International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Desalination of Brackish Water into Potable Water using Solar Still System

Akhilesh S.Pawar†*, Sumit K.Phadke†,Ravikiran D.Kulat†, Nitin B.Koli† and Shivaji P.Yadav†

†Mechanical Engg. Department, Marathwad Mitra Mandals Institute of Technology, SP Pune University, Pune India

Accepted 01 Oct 2016, Available online 05 Oct 2016, **Special Issue-6 (Oct 2016)**

Abstract

Water scarcity is a growing problem for large regions of the world. The primary drivers of increasing water scarcity are population growth and the higher consumption associated with rising standards of living. Access to safe, fresh and pure clean drinking water is one of the major and biggest problems in different parts of the world. Among many of water purification technologies solar desalination/distillation/purification is one of the most sustainable and attractive method employed to meet the supply of clean and pure drinkable water in remote areas at a very reasonable cost. However this article provides the comprehensive review of solar still which is used at domestic level. Though the solar still have not been successfully commercialized as yet, with the ongoing research efforts, they can be modified and improved for future domestic applications.

Keywords: *Domestic solar still, Desalination, Single basin single slope solar still, Single basin double slope solar still Pyramidal still, Performance, Efficiency*

1. Introduction

Pure water is the basic necessary for all living organism. Now days, the availability of clean water resource is a major issue for mankind. A lack of infrastructure for water storage and distribution is also a factor in the developing world. More than71% of the earth surface is covered with the water, but only 1% clean drinkable water is available with the international standards (Dev Rahul, Tiwari G.N. , 2009). There are several techniques to convert brackish water to potable water Advance desalination method like reverse osmosis, Ozone, UV , electro dialysis, activated carbon filtration and vapor compression are used to provide clean potable water. However, people living in remote areas can't afford and those costly technologies solar still is viewed as the alternate renewable energy technology to supply water to remote area at a very low cost. Solar still is easy to fabricate on small scale and requires very less maintenance 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 solar radiation is used for desalination of brackish water in to 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. around30%) and low yield (approximately 23 l/m^2/day) thus it become 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. In this article, various designs of solar stills used at domestic level have been reviewed. The article also provides complete analytical methodology for performance evaluation of solar still in terms of heat transfer analysis, energy analysis, thermal performance and economic analysis. Solar still developed so far includes single basin single slope, single basin double-slope and pyramid type solar still. The broad classifications of solar still are illustrated in Fig. 1. Commonly used materials for fabrication of solar still are listed in Table1.

2. Basic Concepts of Desalination

2.1 Characteristics of Raw Waters

The composition of a raw water source has a guiding effect on the selection of the treatment technology to be used. Different desalination technologies perform most economically indifferent ranges of salinity, in part because some methods of desalination require greater energy per unit mass as the salinity rises. Further, saline waters may contain a considerable variety of dissolved ions, and the proportions of ions found in low-salinity, or brackish, ground waters are typically quite different than those in high salinity seawater or those found in waste waters. Salinity per se is a term related to the electrical conductivity of the water, and it gives a bulk measurement of the total dissolved solids

*Corresponding author: **Akhilesh S.Pawar**

(TDS, typically in ppm or mg/kg). And pH shift during H2O removal (Tabrizi Farshad *et al*. 2010). The thermo physical properties of saline waters are to a first approximation similar to pure water. Additional significant differences between saline water and fresh water stem from the solubility limits of the dissolved ions, including the precipitation of scale-forming salts, such as CaSO4, MgOH, and CaCO3, and the outgassing of CO2 as the raw waters alkalinity.

2.2 Basic concept of solar still desalination method

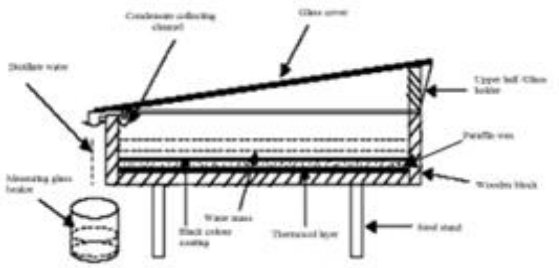

Fig.1 logic for selection of interactions

Top One inlet for supply of saline water or brackish water and outlet for collection of pure distills water is also connected. The five layers are as follows: Wooden block, Thermacol layer, Paraffin wax, Black color coating. From construction point of view wooden block is placed at the base of the system.it mainly plays two roles first is to support the whole system and acts as an accumulator of heat energy. The next layer is of thermacol, which is a bad conductor of heat so we use it as an insulator. From construction point of view the third layer is the most important one.it is of paraffin wax.It is a solid derivable of petroleum and coal. It is a mixture of hydrocarbons and contains at least 20-40 carbon atoms. This bluish white odorless substance has melting point in between 46-68 degrees. Its density is 900kg/m. Its specific heat is 2.14J-2.9J and heat of fusing is 200-220J.It is an excellent substance for storing heat and also acts as a" PHASE CHANGE MATERIAL". In presence of sunlight it absorbs the entire radiant heat incident upon it and stores it during this process its phase changes from solid to liquid and it regain its original solid phase by liberating vast tremendous amount of heat in absence of sunlight. This characteristic of this wax plays a vital role in an operation for desalination of brackish water. The last layer is of black sheet. It absorbs the entire light energy incident upon it and stores the heat energy.at the end of the process when the saline water is converts in a vapor and pure water condenses on a glass in the form of water droplets. This water then collected through outlet (Kabeel AE, 2009).

