Renewable and Sustainable Energy Reviews 20 (2013) 364–377

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Progresses in inclined type solar stills

K. Kalidasa Murugavel [a,*], P. Anburaj [a], R. Samuel Hanson [b], T. Elango [c]

[a] Centre for Energy Studies, National Engineering College, K. R. Nagar-628503, Tamil Nadu, India
[b] Department of Mechanical Engineering, Infant Jesus College of Engineering, Kela Vallanadu-628851, Tamil Nadu, India
[c] Department of Mechanical Engineering, Udaya School of Engineering, Vellamodi-629204, K.K. District, Tamil Nadu, India

A R T I C L E I N F O

Article history:
Received 31 December 2011
Received in revised form
4 October 2012
Accepted 8 October 2012
Available online 9 January 2013

Keywords:
Desalination
Solar still
Inclined still
Productivity enhancement

A B S T R A C T

Basin type solar still is a simple device which can be used for fresh water production. The main drawback of a conventional basin solar still is the low amount of distilled water production per unit area which makes the single-basin solar still uneconomical. In inclined still, higher surface area and thin water surface are its advantages and maintaining continuous wetness along the inclined surface and loss of heat through raw water drain are the problems. This work reviews different methods used to improve the effectiveness on the inclined solar still so far by different researchers and compare their performances.

Contents

1. Introduction

More than two-thirds of the earth's surface is covered with water. Most of the available water is either present as seawater or icebergs in the Polar Regions. More than 97% of the earth's water is salty; rest around 2.6% is fresh water. Less than 1% fresh water is within human reach. As the available fresh water is fixed on earth and its demand is increasing day by day due to increasing population and rapid advancement of industry, there is an essential and earnest need to get fresh water from the saline/brackish water present on or inside the earth. Fresh water from saline/ brackish water can be obtained using different water treatment processes.

In the remote areas, people struggle to get pure water at a low cost. Solar desalination using still is the sustainable solution for this problem. Basin type still is simple and easy to fabricate but not economical due to its lower productivity. To increase the production, different designs were tried; inclined still is one such type. Comparatively, limited progresses were made in the improvements of inclined still. This paper consolidates and presents different efforts made to improve the productivity of the inclined solar still.

* Corresponding author. Tel.: +919677928940; fax: +914632232749.
E-mail addresses: kali_vel@rediffmail.com,
hodces@nec.edu.in (K. Kalidasa Murugavel).

1364-0321/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rser.2012.10.047

2. Types of water treatment processes

Different water treatment processes were evolved to treat water using mechanical, electrical and thermal techniques such as micro-filtration, dialysis, distillation and freezing during the last decades. Table 1 lists some of the water treatment processes.

3. The need for solar Desalination

All the water treatment processes listed in Table 1 use a large amount of energy to remove a portion of pure water from a salt water source. Salt water (feed water) is fed into the process, and the result is one output stream of pure water and another of wastewater with a high salt concentration. It has been estimated by Kalogirou [1] that the production of 1000 m^3 per day of fresh water requires 10,000 t of oil per year. This is highly significant as it involves a recurrent energy expense which few of the water-short areas of the world can afford. Large commercial desalination plants using fossil fuel are in use in a number of oil-rich countries to supplement the traditional sources of water supply. Other countries in the world have neither the money nor oil resources to allow them to develop in a similar manner and because of this energy demand and high cost of plants, we prefer solar energy for the desalination process. Depending on the techniques adopted for evaporation and condensation, the solar desalination processes are classified as shown in Fig. 1.

4. Solar still

A solar still is a simple device which can be used to convert saline, brackish water into drinking water. Solar stills use exactly the same processes which in nature generate rainfall, namely

Table 1
Different water treatment processes.

Serial no.	Name of the type.	Description
1	**Reverse osmosis**	Here saline water is pushed at high pressure through special membranes allowing water molecules pass selectively and not the dissolved salts.
2	**Vapour compression**	Here water vapour from boiling water is compressed adiabatically and vapour gets superheated. The superheated vapor is first cooled to saturation temperature and then condensed at constant pressure. This process is derived by mechanical energy.
3	**Distillation**	Distillation is one of many processes that can be used for water purification. This requires an energy input, as heat, solar radiation can be the source of energy. In this process, water is evaporated, thus separating water vapour from dissolved matter, which is condensed as pure water.
4	**Multistage flash distillation**	The MSF process is combined of series of elements, called stages. In each stage condensing steam is used to pre-heat the seawater feed. By fractioning the overall temparature differential between the warm source and seawater into a large number of stages, the system approaches ideal total latent heat recovery. Operation of this system requires pressure gradients in the plant [2].
5	**Multiple-effect distillation**	Multiple-effect basin stills have two or more compartments. The condensing surface of the lower compartment is the floor of the upper compartment. The heat given off by the condensing vapor provides energy to vaporize the feed water above. Multiple-effect solar desalination systems are more productive than single effect systems due to the reuse of latent heat of condensation [3].
6	**Humidification and dehumidification**	In this system, air is used as a working fluid. This process is based on the principle of mass diffusion and utilizes dry air to evaporate saline water, thus humidifying the air. During dehumidication process, the vapor condenses and deliver pure water [3].
7	**Freezing**	The concept is appealing in theory because the lesser thermodynamic energy required for freezing than for evaporation since the latent heat of fusion of water is 6.01 kJ/mole while the latent heat of vaporization at 100 °C is 40.66 kJ/mole. In refrigeration freezing, a standard refrigeration cycle is used to cool the product water stream until ice forms. The ice is scraped off and melted [3].

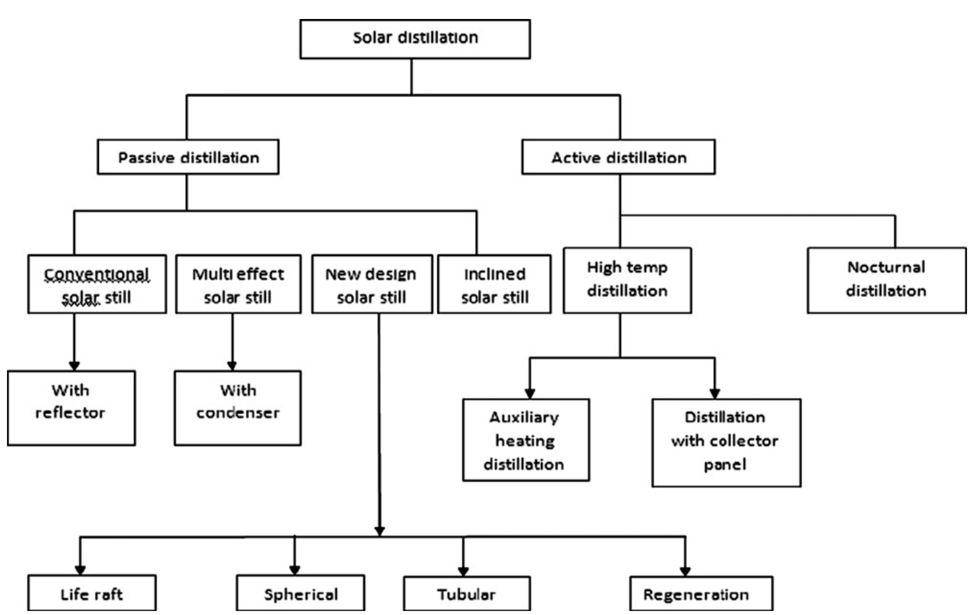

Fig. 1. Classification of solar distillation.