A Review of Conventional and Horizontally Double Sloped Solar Still

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Abstract— A desalination system works on electricity or a convention fossil fuel. Where thermal energy is extracted which leaves carbon residue and other greenhouse gases behind, which a major reason behind ozone depletion and global warming and may other health hazards for mankind. Desalination using a non-conventional resource will help. The desalination using solar energy is one-time investment for lifetime production of pure water up to 15 to 25 years. In this dissertation, multiple method of desalination has been discussed. The productivity of passive solar stills can be improved or enhanced by using various storage materials or by some simple modification in the design of still. These solar still can be used to convert brackish water into fresh water. Conventional solar still has low productivity and productivity of solar still many research iterates and puts their effort consistently. Many researchers have used metal particles of Nano sized to improve the thermal efficiency of the still. In this project, conventional solar still is compared with Horizontally Double Sloped solar still which resulted in increase in efficiency and productivity in the process of desalination which can be carried out by only using the energy from the sun.

Keywords: Economic Analysis, Solar Still, Solar Collectors, Nano Fluids

I. INTRODUCTION

A. Overview of Energy

Energy is defined as "the ability to do work". It plays a vital role in the development of any country. As we know, living organism needs energy for their work. The degree of development of the country is measured by the scale of utilizing of energy for human survival. Humans are continuingly doing research to find the alternatives of energy. So, they can increase their comfort level. As a country grows and develops the gross domestic product (GDP) increases and almost proportional to the energy consumption. Human development index (HDI) of India is very low, as compared to other countries. But, it is assumed that it will increase in upcoming years. Energy intensity is defined by the ratio of energy consumption to GDP. This factor is higher for developing countries in comparison to developed countries. "India's energy intensity is 3.7 times of Japan and 1.55 times of USA".

To fully meet the demand for energy, people use various sources that can provide energy efficiently and effectively. However, as the population grows, so does the need for energy. If we use energy resources very soon, they will be fully exhausted from nature, so we have to look for alternatives to non-renewable energy, which is also called Renewable energy source.

B. Method for Purification of Water

There are various methods to purify water, divided into four main categories are as follows, separation, filtration, chemicals, oxidation. There are five types of contaminants and impurities that are found in water i.e. bacteria, particulates, chemicals, minerals, and pharmaceuticals. Methods existing to remove these elements ranges from simple, cheaper and inexpensive to elaborate and costly. Often used in the production of pure potable water, several techniques must be combined in a particular sequence. The following methods are generally used to purify water as follows.

1) Sedimentation

The settling down of heavy suspended materials by the action of gravity is known as sedimentation.

2) Boiling Water

It is the process of heating water 15 to 20 minutes which kills 99.9% of all microorganisms and vaporizes most chemicals impurities which are dissolved in the water. It is also observed that after boiling, minerals, metals, solids and the contamination become more concentrated in cooking container.

3) Distillation

It is the process in which water boils and recondenses, but in output water, many chemicals are vaporized and recondensed in concentration. It is also expensive to boil & cool water due to the more heat required.

4) Ultraviolet Light

It is also a good bactericide and kills pathogens, but has no residual kill, and can effectively works only in filtered water.

C. Chemicals

Chlorine It is common, cheap, but extremely toxic in nature. It does not decrease physical or chemical contamination; it does increase cholesterol formations, is a carcinogen, and causes heart disease.

Bromine It is used in pools and spas, doesn't smell or taste as bad and doesn't kill bacteria very well.

Hydrogen Peroxide It kills bacteria with oxygen, is chemically made and is very toxic. It is used in emergencies.

Lime and Mild Alkaline Agents It should also be used with caution only by large water plants, or only for laundry.

Coagulation-Flocculation This method implies to add chemical which helps to lump together suspended particles for filtration or separation.

D. Ion Exchange

It exchanges sodium from salt for calcium or magnesium, using glauconitic (greensand), precipitated synthetic organic resins, or gel zeolite, thus softening the water. Minerals, metals, chemicals or odours are not affected, and the water is salty to drink.

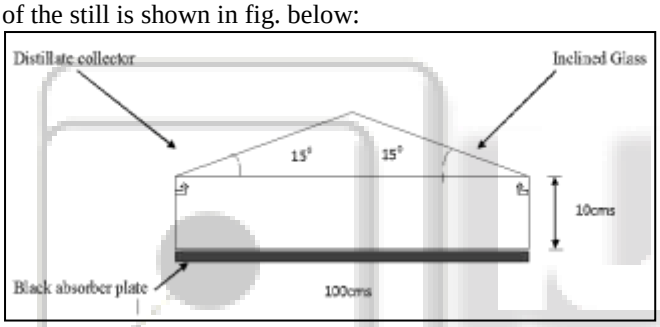
II. TYPES OF SOLAR STILL

Solar stills are basically classified into two types:

1) Active solar still
2) Passive solar still

Active solar still are the one in which external source of energy helps in water evaporation and condensation (at glass surface) process. While in passive type solar still undergoes direct heating no external source in employed for better productivity but various design modification can be done to obtain higher yield. An Opaque type double slope single basin solar still comes in this (i.e. passive) category.

