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CURRENT STATUS OF RESEARCH ON SOLAR STILLS WORLDWIDE.

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Abstract

The standard of living and growth of population require more amount of fresh water. Water is required for various purposes like domestic, industrial and agriculture. Water desalination techniques are used to produce fresh water for both industrial and domestic purposes. One of options for desalination is solar still which uses solar energy. Use of solar energy for desalinating of sea water and brackish well water has been successfully demonstrated in several moderate sized pilot plants throughout the world. Many researchers introduce the wind turbine solar still and brine spray arrangement still, multi stage solar still, different basin depth still, hemispherical solar still, single slope and double slope solar still, multi effect tubular solar still, internal and external reflector, stepped solar still and absorber plate to increase the productivity of still. In this review, an attempt the study current status of solar still worldwide to improve the productivity of conventional solar still and save the cost of production and energy.

Introduction

Unavailability of fresh and clean drinking water is one of the major problems in the world. Agriculture and industries also require fresh water for their needs [1]. Human and animals both are use fresh water everyday [2]. In the present time many water purification technologies are available. The performance parameters like heat transfer analysis, energy analysis, thermal efficiency and economic analysis have been demonstrated by various researchers for the domestic designs of solar stills [3]. Solar desalination systems offer sustainable tools for fresh

water production [4]. Many sources of energy can be used for distillation of water such as fossil fuel and electricity. Renewable energies can also be used for this purpose to avoid energy and environmental crisis [5]. But the solar still provide fresh and clean water very cheapest cost [6].

Desalination through heat pipe and parabolic collector: Jafari made a new desalination system using a combination of heat pipe, evacuated tube and parabolic trough collector. Results show that the rate of production and efficiency can reach to 0.27 kg/(m^2 h) and 22.1%. In this research aluminum conducting foils are used in the space between the heat pipe and the twin-glass evacuated tube collector to transfer heat from the tube collector to the heat pipe and the twin-glass evacuated tube collector to the heat pipe, oil is filling the space between heat pipe and twin-glass evacuated tube collector [7].

Study of basin type solar still: Ayman introduced a modified basin type solar still. That system consists of a solar basin connected to an external air-cooled condenser and utilizes a vacuum pump to develop the vacuum condition. He is investigated decrease the saline water evaporation pressure allows a much reduction of energy in operation. The cost of analysis is carried out economical to the constructed desalination system. The experimental results get different for different seasons. An enhancement of 16.2% and 29.7% in productivity and a maximum desalination system efficiency of 40% obtained [8]

Semi circular absorber solar with baffles: The experimental investigation on a semi-circular absorber solar still with baffles for fresh water production is performed by Sathyamurthy. This research is increase the contact time of water in the basin for fresh water production. An experimental as well as theoretical investigation is carried out on research the daily production of present solar still is higher than that for conventional still 16.66%. The productivity and efficiency of present still are analyzed with the influence of the number baffles and the water flow rate. It can be coupled with multi-state of solar stills to increase productivity. This semi circular absorber solar still is sufficiently extended for other continuous solar desalination systems [9]

Study of evacuated solar collectors: Dan and Smyth performed analysis and comparison of concentrated evacuated tube heat pipe solar collectors. These evacuated tube heat pipe solar collectors were experimentally tested at a tilt angle of 60 to the horizontal. In this research concentrated evacuated tube heat pipe solar collectors made of single-sided and double sided absorber has been analyzed and compared under control conditions. The concentrated double-

sided absorber evacuated tube heat pipe proves better compared to the concentrated single-sided absorber evacuated tube heat pipe solar collector due to higher outlet temperature with greater temperature differential and improved thermal performance. That experiment shows temperature response and collection efficiency, heat loss coefficients and energy collection rates as well as the incident angle modifier (IAM) were recorded and compared at five different transverse angles (0–40) at 10 increments [10].

Analysis of a conical solar still: A conical solar still was made by Sheben. In the study, he estimated the heat transfer coefficients of a conical solar still. The experimental results of conical solar still were compared with a conventional solar still which has the same area. The results showed that, the daily yield for conical and conventional solar stills was 3.38 and 1.93 L/m^2 day. Heat and mass transfer coefficients were evaluated by the Nusselt and Sherwood numbers. The maximum resultant of total heat transfer coefficient is 66 and 32W/m2. The analogy between heat and mass transfer coefficients was also investigated (latitude 30.56 N and longitude 31.01 E). The still base area was 0.8 m^2 [11].

Thermal energy storage system: Nithyanandam introduced the design of a latent thermal energy storage system with embedded heat pipes. He shows that the thermal energy storage plays an important role in extending the operation of a concentrating solar power (CSP) plant. In view of this, latent thermal energy storage system embedded with gravity-assisted heat pipes is considered in the present study. This experiment illustrates a methodology for design and optimization of LTES with embedded gravity assisted heat pipes (HP-TES) for a CSP plant operation. The CSP plant operation increases its capacity factor and can lead to reduction in the cost of electricity equivalent to that of fossil-fueled power plants [12].

Double basin solar still with vacuum tubes: Panchal introduced the enhancement of distillate output of double basin solar still with vacuum tubes. In this research black granite gravel is used to increase the distillate output by reducing the quantity of brackish or saline water in both basins. The size of the lower basin is 1006 mm × 325 mm × 380 mm and the outer basin is 1006 mm × 536 mm ×100 mm. used. Three different conditions used to determine the performance of double basin solar still like a double basin solar still alone, double basin solar still with black granite gravel, double basin solar still with vacuum tubes and black granite gravel. Experimental results and comparison with other researchers increases by vacuum tube 56% and 65% [13].

