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A thorough investigation of the effects of water depth on the performance of active solar stills

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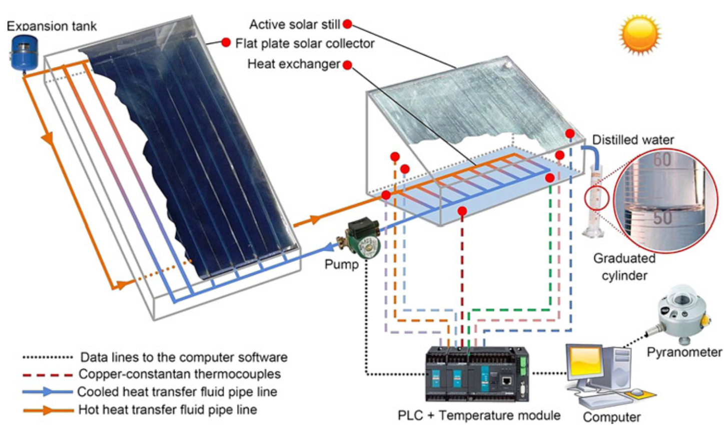
HIGHLIGHTS

- A thorough study was done on the effects of water depth in active solar stills.
- The long-term effects of the water depth were investigated for the first time.
- Two parallel active solar stills coupled with solar collectors were fabricated.
- The experiments were conducted for 10 continuous days to find the actual effects.
- The stills' production did not change significantly as the water depth decreased.

GRAPHICAL ABSTRACT



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ABSTRACT

One of the most important operating parameters which affects the performance and efficiency of active solar stills is brine depth. In all of the previous experimental or theoretical studies, effects of water depth were investigated during only the first 24-hour period (or even shorter periods) of the operation of active solar stills. In other words, only the first day was taken into account. However, the production of an active solar still depends on several parameters such as brine temperature at sunrise (initial temperature), which are all affected by the depth variation after the first day of operation. However, the present research experimentally investigates the long-term effects of water depth on the performance of active solar stills for the first time. For this purpose, two parallel active solar stills coupled with solar collectors with different surface areas were fabricated and an experiment was conducted for 10 continuous days. Unlike previous studies, results indicated that the overall trend of distilled water production and efficiency increased with increased water depth. Hence, higher water depth is recommended for practical uses of solar stills (more than two days).

1. Introduction

Nowadays, researchers have focused on the development of new technologies for overcoming the vital problem of water scarcity. Production of freshwater using desalination technologies along with

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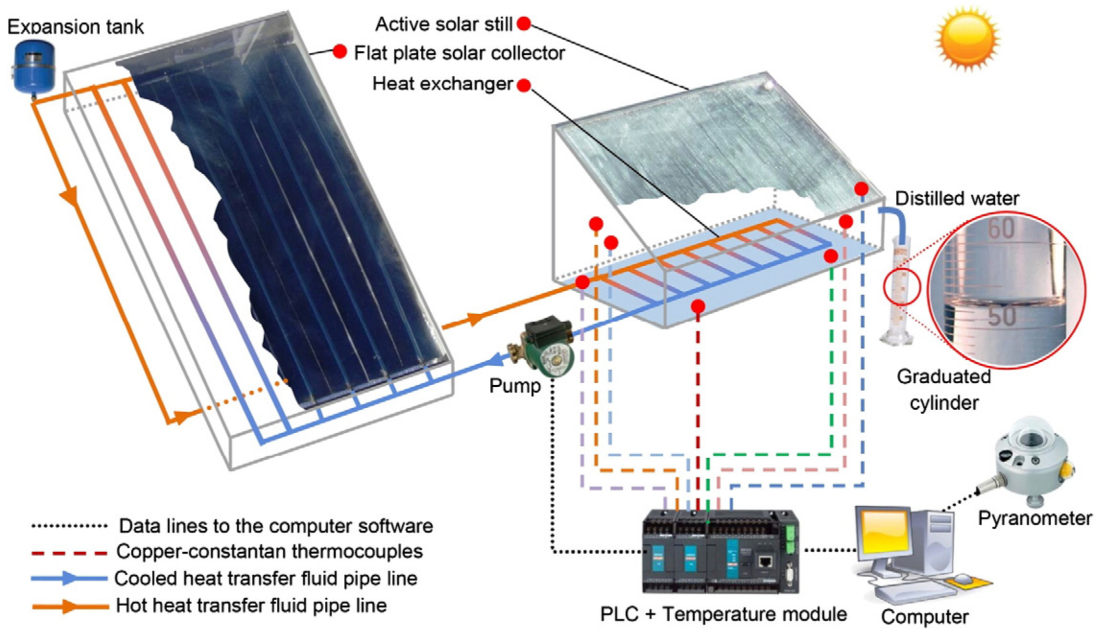

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Fig. 1. (a) A schematic view of the active solar still system, and (b) a photo of the active solar still system.

renewable energy systems is assumed to be a practical solution to water scarcity as well as energy and environmental crises [1–3]. Over the years, various devices have been developed to use solar energy for water purification, including solar stills [4,5]. Solar stills are well capable of utilizing the solar energy to desalinate brine. Thus, they are suitable alternatives to other expensive and unsustainable energy sources such as fossil fuels [6]. Therefore, solar stills can be used as one of the most suitable solar desalination units for low-capacity, low-cost, simple-to-operate and self-reliant water supply systems [7,8].

There are two main categories of solar desalination systems in terms of energy supply: passive and active solar stills [9]. In spite of the advantages of passive solar stills, their low productivity is considered as their main drawback [10,11]. This is caused by limited input energy which can be compensated by the active mode by feeding a thermal energy to the basin in addition to the energy received by the water exposed to solar radiation [12–14]. This extra thermal energy may be provided via any available waste recovery thermal energy from industrial plants or solar collectors.

The thermal performance of an active solar still is a function of design parameters such as water depth, the thickness of glass cover, the thickness of insulation, the material of the condensing cover, the type of solar collector and the number of collectors [15,16]. In addition, the changes in climatic parameters such as solar intensity, ambient

Table 1
The decreasing trend of water depth during the experiment.

Day	Starting day	1	2	3	4	5	6	7	8	9	10
Water depth in still number 1 (cm)	10	10	9.2	8.3	7.5	6.8	6	5.2	4.5	3.7	–
Water depth in still number 2 (cm)	10	10	9.5	8.9	8.3	7.8	7.3	6.7	5.7	4.8	4