A Review to Improve the Productivity of the Hemispherical Type Solar Sill

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Abstract-Water is the basic need for sustaining life on the earth. With the passage of time due to technical usage and their waste disposal along with ignorance of human being caused water pollution, which led the world to water scarcity. To resolve this problem Solar Distillation is one of the best Techniques. But, due to its lower productivity it cannot be commercial in the market. So that Lots of work can be done to improve the solar still efficiency or productivity. With the help of past research work we can conclude that if we are using flat circular based absorber type hemispherical solar still than its productivity will going to be increased.

Key words: *solar still, hemispherical, productivity, Distillation, passive*

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I. INTRODUCTION

Water is the basic need for sustaining life on the earth. With the passage of time due to technical usage and their waste disposal along with ignorance of human being caused water pollution, which led the world to water scarcity. Due to water pollution the surface and underground water reservoirs are now highly contaminated [1]. Most of the human dices are due to brackish water problem. Around 1.5 to 2 million children are die and 35 to 40 million people are affected by water borne dices. However the increasing industrial activities may lead to a situation where by countries need to reconsider their option with respect to the management of its water resources. Around 3% of the world water is potable and this amount is not evenly distributed on the earth. So, developed and under developed countries are suffering the problem of potable water. Distillation is an oldest technique to distillate brackish or salty water in to potable water. Various technologies were invented for desalination from time to time and it has been accepted by people without knowing future environmental consequences. Desalination techniques like vapour compression distillation, reverse osmosis and electrolysis used electricity as input energy. But in the recent years, most of the countries in the world have been significantly affected by energy crisis because of heavy dependency on conventional energy sources (coal power plants, fossil fuels, etc.), which has directly affected the environment and economic growth of these countries. The changing climate is one of the major challenges the entire world is facing today. Gradual rise in global average temperatures, increase in sea level and melting of glaciers and ice sheets have underlined the immediate need to address the issue. All these problems could be solved only through efficient and effective utilization of renewable energy resources such as solar, wind, biomass, tidal, and geothermal energy, etc [2].The alternative solution of this problem is solar distillation system and a device which works on solar energy to distillate the water is called solar still. Solar still is very simple to construct, but due to its low productivity and efficiency it is not popularly used in the market. Solar still is working on solar light which is free of cost but it required more space. Its material is easily available in the market and it cannot require a higher skill for the maintenance. To increase the simple solar still efficiency so many works are done. Compared to passive solar still active solar still productivity is higher.

II. PRINCIPLE OF SOLAR STILL

The basin of the solar still is filled with impure water and the sun rays are passed through the glass cover to heat the water in the basin and the water gets heating up.Because of temperature difference between water and glass surfaces water gets evaporated. As the water inside the solar still evaporates, it leaves all contaminates and microbes in the basin. The purified water vapour condenses on the inner side of the glass, runs through the lower sideof the still and then gets collected in a closed container which is used as drinkable water[2].

Many solar desalination systems were developed in years by using the above principle of solar still in the world. So many works done on solar still, on this work solar still is divided in two parts: (i) passive solar still, (ii) active solar still.

In a passive solar still, the solar radiation is received directly by the basin water and is the only source of energy to raise the water temperature and consequently, the evaporation leading to a lower productivity.There are lots of work can be going on to increase the productivity of solar still.

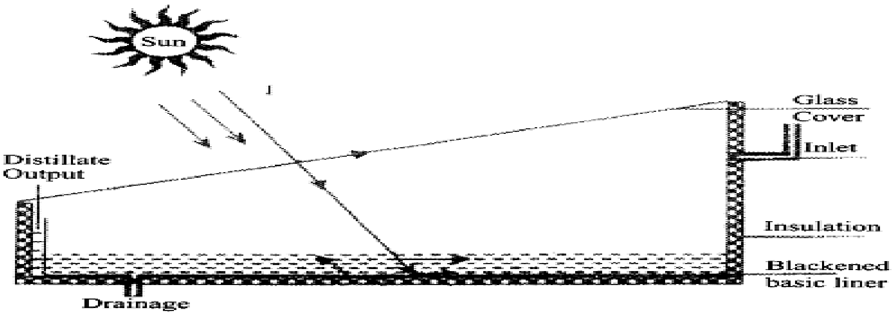


Fig.1. Schematic diagram of passive solar still [3]

