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Short Review on Passive Solar Distillation Still

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ABSTRACT: This review reports about the past and recent innovation carried out in the field of solar still. Methods and means to improve the performance of solar still are highlighted. Mainly, the impact of fin integration, usage of energy-storing materials, phase changing material and absorbing material, mixing of nano-particles, metal matrix structure, usage of sprinkler, and integration of collectors are discussed. It is also concluded that the distilled output of solar still is remarkably enhancing with the integration of solar collectors, nano-particles in water etc. Also, it is noticed that the modified solar still is more efficient than conventional solar still.

KEYWORDS: Solar, Still, Drinking water, Performance, Enhancing, Method.

I. INTRODUCTION

The consumption of pure water is rising around the world, because of population growth and rapid industrial evaluation. This cause a major leakage of pure water. Pure water is most essential in the domestic cycle as well as in agriculture and industry also. But water is generally polluted with chemical agents and harmful organisms. In the region where the abundance of solar energy and where the sources of impure water are available, supplies a considerable amount of pure water can be produced at affordable cost by solar still which can be easily built and maintain.

II. LITERATURE REVIEW

Potoglou et al. [1] in their study they conducted the real-time experiments with single basin solar still. In their study wastewater from the olive mill is used as a working fluid and these experiments were conducted at Athens at the latitude of 37° 58' 11" N and longitude of 23° 44' 23" E. In this experimental setup the daily yield is about 15,000 ml per day and the basin material is made of galvanized steel. This paper presents the effects of using wastewater from the olive mill and they also use the earth-heat exchanger to provide extra heat for the distillation of wastewater.

Parsa et al. [2] in their investigation they conducted real-time experiments with single slope single basin solar still. In their study saline water is used as working fluid and these experiments are conducted at Tehran for the latitude of 35.8842° N and longitude of 51.4199° E. In this experimental setup the daily yield of 500ml per m² per hour. The basin material is made of a galvanized sheet of 2 mm thickness. This paper presents the impact of high altitude on the performance on the passive solar distillation system at the height of 3964m. These experiments were conducted at the high altitude of different places from this evaluation of experiments the rate of evaporation is high because of backpressure drop due to high altitude in the Tehran over Tochal location.

Al-Hayek et al. [3] in their experimental study conducted real-time experiments with single basin type solar still. In their study distilled water is used as working fluid and these experiments are conducted at Jordan for the latitude of 30.5852° N and longitude of 36.2384° E. In their experimental setup the daily yield of 3 to 5.5 l/m³ and the material of the basin are made of galvanized stainless steel sheet. This paper presents the impact of different designs of solar stills on water distillation. The system reveals that the distilled output of asymmetrical greenhouse type is 20% more than that of symmetric greenhouse type.

Meukamet et al. [4] in their experimental study conducted real-time experiments with single basin solar still. In

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their study alcohol is used as working fluid and these experiments are conducted at Cameroon for the latitude of 7.3697° N and longitude of 12.3547° E. The basin material is made of stainless steel. This paper presents an experimental study of two solar stills, a single compartment model and a two-compartment type application of alcohol distillation. The result shows that the two-compartment type distillation is more effective than single compartment distillation.

Somanchiet al. [5] experimentally evaluated in single slope solar still. In their study the saline water is used as working fluid and these experiments are conducted at Hyderabad for the latitude of 17.3850° N and longitude of 78.4867° E. In their experimental setup the water level of 8cm. The basin material is made of stainless steel. This work presents the modelling and analysis of single slope solar distillation still at different water depth. Among the various phase change material and energy storage material Magnesium Sulfate Heptahydrate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) is having higher efficiency.

ApurbaLayeket al. [6] conducted an experimental investigation in single basin solar still. In this study brackish water is used as working fluid and these experiments are conducted at Durgapur for the latitude of 23.5204° N and longitude of 87.3119° E. In their experimental setup the water depth of 2cm. The basin material is made of galvanized iron sheet. This paper presents the exergetic analysis of basin type solar still. The result shows that the exergy destruction rate of the baseliner is maximum while comparing with glazing and brackishwater.

Sathishet al. [7] in their experimental study they conducted real-time experiments with single basin solar still. In their study saline water is used as the working fluid and these experiments are conducted at Coimbatore for the latitude of $10^{\circ}56'$ N and longitude of $76^{\circ}54'$ E. In their experimental the daily yield of 4l per m^2 per hour and the material of the basin are made of mild steel. The performance of solar still improved by using metal matrix the structure as energy storage. The rate of efficiency is increased by modernizing the still by metal matrix structure while compared with others.

