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Review on Solar Still

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ABSTRACT:Solar distillation is one of the numerous processes that can be used for water purification. This requires heat as an energy input and solar radiation can be the source of energy. This energy is then used for evaporating water inside a device which is termed as a 'Solar Still'. A solar still is a device in which the solar distillation process occurs and is used for the low-cost production of potable water in areas where there is limited accessibility to fresh water or where rain, piped or well water is impractical. Solar still uses the principles of evaporation and condensation which uses energy from sunlight to separate fresh water from salts or other contaminants. Solar still consists of a basin that contains impure water and is covered tightly by glass cover. The water contained in the basin is evaporated by the heat of solar rays and is collected as pure water in the form of condensate. This project focuses on the design and development of single basin solar still with evacuated tubes and solar collector to convert the saline water into distilled water and to raise the daily productivity of solar still with less heat losses.
KEYWORDS: Solar Distillation, Solar Radiation, Basin, Glass cover, Solar Reflectors, Evacuated Tubes

I. INTRODUCTION

Water is a valuable natural gift and is being contaminated by human activities, urbanization and industrialization. The groundwater is frequently over exploited to meet the increasing demand of the people. Less than 1% of earth's water is available for human consumption and more than 1.2 billion people still have no access to safe drinking water. Over 50% of the world population is estimated to be residing in urban areas, and almost 50% of megacities having population over 10 million are heavily dependent on groundwater, particularly in the developing countries like India. Most of the rural people still live in utter poverty and often lack access to clean drinking water. Nearly half of the population is illiterate which is not aware of the waterborne diseases affecting their health. About 70% of the infectious diseases in India are waterborne. Indian villages are posed with problem of overexploitation of groundwater due to increasing dependency on it because other fresh water resources are declining fast. To purify this water and make it portable different methods are utilized such as desalination, electrodialysis, reverse osmosis, etc., are used.

Distillation process is considered to be one of the most broadly adopted techniques for converting saline water into pure water. More than 90% of the Worldwide installed sea water desalination capacity is based on distillation process which can be supplied by solar energy or any other fuel while in vapors compression, reverse osmosis and electrodialysis mechanical or electrical energy is used.

Distillation is one among various processes available for water purification, and sunlight is one of several forms of heat energy that can be used to power that process. To disperse a common belief, it is not necessary to boil water to distill it. Simply elevating its temperature will adequately increase the evaporation rate. In fact, although vigorous boiling accelerates the distillation process, it also can force undesirable residue into the distillate, defeating purification.

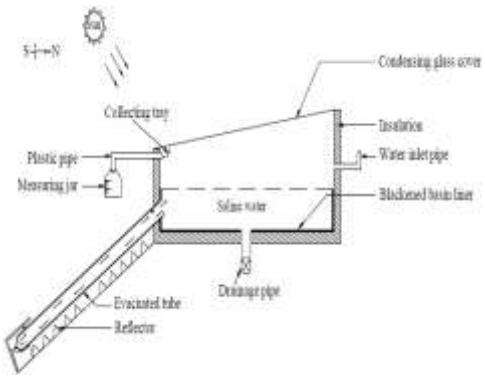

Fig.Schematic representation of Solar Still

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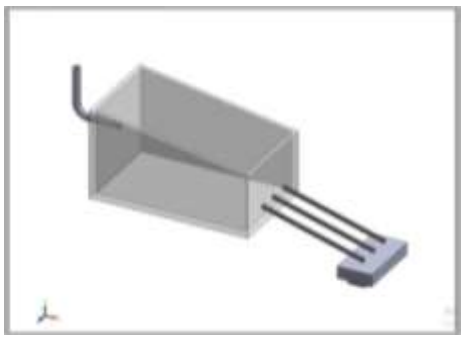

Fig.CAD model of Solar Still

Solar distillation utilise the heat of the sun directly in a piece of equipment to purify water. The equipment, called a solar still, is a man-made device in which the natural hydrological cycle has been imitated in miniature fashion and consists mainly of a shallow basin with a transparent glass cover. Solar still operates on the principle of solar distillation. A solar still replicates the way as rain water i.e. evaporation and condensation. Saline water is filled up in the black painted basin of the solar still which is completely enclosed in an air tight surface and a sloping transparent glass cover is provided at the top, then solar radiations are permitted to fall on it. Solar radiation is transmitted through the inclined glass cover which is absorbed in the black lining. The distiller is designed so that an efficient amount of solar radiations get trapped inside it. This raises the internal temperature of distiller which causes the saline water to evaporate leaving behind all the salt contents, herbicides, insecticides, viruses, bacteria, etc. The Solar reflectors and evacuated tubes can be employed to increase the water vaporization by increasing the temperature on the internal fluid heat absorber. This will improve efficiency and increases the quantity of daily pure water production. The resulting water vapour rises and condenses underneath of the cover as pure water and is collected in the condensate channel provided in the basin due to the inclination provided to the glass covers. Finally fresh water is obtained leaving behind the salts, minerals, and most other impurities, including germs.