3. Different types of solar stills based on design

3.1. Single basin single slope solar still

Dev and Tiwari (2009) dealt with different inclination angles of the condensing cover (15degree, 30degree, 30degree, 45degree) in their experimental setups of single slope passive solar stills and also evaluate optimum water depth (0.04m)inside the basin to maximize the yield.The optimum inclination angle was obtained 45degree for the best performance of single slope solar stills.Figure shows the different solar still used in the experiment Fig. 2.

Fig.2 Solar still with different angles

3.2 Single basin double slope solar still

Tabrizi and Sharak,(2009) fabricated a single basin double slope solar still.The basin was loaded with sand (2.5 g/cm^3), because of its low cost and large availability as a heat reservoir.Average measured specific heat capacity of the sand is 704J/kg/1C (Samee MA,*et al*.2007).

Fig.3 Kabeel pyramidical solar steel

3.3 Analysis and evaluation

There are several different methods for desalination of water. They are as follows –

1. Reverse Osmosis

This process mainly contains a RO membrane which works for the removal of dissolved salts. The contaminants which have molecular size more than 200 can't be passed from the membrane but the water this is how pure water accumulates at the other side of membrane and we finally get the pure water. This is the simplest method but it does have some drawbacks. Complete removal of minerals can alter the water PH and we need demineralized for industrial purpose.

2. Activated carbon filtration method

In this method carbon metal is mainly used for purification purpose. In operational point of view circular carbon rod with a ceramic coating is used. While filtration carbon atoms attracts the contaminants without hazarding the basic properties of water. it is the fast process. Except some loose ends, they are as follows. Carbon atom has a limited life and we need to change it after particular time period. the

purification isn't uniform it depends on the carbon quantity. There is chance that some of the impurities cannot be purified and persists.

Ultraviolet filtration: Basically UV energy found in the electromagnetic spectrum between visible light and X rays which is invisible. UV energy penetrates the outer cell membrane of the contaminants. And disrupt its DNA preventing reproduction which is the excellent method to nullify the bacteria. It kills the bacteria but doesn't remove it from the water and is a little bit costlier. And for working of UV filtration we need electricity.

Solar Still Performance: However in comparison to all these methods solar still desalination proved to be the best one. Because it's advantages over the other methods are as follows. It doesn't require electricity, installation of such system is less expensive than others, and system is ecofriendly, widely used in domestic areas. By using the paraffin wax in the process the desalination/purification of water is increased from 5 to 6 liter per day. The productivity of the solar still follows the solar irradiation profile. It increases until midday and then decreases until sunset, as shown in Fig.4 (N. Ishimaru, 1994).

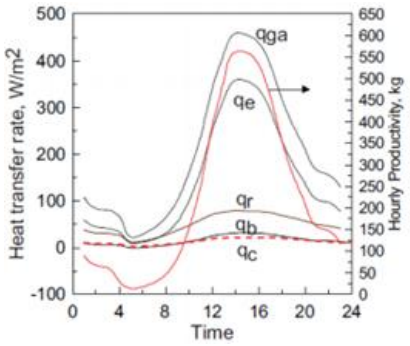

Fig. 4 Solar still performance, heat transfer rates, and productivity

This figure also shows the calculated magnitude of each heat transfer component. The results show that both higher solar intensity and effective glazing cooling increase the solar still productivity. If the still is well insulated, the stored heat maintains evaporation after sunset.

Conclusions

Solar desalination is attractive as a renewable powered means of providing fresh water at both large and small scales, and many of the worlds water-scarce regions have abundant solar energy. This review has considered basic concepts of desalination of saline water, simple solar stills provided with paraffin wax increases the efficiency and performance so we get 5 to 6 liter of pure water per day. In comparison to other desalination method solar still installation system is cheapest and ecofriendly. It can be inferred that solar-driven desalination will have a significant role in supplying the world's fresh water in the years to come.

References

J.Dev Rahul, Tiwari G.N.,(2009),Characteristic equation of a passive solar still Desalination, 19, pp. 245-246.

Farshad Farshchi Tabrizi, Ashkan Zolfaghari Sharak (2010), Experimental study of an integrated basin solar still with a sandy heat reservoir Desalination, 253(1).

Kabeel AE, (2009), Performance of solar still with a concave wick evaporation surface, Energy, 34 pp.152-156.

N. Ishimaru,(1994),Solar photovoltaic desalination of brackish water in remote areas by electrodialysis, Desalination, 29, pp. 198-210.

Samee M A, Mirza U K,Majeed T,Ahmad N, (2007),Design and performance of a simple single basin solar still, *Renewable Sustainable Energy Rev., 9,* pp. 129-133.