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Thermal models of solar still—A comprehensive review

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ABSTRACT

Water is vital to life and supplying of potable water can hardly be overstressed in recent years. The conventional desalination processes require significant amount of energy to convert brackish water into potable water for human consumption and industry. With an extensive research on various desalination systems over the last few decades, solar desalination is one of the most promising methodologies to provide high quality water to the human community by using sustainable source. The demand for a small scale self-contingent desalination device is the need of the hour. Solar still is an innovative device that utilizes solar energy to produce distilled water from brackish water. Numerous experimental research works have been reported in the literature to analyze the performance of various types of solar stills under local climatic conditions. Thermal models have also been presented based on energy balances and the theoretical results have been validated through experimental data by many researchers. Thermal models have a great advantage of predicting the performance of virtually designed solar stills without spending much cost and time. Accordingly, the usage of most recent theoretical attempts and proposed ideas tackling this point is limited. An attempt has been made in this article to provide a comprehensive review on thermal models developed for various types of solar stills and modifications done to improve their performance over the years. Our findings indicate that few more parameters and design aspects to be considered while designing new solar still. The efficacy of this study is that it provides energy researchers' insights into solar still design for clean water production and, thus, it promotes commercialization of this product in rural development. Finally, some general course of action are given for the selection of solar still with flexible, consistent and robust design. Suggestions for further research are also incorporated.

Contents

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1. Introduction

Water is a precious natural gift and an important renewable resource having several intrinsic advantages for human use. We are living today, in a ravenous world. The availability of clean and pure drinking water is the most urgent need for human community in many countries. The polluted water is not only devastating the people but also to all living things in this world. More seriously, it is a hazard to human health and nobody can escape from its horrible effects. The water-borne diseases are highly infectious which spread through contaminated water. The pure water is also needed for the areas like hospitals and dispensaries, chemical industries, battery maintenance, laboratories, etc. In developing and underdeveloped countries, the ground water resource is currently being depleted at a faster rate rather than the replenishment as compared to developed countries. The excessive use of chemical fertilizers and pesticides for agriculture is also an important reason to pollute the exhausting underground water. Indian villages are posed with overexploitation of ground water due to increasing dependence on it as other fresh water resources are dwindling fast [1]. This problem could be partially tackled by deriving the potable water from available brackish water with the help of technology developed by the scientists and researchers.

Safe drinking water from available water sources should be made by the application of eco-friendly technologies with least financial resources. Kalogirou [2] reviewed a large variety of systems, both conventional and renewable energy, used to convert sea water into fresh water suitable for human use. The conventional water distillation processes consume larger amount of energy to separate a portion of pure water from the brackish water. The physical change in the state of water as well as filtering via membrane processes, such as Multi-Stage Flash (MSF) distillation, Multiple Effect Distillation (MED), Vapor Compression (VC) distillation, Reverse Osmosis (RO), and Electro-dialysis (ED) are most often used to treat brackish water. Some of these processes are complex, requiring skilled operation and maintenance, and not considered to be energy efficient and economical.