Working of solar still is quite simple. It consists of a well fabricated basin having inclined surface on the top. Several valves for water inlet, outlet and distillate collection is provided. The water is poured from one end and filled up to a desired level (a lower depth of water gives higher productivity). The setup is placed in the sunlight. Sun rays after getting refracted from top glass surface falls on the water, raising its temperature. Slowly because of the rise in temperature inside the still, the water starts evaporating and gets condensed on the lower side of the glass surface. The condensed water then flows down on the inclined surface and gets collected in the distillate vessel. The schematic diagram of the still is shown in fig. below:



A. Double slope single basin solar still

Two major challenges for human society today are shortage of fresh water and shortage of conventional energy. Solar radiation is the best method for converting salty, brackish water to fresh water using an unconventional energy source that is freely and abundantly available on planet Earth. The main disadvantage of conventional tanks is still very low productivity. The most important design parameters affecting productivity are the optimization of glass slope, absorber plate area, free water level and water depth. The main problem with conventional stills is maintaining a minimum depth and a large surface area of water. An inclined solar still is an alternative to increase the surface of the water and keep the depth to a minimum. Researchers have made efforts to develop various designs of inclined solar stills to maintain minimum water depth using wicks, steps in stills to increase productivity.

III. LITERATURE REVIEW

M.H. Sellami, T.Belkins, M.L.Aliouar [2017] Four identical solar still prototypes were constructed and assembled, one of which was used as a witness unit (i.e. a reference unit without a sponge) while the parameters under investigation were applied to the other three units. The four units operate under recorded meteorological conditions, namely ambient temperature, solar irradiance and wind velocity shows a cross section schematic of the single-slope basin solar still used in these experiments. The solar still support was made of 40 mm thick wood. Its basin (absorber) is a tray (480 × 370 × 30 mm) made of 3 mm thick galvanized metal. The absorbers of both stills were blackened on the surface to ensure maximum absorption of solar irradiance for effective heating of the brackish water. The base of each assembly was further glued with a 30 mm thick polystyrene insulation. The 3 mm thick removable glass cover of the stills was placed such that it makes an angle of 30° with the horizontal which is recommended for the Ouargla region. The glass cover was sealed tightly with silicone sealant to prevent any vapor leakage.

Lovedeep Sahota, G.N.Tiwari [2016] Body of the still is fabricated with fiber reinforce plastic (FRP) with a top cover of 4 mm thick transparent glass at angle of 30°. The still is kept in east-west direction to retrieve maximum solar radiation. The internal surface area of the still's rectangular base is 2×1 m² and is blackened to absorb maximum sunlight. A fraction of sunlight is reflected from the outer surface of the transparent condenser cover and the water surface, the maximum of sunlight penetrates into the distillate and is absorbed in the liquid and the blackened inner surface.

P. Vishwanath Kumar, Anil Kumar, OmPrakash, Ajay Kumar Kaviti [2015] In the there study, a detailed an evaluation of all single- and multi-effect type solar stills with passive and active configurations can be obtained. The current reading aims to communicate the design conditions and highlight the features and shortcomings of the various solar stills that have been studied up until the recent past. There is also a discussion of the scope of the prospect with some recommendations for improving solar stills to economically produce sustainable drinking water.

Ali. F.Muftah, M.A. Alghoul n, Ahmad Fudholi, M.M. Abdul- Majeed, K. Sopian [2014] This effort aims to review the many studies on the factors that influence the presentation of solar still images. The results showed that the disinfection yields of solar stills are greatly affected by environmental conditions (e.g. ambient temperature, solar radiation, wind speed, dust and cloud cover), operating conditions (e.g. water) and design conditions (e.g. different passive/active designs of solar stills, cover slope, equipment selection, supplies, reflectors, insulation, gap distance and sun tracking system). This study demonstrated the fact that the decontamination productivity of a solar facility is severely affected by climatic, operational and structural parameters.

K.R. Ranjan1, S.C. Koushik1 and N.L. Panwar1 [2013] in this work, a broad thermodynamic model is accessible for the exergy analysis of a passive solar distillation system. The passive solar still is analyzed using thermodynamic energy and exergy analysis methods. A parametric study was conducted to determine the effect of various parameters such as saltwater depth, wind speed, insulation thickness, and glass enclosure tilt angle on the yield, energy, and exergy efficiency of a bowl-type passive solar still.

IV. METHODOLOGY AND EXPERIMENTAL SET UP

The experimental setup consists in 4 devices:

– Solar still combined to a condenser

- Compressor
- Thermometer
- Graduated bottle

A. Solar still

B. Conventional still with saline water

C. Solar still efficiency

Two kinds of solar still efficiency are distinguished: the hourly efficiency and the daily efficiency. The hourly efficiency reflects the ratio between the average latent heat, generated by the hourly produced water, and the total amount of absorbed solar energy. The variation of solar irradiance during the day time engenders, obviously, an hourly variation of solar still efficiency.

V. Conclusion

This project consists of two passive solar stills with one pool with double slope, water is used in both stills i.e. conventional still and non-conventional still. Observations were recorded during the experiments and from the analysis of the results that came and graphs were plotted with respect to the relevant parameters as follows.

- In terms of yield, maximum conversion of water is obtained from Horizontally Double Sloped solar still with 780ml of pure water at 1 cm depth of saline water, which is in comparison 34.48%
- The efficiencies get maximum by 10.37% when non-conventional solar still is used with only saline water at 2 PM. on using conventional still with saline water at 1cm it gives 9.17% at 1 PM.
- In terms of efficiency, it is observed that the overall maximum efficiency is obtained by Horizontally Double Sloped solar still is 10.37% which is 13.08% higher than the yield of conventional still using water
- So, it can be concluded that the Horizontally Double Sloped solar still is more optimized still for the production of pure water by using single basin double slope passive solar still.

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