The solar distillation systems are mainly classified as passive solar still and active solar still. The numerous parameters are affecting the performance of the still such as water depth in the basin,material of the basin, wind velocity, solar radiation, ambienttemperature and inclination angle. The productivity of any type ofsolar still will be determined by the temperature difference between the water in the basin and inner surface glass cover. In a passive solar still, the solar radiation is received directly by the basin water and is the only source of energy for raising the water temperature and consequently, the evaporation leading to a lower productivity. This is the main drawback of a passive solar still. Later, in order to overcome the above problem, many active solar stills have been developed. Here, an extra thermal energy is supplied to the basin through an external mode to increase the evaporation rate and in turn improve its productivity. The active solar distillation is mainly classified as follows [2]:

(i) High temperature distillation—Hot water will be fed into thebasin from a solar collector panel.

(ii) Pre-heated water application—Hot water will be fed into the basin at a constant flow rate.

(iii) Nocturnal production—Hot water will be fed into the basinonce in a day.

III. SOLAR DISTILLATION SYSTEM

GN Tiwari et al reviewed the present status of solar distillation systems for both passive and active modes. In this field a large group of authors reported that the passive solar distillation system is a slow process for purification of brackish water. The yield of this still is about 2L/day per m^2 of still area, which is much less and may not be economically useful.However, there is a method to increase the yield by integration of solar collector into the basin. This is generally referred to as active solar stills. These may be flat plat collector, solar concentrator or evacuated collector. These collectors may produce temperatures within the range of 80–120°C depending upon the type of solar collector. However, the range of temperature within solar stills is reduced to about 80°C due to high heat capacity of water mass within the basin. Hence there is a practical application of such active systems to extract the essence of medicinal plants placed under the solar still at about 80°C. The systems used for extraction of the essence of medicinal plants have become economical. [1]

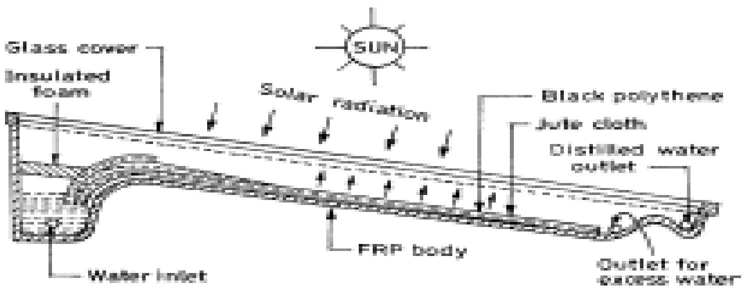


Fig.2. Cross - Sectional View of FRP Multi-Wick Solar Still [1].

Salah Abdallah et al. worked to measuring the Effect of various absorbing materials on the thermal performance of solar stills. From this Experiment they found that there is a strong need to improve the single slope solar still thermal performance and increase the production rate of distilled water. Different types of absorbing materials were used to examine their effect on the yield of solar stills. These absorbing materials are of two types: coated and uncoated porous media (called metallic wiry sponges) and black volcanic rocks. Four identical solar stills were manufactured using locally available materials. The first three solar stills contain black coated and uncoated metallic wiry sponges made from steel quality AISI 430 type, and black rocks collected from Mafraq Area in north-eastern Jordan. The fourth still is used as reference still which contains no absorbing materials (only black painted basin). The results showed that the uncoated sponge has the highest water collection during day time, followed by the black rocks and then coated metallic wiry sponges.

Fig.3. various absorbing materials used in solar stills

a) Uncoated metallic wiry sponge b) coated metallic wiry sponge, c) black volcanic rocks. [2]

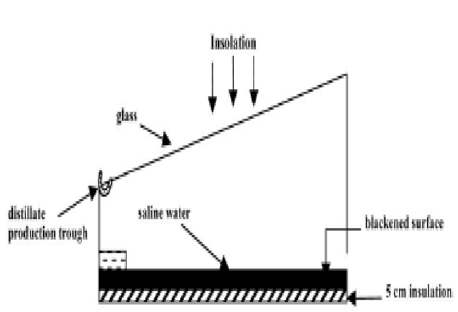
On the other hand, the overall average gain in the collected distilled water taking into the consideration the overnight water collections were 28%, 43% and 60% for coated and uncoated metallic wiry sponges and black rocks respectively.[2]

