



Stepped solar Stills: A comprehensive review of Design, Performance, and optimization strategies for sustainable water desalination

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ABSTRACT

Solar distillers are frequently used to desalinate water into drinkable water by utilizing solar energy. However, their low productivity and efficiency have hindered their widespread adoption, especially in dry and isolated areas where freshwater is crucial. Stepped solar stills, which merge a sequence of cascading basins that operate at progressively lower temperatures, are an intriguing idea that aims to improve the performance and productivity of solar stills. This research intends to scrutinize stepped solar stills' effectiveness, examining their design, operation, and applications. Various configurations of stepped solar stills, such as the number of stages, materials used, and heat transfer techniques, are discussed in the paper. Theoretical and practical investigations into the thermal behavior and heat transfer properties of stepped solar stills are evaluated, as well as the technology's benefits and constraints. The study also assesses the usefulness of stepped solar stills in different climatic conditions, as well as their potential use in agriculture, industry, and disaster relief efforts. Additionally, the economic viability and environmental sustainability of stepped solar stills are analyzed. In summary, this review paper delivers an in-depth analysis of stepped solar stills and their potential to mitigate global water scarcity. The research concludes by identifying future research and development prospects and challenges in this field.

1. Introduction

Life on planet Earth depends on water, which is one of the most crucial substances. It is indispensable for daily activities and plays a vital role in agriculture, industry, and other sectors. Fresh water resources are limited and fast diminishing. Freshwater is increasingly in demand due to population increase and growth in the industry [1]. As we know,

water covers nearly 71 % of the surface of the Earth. All forms of water can exist in the oceans (which cover nearly 96.5 % of the water on Earth), lakes, rivers, icecaps, glaciers, and soil moisture water, besides water vapor. The freshwater percentage on the surface of the earth is about 3 %, with nearly 2.5 % not being usable (trapped in the atmosphere, polar mountains, soil that is heavily contaminated, glaciers, or lying excessively deep beneath the earth's ground to be extracted

Abbreviations: SS, Solar Still; ETC, Evacuated Tube Collectors; HDH, Humidifying-Dehumidifying; MED, Multi-Effect; MSF, Multi-Stage Flash; FO, Forward Osmosis; RO, Reverse Osmosis; PV, Photovoltaic; PCM, Phase Change Material; SLS, Sodium Lauryl Sulfate; TBT, Top Brine Temperature; DP, Daily Productivity; TDS, Total Dissolved Solids; CPL, Cost Per Liter.

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