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Investigation of the factors influencing the efficiency of a solar still combined with a solar collector

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ABSTRACT

A solar still was designed for the evaporation of desalination brine. The influence of several factors, such as the basin heating, the material of the cover (glass or polycarbonate), the existence of a mirror, the activation of an air extractor, and the existence of a black painted floor in the solar still, was evaluated in terms of their contribution to brine evaporation. The experiments were conducted with a factorial design approach. The combination of the factors that produced the best results was used in a subsequent daily monitoring study for brine evaporation. The monitoring parameters were the hourly average incident radiation, the changes in the temperature, the brine mass, and the brine volume. The accumulated amounts of the solar energy were calculated, and the correlation relationship was assessed.

Keywords: Basin heating; Factorial design; Solar radiation; Air extractor; Mirror

1. Introduction

The shortage of freshwater resources and the need for additional water supplies are already critical in many arid regions of the world and will be increasingly important in the future. Seawater desalination is usually found as a reliable solution in arid regions to meet the continuously growing demands for water due to population growth and economic and social developments and to reduce the dependence on groundwater resources [1,2].

Desalination plants generate pure water and brine (also known as retentate, concentrate, or reject), which is reported to be approximately 55% of the collected seawater [3]. The unwanted by-product, brine, may have a concentrated salinity as high as two times the typical seawater salinity [4]. The salinity of brine produced by desalination plants is reported to be approximately 60 parts per thousand (ppt) [2]. The temperature of the brine depends on the desalination technology. For example, the temperature of brine produced by evaporation technologies such as multi-stage flash (MSF) and multi-effect distillation (MED) could be very high [2,5]. Al-Mutaz and Al-Namlah [5] reported that in Saudi Arabian desalination plants, operational temperature during MSF process ranges between 90 and 115°C, although much lower temperatures were reported for reverse osmose brine [6]. One of the operational problems of the high-temperature desalination plants is the precipitation of carbonates. Glade et al. [7] reported that in multiple-effect distillers with horizontal tube falling film evaporators,

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