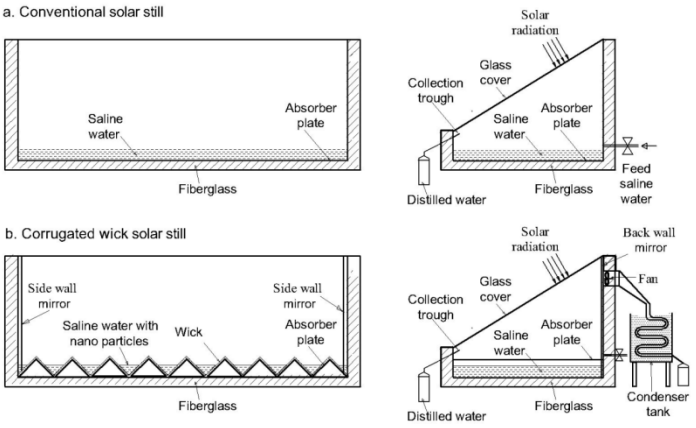

Figure 1. Cross-sectional view of solar stills

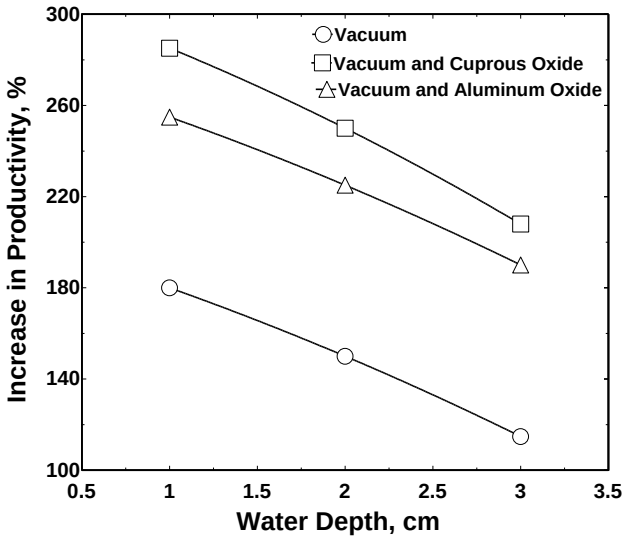

Figure 2 Variations of increase in productivity for the modified and the conventional stills.