V.K. Dwivedia et al. can compare the internal heat transfer coefficients in passive solar stills by different thermal models by an experimental validation. In this paper, an attempt has been made to evaluate the internal heat transfer coefficient of single and double slope passive solar stills in summer as well as winter climatic conditions for three different water depths (0.01, 0.02 and 0.03 m) by various thermal models. The experimental validation of distillate yield using different thermal models was carried out for composite climate of New Delhi, India (latitude 28°35′N, longitude 77°12′E). By comparing theoretical values of hourly yield with experimental data it has been observed that Dunkle's model gives better agreement between theoretical and experimental results. Further, Dunkle's model has been used to evaluate the internal heat transfer coefficient for both single and double slope passive solar stills. With the increase in water depth from 0.01 m to 0.03 m there was a marginal variation in the values of convective heat transfer coefficients. It was also observed that on annual basis output of a single slope single slope solar still is better (499.41 l/m^2) as compared with a double slope solar still (464.68 l/m^2).[3]

Fig.4. Photograph of the Experimental Single Slope Solar Still. [3]

Fig.5. Photograph of the Experimental Double Slope solar still. [3]

A.A. Al-Karaghoulia et al. working on comparative study of theperformances of single and double basinsolar-stills. They fabricated two solar-stills (single basin and double Decker) and tested at theCampus of the University of Bahrain. Both stills have the same basin area. The inner dimensionsof each were 90×50 cm (effective area is 0.45 m^2). For the double Decker basin solar-still,the upper glass cover and the first basin were tilted at 12° with respect to the horizontal, whilefor the single-basin solar-still; the glass cover was tilted at 36° with respect to the horizontal.Several copper-constantan thermocouples were installed in both stills to measure the glasscover temperature, the chamber temperature, the water temperature and the ambient-airtemperature. The hourly amount of extracted distilled water, the various temperatures and theinsolation were monitored for a five-month period (February–June). Two types of measurementswere performed; one with still-sides insulation and the other without. It was found thatthe monthly average amount of the total daily-distilled water production was highest in Junefor both types of stills. This is expected, since the insolation during this month is higher thanthat in any other month during the testing period. For the double-basin still, with sides insulated,the June production was 1760 ml per day (3.91 l/m^2/day), and in the non-sides insulationcase the total daily amount was 1410 ml per day (3.13 l/m^2/day). For the single-basin still,the June daily production was 1280 ml per day (2.84 l/m^2/day) in the case of stills with side'sinsulation and 1105 ml (2.455 l/m^2/day) in the case of no-side insulation.



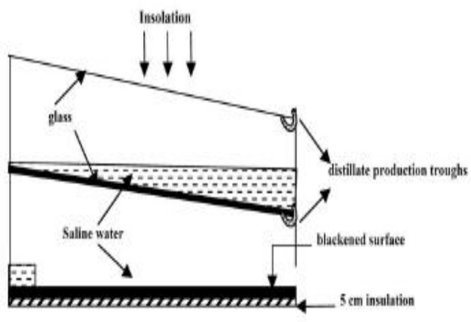
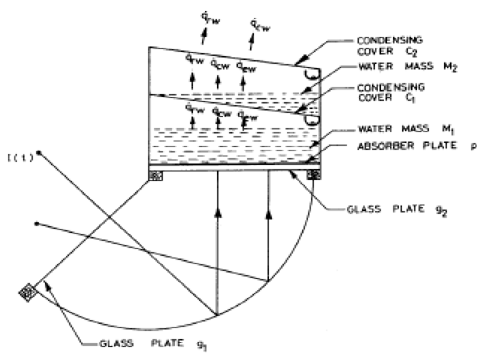


Fig.6. Cross-section of the double-basin water Fig. 7. Cross sectional side view of the single-basin solar-still

Solar-still designed at the University of Bahrain. [4]

