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Different domestic designs of solar stills: A review

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ABSTRACT

Access to safe, fresh and clean drinking water is one of the major problems in different parts of the world. Among many water purification technologies solar desalination/distillation/purification is one of the most sustainable and attractive method employed to meet the supply of clean drinkable water in remote areas at a very reasonable cost. Over the past three decades, there have been numerous designs of solar still system developed worldwide. However the technology is not commercialized and standardized because of its lower yield. This article provides a comprehensive review of the various designs of solar stills used at domestic level. Performance parameters like heat transfer analysis, energy analysis, exergy analysis, thermal efficiency and economic analysis have been presented for the domestic designs of solar stills. Though solar still have not been successfully commercialized as yet, with the ongoing research efforts, they can be modified and improved for future domestic applications.

Contents

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Nomenclature

T_a	atmospheric temperature in (°C)
T_g	glass cover temp in (°C)
T_w	basin water temp in (°C)
I_g	total solar radiation in (W/m^2)
P_w	partial pressure of vapour at water surface
P_g	partial pressure of vapour at glass surface
h_{cw}	convective heat transfer coefficient from cover to atmosphere
h_{ew}	evaporative heat transfer coefficient from water to cover
q_{ew}	evaporative heat transfer coefficient
m_w	yield of solar desalination system
η	efficiency of solar desalination system
α	absoptivity
τ	transmitivity
$(\alpha\tau)_{\text{eff}}$	effective product of absoptivity and transmitivity
ε_w	water emissivity
ε_g	glass emissivity
Δt	time interval
U_b	overall bottom heat loss coefficient (W/m^2/°C)
U_l	Overall heat loss coefficient (W/m^2/°C)

Subscript

g	glass
b	basin
a	ambient
w	water

1. Introduction

Fresh water is the basic requirement for all living organism. Nowadays, the availability of clean water resource is a major issue for mankind. More than 71% of the earth surface is covered with the water, but only 1% clean drinkable water is available with the international standards. There are several techniques to convert brackish water to potable water [1]. Advance desalination method like reverse osmosis, Ozone, UV, electro dialysis, activated carbon filtration and vapour compression are used to provide clean potable water. However, people living in remote areas can't afford and use those costly technologies [2]. Solar still is viewed as the alternate renewable energy technology to supply water to remote areas at a very low cost. Solar still is easy to fabricate on small scale and requires very less maintenance [3]. A solar passive distillation system collects the solar energy to produce pure water by the process of evaporation and condensation in the basin, leaving behind all the organic and inorganic impurities [4]. Solar radiation is used for desalination of brackish water into potable water. Many designs of solar stills have been developed for the production of pure water. However, solar stills are not widely used because of its low thermal efficiency (max. around 30%) and low yield (approximately 2–3 l/m^2/day) [5,6]. Thus it becomes necessary to increase the yield of the present solar desalination systems. Many studies have been carried out to enhance the thermal efficiency and productivity of the still by various researchers [7–10].

In this article, various designs of solar stills used at domestic level has been reviewed. The article also provides complete analytical methodology for performance evaluation of solar still in terms of heat transfer analysis, energy analysis, exergy analysis, thermal performance and economic analysis.

2. Classification of solar still

Many research work has been carried out on designs of solar still by various researchers throughout the world. Most of the conventional still developed employs a single basin for meeting water requirements up to 5 l/day. The various designs of domestic

Table 1
Materials used for fabrication of solar still.

Materials	Use
Plexiglass, toughened glass and polythene	Glass cover
Fibre reinforced plastic, wood, G.I sheet	Basin
Glass wool and ceramic wool	Insulation
Aluminum cladding	Supporting structure
Sand, photo catalyst, sponge, wax	Heat storage

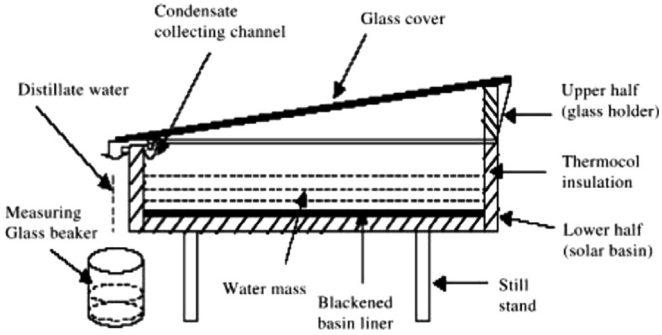

Fig. 2. Schematic diagram of Sahoo et al. solar still [11].

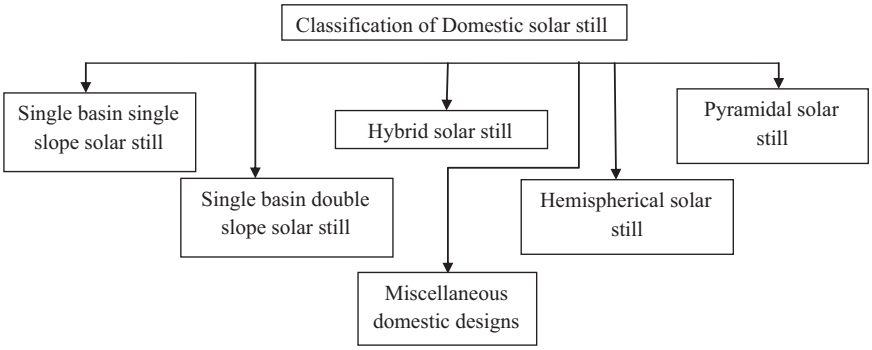

Fig. 1. Classification of domestic solar still.