Solar distillation is the most reliable, least expensive method of 99.9% real purification of most types of contaminated water exclusively in developing nations where fuel is uncommon or too expensive. Solar distillation process can be used to produce drinking water or to produce pure water for laboratories, lead acid batteries, automotive cooling systems, hospitals, chemical and industrial laboratories and in manufacturing commercial products. Conventional distillation technique consumes three kilowatts of energy for each gallon of water, whereas solar distillation uses energy from the sun which is readily available. Filtration and deionizing systems are more expensive to purchase and use and does not completely purify the water by removing all contaminants. Therefore Solar Still can be employed to produce fresh water as it is cheap and requires little to no maintenance.

II. LITERATURE REVIEW

[1].T. Arunkumar et al. (2) presented the fabrication of seven solar still designs (spherical, pyramidal, hemispherical, double basin, concentrator-coupled CPC tubular, CPC coupled with pyramid solar still) and their performance evaluation in converting brackish water into fresh water for drinking are presented. From the experimental results, tubular solar still coupled pyramid solar still shows the maximum amount of productivity due to the concentrator effect. The productivity of the solar still entirely depends on the climatic parameters as well as increasing the water temperature.

[2].Bhattacharyya et al. (5) concluded that the design development of both active and passive solar stills accelerates more and more solar energy utilization for desalination of water in a cost effective manner. For rural people in remote areas, passive solar still specially the wick or capillary type seems to be an attractive choice to get water for drinking and other domestic purposes. Advances have made to improve the evaporation rate of a capillary solar still by changing the fiber and fabric.

[3].Mulyanef et al. (3) studied experimental performance of solar still using reflector to produce fresh and salt water in the climate of Padang city, Indonesia. The solar collector is equipped with a reflector placed on the top of the cover with slope of 30º. Test results show that using reflector can increase temperature in the basin. Freshwater productivity also increases and speeds up time in producing salt. Average daily freshwater productivity increased by 16.8% during the testing period by adding reflector compared to solar still without reflector.

[4].K. Sampathkumar et al. (1) made an attempt to couple the water-in-glass evacuated tubes with single basin solar still is reported in this paper. Even though many active methods have been developed to increase the productivity of the solar still, the proposed experimental technique has increased the daily average production to 72%. For high temperature distillation, evacuated tubes have better performance when compared to flat plate collector and other solar collectors.

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[5].Panchal and Mohan et al. (7) reviewed various methods in increasing the distillate output in solar still. Numerous approaches that previous researchers utilized were presented; moreover, the results of different still designs with fins, various energy storage materials, and multi-basins were compared.

[6].G.N. Tiwari et al. (6) reviewed work on solar distillation, its present status in the world today and its future perspective. The review also includes water sources, water demand, availability of potable water and purification methods including the state of art and historical background. The classification of distillation units has been done on the basis of literature survey till today. The basic heat and mass transfer relation responsible for developing, testing procedure for various designs of solar stills have also been discussed. The present status of solar distillation units in India, economics of single and double slope fibre re-inforced plastic on the basis of long-term performance and recommendations for future have been discussed in brief.

[7].Al-Hinai et al. (4) individually performed parametric studies on conventional single slope and conventional double slope solar stills. They reported that distilled output of double slope solar still is higher compared with single slope.

[8].Abdallah et al. (9) deployed a sun tracking system for enhancing the solar still productivity. A computerized sun tracking device was used for rotating the solar still with the movement of the sun. A comparison between fixed and sun tracked solar stills showed that the use of sun tracking increased the productivity for around 22%, due to the increase of overall efficiency by 2%. It can be concluded that the sun tracking is more effective than fixed system and it is capable of enhancing the productivity.

[9].Syed Firozuddin et al. (10) Various aspects of single basin solar still with evacuated tubes solar collector with a focus on the use of evacuated tubes to increase the daily productivity of solar still with less heat losses. The pure water can be obtained by distillation in the simplest solar still.

[10].Hikmet S. Aybar et al. (8) reviews desalination by solar still, and the recent studies on the solar still systems. The review includes basic principle of solar distillation, and also the quality of distilled water. A classification of the solar still systems was made in order to explain the types of solar still systems. General mathematical modeling methodology of solar stills and some mathematical modeling studies are given. The efficiency and performance of the solar still system are also given and discussed.

III. OBJECTIVE

The main objective of this project is to enhance the performance of a simple solar still. To achieve this objective, certain modifications are to be done on the simple solar distillation system, and experimental and theoretical parametric studies are performed:

a) To enhance the performance of a simple solar still.
b) To enhance the productivity of a solar still by increasing temperature difference between water and glass.
c) To increase the daily productivity of solar still with less heat losses, the evacuated tubes are used with the solar basin.
d) To enhance the efficiency of a solar still by reducing the heat losses by using energy storage materials inside the basin and by studying the effect of various parameters like water depth, sponge liner thickness and colors, etc.
e) To fabricate a prototype model.

IV. CONCLUSION

Distillation is the process where water is removed from the contaminants and is then collected in the collecting tank. This can be achieved by the use of solar energy as the energy source. The device solar still utilizes solar energy to carry out the process of distillation of water which is called as solar distillation. The Solar distillation involves zero maintenance cost and no energy costs as it involves only solar energy which is free of cost. Solar still can be used in areas to obtain freshwater where other sources of water are impractical. Solar still coupled with evacuated tubes and solar reflectors are found to be effective to increase the productivity of the device. A solar still is a green energy product that uses the natural energy of sun to purify water and has low maintenance costs. Therefore, it can be a great alternative for the production of fresh water and can be used anywhere where adequate sunlight is present.

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