Effect of the number of stages: In his research Karimi took 4 similar solar still devices with different stages n order to accurately control the environmental conditions. It was concluded that with more stages, the production enhance more in the continuous mode compared to the non-continuous mode. He observes that there is no significant difference between the performance of the single-stage device in continuous and non-continuous modes. Resultant shows that with

increased number of stages and distillate production can be predicted with a quadratic function [14].

Analysis of fin type solar still: Performance analysis of fin type solar still integrated with fin type mini solar pond was conducted by Appadurai and Velmurugan. In theoretical performance and experimental analysis on conventional solar still, fin type solar still, fin type solar pond integrated with fin type solar still are investigated. The experimental work was carried out in the latitude angle 10°. When fins were attached at the basin then the heat transfer rate from basin to water was increased. Resultant estimated around at 47%, 45.5% and 50%, respectively. The addition of the fins in the mini solar pond was definitely a plus in improving the thermal performance of the single basin solar still by increasing the overall water collection over 24 h [15].

Estimation of internal heat transfer: Kumar estimated the internal heat transfer coefficients of a deep basin hybrid (PV/T) active solar still. The average annual values of convective heat transfer coefficient for the passive and hybrid (PV/T) active solar still are observed as 0.78 and 2.41 W/m^2 respectively at 0.05 m water depth. The comparison of hourly yield predicted using various thermal models to the experimental has also been carried out by evaluating the correlation coefficient and percentage deviation. The internal heat transfer coefficients are evaluated by using thermal models proposed by various researchers [16].

Hybrid solar still using waste heat: Park introduced the experimental evaluation of hybrid solar still using waste heat. The maximum performance of the modified solar still is achieved at the operation condition obtaining maximum productivity at the second effect plate, indicating that

the modified section of the hybrid solar still plays a more important role than the basin section in the entire performance of the hybrid still. Experimental results show that the productivity of the hybrid still increases linearly with increasing heat input, recording 18.02 kg/m^2 at 22.37 MJ/d. Performance tests with waste heat were performed with three operational parameters: the amount of heat inputted into the hybrid still, the seawater flow rate to the wick and the seawater level in the basin. The maximum productivity of distillate was obtained at the lowest seawater level even in the case of the experiment with waste heat source [17].

Analysis on inclined solar still: Hansen worked on performance analysis in inclined solar still with different new wick materials and wire mesh. In this research Maximum distillate achieved when we using water coral fleece with weir mesh–stepped absorber plate. In this work, the new materials are used for absorption, capillary rise, porosity, water repellence and heat transfer co-efficient. Analyzed the water coral fleece material with porosity (69.67%), absorbency (2s), capillary rise (10 mm/h) and heat transfer coefficient (34.21 W/m^2) is good for higher productive solar still [18].

Analysis of vertical multiple-effect diffusion solar still: In this study, Tanaka made a vertical multiple-effect diffusion solar still coupled with a tilted wick still. The vertical multiple-effect diffusion still consists of a double glass cover and a number of vertical and parallel partitions in contact with saline-soaked wicks with narrow air gaps between the partitions. The total daily distillate production was predicted to be about 19.2, 16.0 and 15.9 kg/m2 day on the spring equinox and summer and winter solstices respectively [19].

Thermal models of solar still: Elango presented a solar still model, which is based on energy balances and the sun heat. The efficiency of this study is that it provides energy researchers' insights into solar still design for clean water production and, it promotes commercialization of this product in rural development. Thermal models have a great advantage of predicting the performance of virtually designed solar stills without spending much cost and time [20].

Study of hot air injection and PCM: Kabel studied the performance of a modified solar still using hot air injection and PCM (phase change material). He used A double passes solar air collector–coupled modified solar still, with Phase Change Material, have been experimentally investigated to enhance the freshwater productivity. The influence of the injected hot air on the performance of a modified still, with PCM, is investigated. The experimental results show that, the freshwater productivity approximately reached 9.36 (L/m2 day) for the double passes solar

air collector–coupled modified solar still, with PCM, while its value is recorded 4.5 (L/m2 day) for the conventional still. The freshwater productivity of the double passes solar air collector–coupled modified solar still with PCM is 108% higher than that of the conventional still [21].

Study of double-slope solar still: Mustapha done the numerical study of a double-slope solar still coupled with capillary film. In this study resultant shows that the productivity of the present system was about 60% higher than that of the conventional and capillary film types. The productivity of the capillary film solar still was sensitive to the mass flow of the feeding water. .The contributions of the glass cover, metal plate and condenser plate are 43%, 18% and 39% of the total distillate yield respectively [22].

Conclusions

By the study of above literature reviews it can observed that, the performance of solar still depend on basin area, depth of water, slop of the glass cover, reflector angle and absorber material . They all play very important role for productivity of still. Various researcher developed different designs of stills, like single slop and double slop still, hot air injection still, absorber plat solar still, tubular solar still, stepped solar still etc. They all improved the productivity of still at various levels. In the multi-effect device, the latent heat of vapor can be used many times so that it has a high PR. The condensation processes is strengthened because condensation area of the device is always larger than the evaporation area, which has a beneficial effect in improving the evaporation heat transfer. We observed the productivity of a tubular solar still with two methods based on CFD simulation and theoretical analysis. In case of conical still the water productivity of the conical solar still was higher than the conventional still under the same design and climatic conditions. The analogy between the heat and mass transfer showed a linear relationship between the dimensionless parameters (Nu/Gr Pr) and (Sh/Gr Sc). Solar absorber still resulted in many times beter performance than to conventional still. So we can say that the productivity of solar still was improved by the use of absorbers, reflector, injectors and various design parameters.

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