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Cost analysis for several solar desalination systems

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HIGHLIGHTS

- A cost analysis is presented for selective passive and active solar stills.
- The capital costs (P) of the passive solar stills are relatively low.
- The best values of *CPL* are almost corresponding to the lowest values of the present capital cost.
- The production *CPL* of distillate using studied solar stills is more competitive compared to both Egyptian and Saudi markets.

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ABSTRACT

In this paper, a detailed cost analysis was presented for various configurations of passive and active solar stills. An Excel program was prepared for calculating the cost analysis parameters for the considered systems. There are only two input parameters; the present capital cost (P) and the annual yield (M = daily average productivity × 260 days). Number of life years was assumed to be 10 years. Cost comparisons between the different passive and active solar stills and with another works were presented; and some conclusions were drawn. Based on the obtained results, it can be concluded that the production cost per liter of potable water using either passive or active solar desalination techniques was more competitive compared to the price per liter in both Egyptian and Saudi markets.

Contents

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1. Introduction

The sun is the main source of all types of energy resources in the earth. Using fossil fuels leads to long term environmental problems, such as acid rains and greenhouse effects. The heavier problems are coming from using nuclear energy, mainly due to the unsaved risks. Under these conditions, there is a growing interest for renewable and eco-friendly energy sources such as solar energy. Solar energy is safe, clean in use and friendly with the environment.

The life without water is impossible; where, the origin and continuation of mankind is based on water. Water is one of nature's most important gifts to mankind. It covers 75% of the earth's surface and constitutes 60–70% of the organism's weight. Actually, only 1% of the world's water is usable to us [1]. Thus, that 1% of the world's water supply is a precious commodity necessary for our survival [2]. Fresh water can be obtained from seas and oceans by desalination techniques. The most developed and widely used technique for seawater desalination is the solar distillation process, especially in arid zones. Solar distillation of saline water has been used for many years. The decreased fresh water is not the only reason for forcing the increased application of water desalination technology. In many parts of the world, the increased pollution of rivers, lakes, and in some cases ground water has significantly reduced the quality of available fresh water sources.

Solar still is the most suitable and common device for converting brackish water to potable water. It can be easily fabricated using locally available materials that are easy to operate and maintain [3]. Various enhancement techniques have been investigated to improve the productivity of the solar distillation systems. These modifications could be applied to passive and active stills. Among of these modifications for the passive systems; using additional effects as dye, wick, fins, corrugated absorber plate, extra condenser, internal reflectors, step-wise basin and inverted absorber.

It is noticed that, a lot of researchers are interested in maximizing the production rate per basin unit area of solar stills, but the distillate production cost per liter (*CPL*) stills the major problem. Thus, compromising between distillate and potable water production cost per liter (*CPL*) has to be significantly considered. A lot of papers have been appeared in the last decade concerning the cost of production per liter. Different modifications are proposed for improving the productivity of the solar stills as well as the cost per liter of distilled water. These modifications can be achieved by either passive or active techniques. Kalogirou [4] reported that the 25% of the price of distillate attributes to the energy cost, if it produced using conventional fossil fuel in Cyprus. Somwanshi and Tiwari [5] reported that the water production cost was 0.0096 $/l for hot and dry climate and 0.0125 $/l for warm and humid climate.

In this paper, a detailed cost analysis is investigated for some selected passive and active design configurations of solar stills. It is referred that, all the studied solar stills in this work have been examined and produced for a specific experimental analysis not for the pilot plant level.

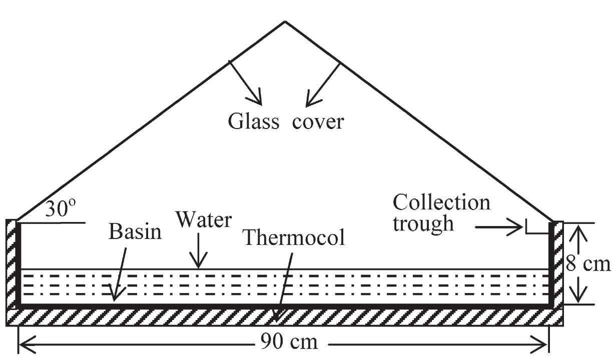

Fig. 1. Double slope single basin solar still [6].

2. Description of selected passive solar stills

2.1. Single basin solar still

Double slope single basin solar still is investigated by Rajaseenivasan and Murugavel [6]. The still is fabricated with a basin area of 0.9 m × 0.7 m and glass cover tilt angle of 30° with respect to the horizontal as shown in Fig. 1. The energy efficiency of the still is estimated as 31.63% for water depth of 2 cm in the basin. Single slope single basin

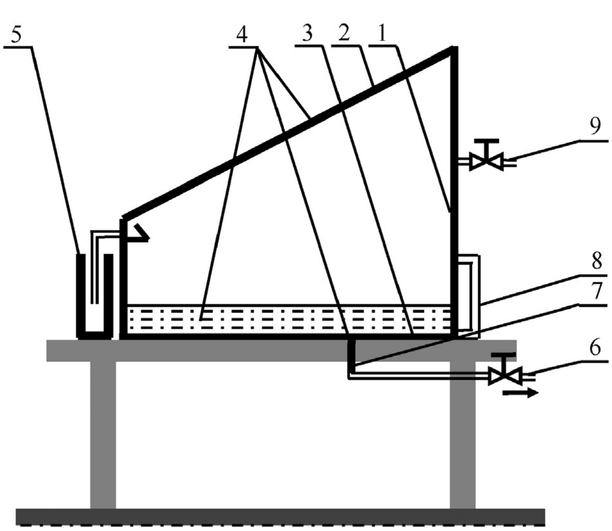

Fig. 2. Single slope single basin solar still. (1) Solar still frame, (2) glass cover, (3) absorber plate, (4) digital thermometer, (5) water vessel, (6, 9) control valve, (7) water drain and (8) graduate level [8].