In February, March,April and May the average total daily productions were 1045, 1340, 1420 and 1630 ml per dayin the case of stills with sides insulated and 843, 936, 1045 and 1180 ml per day in the case ofno-side insulation of the double-basin still respectively. For the single-basin still, the productionwere 720, 765, 890 and 1010 ml per day in the case of stills with sides insulated respectively,and 655, 745, 810 and 945 ml in the case of no-side insulation respectively. Thesemeasurements reveal the following: (i) adding 2.5 cm of styrobore insulation material to the solar stills' sides causes a noticeable increase in water production; and (ii) the daily averagestill production for the double-basin still is around 40% higher than the production of thesingle-basin still. [4]

SangeetaSuneja et al. measured n Effect of water depth on the performance of an invertedabsorber double basin solar still. They perform transient analysis of a double basin solar still has been presented. Explicit expressions have beenderived for the temperatures of various components of the inverted absorber double basin solar still andits efficiency. The effect of water depth in the lower basin on the performance of the system has beeninvestigated comprehensively. For enunciation of the analytical results, numerical calculations have beenmade by them using meteorological parameters for a typical winter day in Delhi. They observed that thedaily yield of an inverted absorber double basin solar still increases with the increase of water depth inthe lower basin for a given water mass in the upper basin. [5]



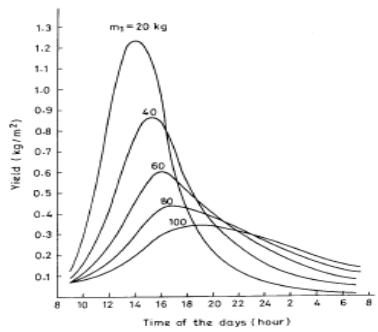


Fig. 8. Schematic view of an inverted absorber Fig. 9. Effect of water depth in the lower basin on the

Double basin solar still (M1=m1 and M2=m2). [5] Hourly variation of the total yield. [5]

SangeetaSuneja et al. worked onparametric study of an inverted absorber double-effect solar distillation system and Analysis of an inverted absorber double-effect solar still is presented. Energy balance equations have been written, and analytical expressions for water and condensing cover temperatures and the hourly yield have been derived. Numerical computations have been carried out for a typical day in Delhi. The results thus obtained have been compared with those of the conventional double effect (double basin) solar still. It was observed that an inverted absorber solar still gives a higher output than the conventional double-effect one.Absorber solar still gives a higher output than the conventional double-effect one. [6]

G.N. Tiwari et al. worked on Computer modeling of Passive/Active Solar Stills by using inner Glass Temperature. Expressions for water and glass temperatures, hourly yield and instantaneous efficiency for both passive and active solar distillation systems have been derived. The analysis is based on the basic energy balance for both the systems. A computer model has been developed by them to predict the performance of the stills based on both the inner and the outer glass temperatures of the solar stills. In this work two sets of values of C and n (C_{inner}, n_{inner} and C_{outer}, n_{outer}), obtained from the experimental data of January 19, 2001 and June 16, 2001 under Delhi climatic condition, have been used. [7]

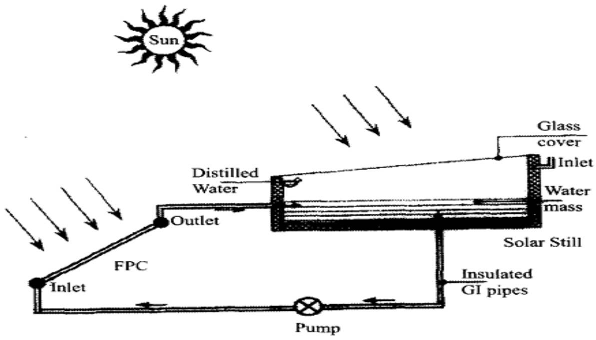


Fig. 12.a. Schematic diagram of active solar still. [7]

It is concluded that (i) there is a significant effect of operating temperature range on the internal heat transfer coefficients and (ii) by considering the inner glass cover temperature there is reasonable agreement between the experimental and predicted theoretical results.

Analysis of Double Effect Active Solar Distillation

Bhagwan Prasad and G N Tiwari Perform an analysis of a double effect, active solar distillation unit has been presented by incorporating the effect of climatic and design parameters. Based on an energy balance in a quasi-steady condition, an analytical expression for hourly yield for each effect has been derived. Numerical computations have been carried out for a typical day in Delhi, and the results have also been compared with single effect, active solar distillation unit. It has been observed that there is a significant improvement in the performance for a minimum flow rate of water in the upper basin. [8]

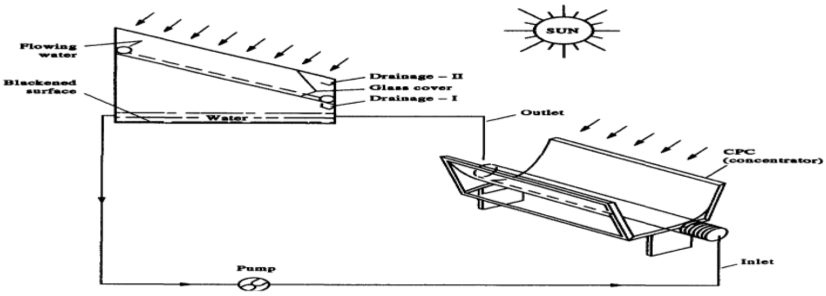


Fig. 13 Cross-sectional view of double effect active distillation system [8]

T. Arunkumar working on An Experimental Study on a Hemispherical Solar Still and This work reports a new design of solar still with a hemispherical top cover for water desalination with and without flowing water over the cover.

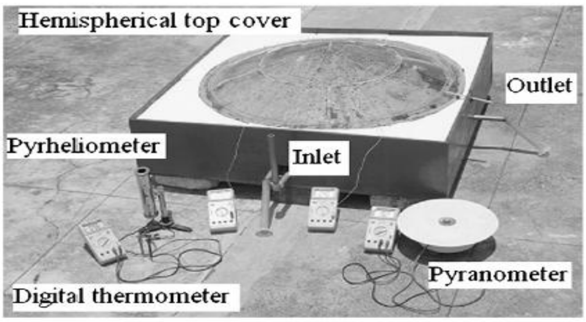


Fig.14. Experimental solar still

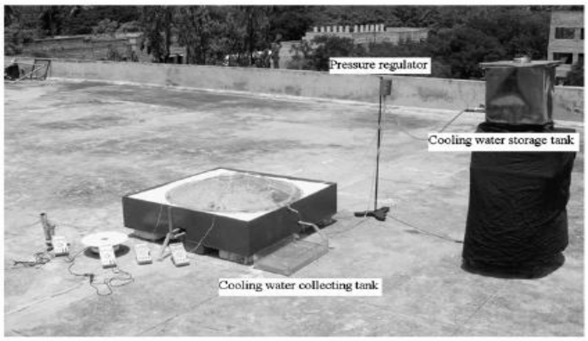


Fig.15. Solar still showing cooling water system [9]

The daily distillate output of the system was increased by lowering the temperature of the cover by water flowing over it. The fresh water production performance of this new still was observed in Sri Ramakrishna Mission Vidhyalaya College of Arts and Science, Coimbatore (11° North, 77° East), India. The efficiency was 34%, and increased to 42% with the top cover cooling effect. Diurnal variations of a few important parameters were observed during field experiments such as water temperature, cover temperature, air temperature, ambient temperature and distillate output.

Solar radiation incident on a solar still is also discussed here.[9]

Basel I. Ismail et al. represents a Design and performance of a transportable hemispherical solar still. A simple transportable hemispherical solar still was designed and fabricated, and its performance was experimentally evaluated under outdoors of Dhahran climatic conditions. It was found that over the hours of experimental testing through daytime, the daily distilled water output from the still ranged from 2.8 to 5.7 l/m^2 day. The daily average efficiency of the still reached as high as 33% with a corresponding conversion ratio near 50%. It was also found that the average efficiency of the still decreased by 8% when the saline water depth increased by 50%. [10]

IV. CONCLUSION

Our main focus is to improve the active solar still efficiency. The numerous parameters are affecting the performance of the still such as material of the basin, wind velocity, water depth in the basin, solar radiation, ambient temperature, inclination angle and type of collector used. The productivity of any type of solar still is determined by temperature difference between inner surface of glass cover and surface of water.

V. SCOPE OF FUTURE WORK

Very few researchers work on to improve the Productivity of Hemispherical type Solar still. If we want to improve the productivity of the Hemispherical solar still than we have to increases the contact area of water to the basin absorber plate. So, if we use the flat circular based absorber plate in the hemispherical type solar still than its productive output will be increasing.

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