Janiet al. [8] in their experimental study they conducted real-time experiments with double slope single basin solar still. In their study saline water is used as working fluid and these experiments are conducted at Valsad for the latitude of 20.61° N and longitude of 72.91° E. In their experimental setup, the water depth of 10mm, 20mm and 30mm and the basin material is made of mild steel. This work presents the performance evaluation of single basin dual-slope solar still with circular and square cross-sectional hollow fins. The investigation exposed that the special arrangement of using circular and square fin helps to improve efficiency significantly.

Gnanarajet al. [9] in their experimental they study conducted real-time experiments with double slope single basin solar still. In their study brackish and saline water is used as working fluid and these experiments are conducted at Tirunelveli, Tamil Nadu for the latitude of 8.7139° N and longitude of 77.7567° E. In their experimental setup the water depth of 20mm. The basin material is made of iron. This work aims at enhancing the distillate production of double slope single basin solar still with internal modification. It is inferred that the still with finned corrugated basin, black granite, wick, reflector and all internal and external modification. Such modified arrangements make still is more effective than the conventional still.

Elangoet al. [10] in their experimental they study conducted real-time experiments with single slope single basin solar still. In their study nano-fluid water is used as working fluid and these experiments are conducted at Kovilpatti, Tamil Nadu for the latitude of $9^{\circ} 11'$ N and longitude of $77^{\circ} 52'$ E. In their experimental setup the daily yield of 2.5-4l per m^2 per day. The basin material is made of galvanized iron sheet. This paper compares the performance of single basin single slope solar still with and without water nano-fluid. The solar still with (Al_2O_3) nano-fluid has 29.95% higher productivity and the solar still with (ZnO) and (SnO_2) nano fluids has 12.67% and 18.63% more productivity rate than the solar still with water.

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Abujazaret al. [11] in their experimental study they proposed with inclined stepped solar still. In their study seawater is used as working fluid and these experiments are conducted at Malaysia for the latitude of $2^{\circ} 56'22''N$ and longitude of $101^{\circ} 47'16''E$. In their experimental setup the water depth of 3cm. The basin material is made of stainless steel. In this system, a copper inclined stepped solar still was designed and fabricated to study the seawater desalination of the productivity of copper inclined stepped solar stills. The result reveals that the production rate of the still is more affected by environmental parameters.

Bechkiet al. [12] in their experimental study they conducted real-time experiments with simple basin solar still. In their study brackish and saline water is used as working fluid and these experiments are conducted at Algeria, for the latitude of $31.95^{\circ}N$ and longitude of $5.40^{\circ}E$. In their experimental setup the daily yield of 6.011 per m^2 per day. The basin material is made of fiber. The performance of the solar distillation system improved by using partial intermittent shading.

Hamdy Hassan et al. [13] in their experimental study they conducted real-time experiments with single slope solar still. In their study saline water is used as a working fluid and these experiments are conducted at Egypt, for the latitude of $27^{\circ} N$ and longitude of $31^{\circ}E$. The basin material is made of galvanized steel sheet. This paper presents an experimental work to study the effect of the condenser on improving the performance of the still. Result reveals that the using of steel fibres and sand in the basin and the heat sink condenser increases the temperature of the saline water.

VaibhavRaiKhareet al. [14] in their experimental study they conducted real-time experiments with single slope solar still. In their study saline water is used as a working fluid and these experiments are conducted at Jaipur, for the latitude of $26^{\circ}13'N$ and longitude of $75^{\circ}49'E$. The basin material is made of metallic galvanized iron sheet. The performance of the solar still is improved by using CFD. In this investigation, the result shows that the impact of depth of water in the basin is a major concern and still have more productivity at low water depth.

El-Bialy et al. [15] in their experimental study they conducted real-time experiments with inclined single slope single basin solar still. In their study saline water is used as a working fluid and these experiments are conducted at Egypt, for the latitude of $27^{\circ}N$ and longitude of $31^{\circ}E$. In their experimental setup the water depth of 8cm. The basin material is made of rubber. In this work, the performance of single slope single basin solar with a floating absorber. It is inferred that the productivity of the single basin distiller with floating absorber is found to be higher than that of the single basin distiller.

Muftahet al. [16] in their experimental study they conducted real-time experiments with single basin solar still. In their study saline water is used as working fluid and these experiments are conducted at Malaysia for the latitude of $2^{\circ} 56'22''N$ and longitude of $101^{\circ} 47'16''E$. In their experimental setup the daily yield of 71 per m^2 per day. The basin material is made of galvanized steel sheet. In this work, the performance of solar still is improved by superior design concepts. It is inferred that the daily productivity range of the stepped solar still is increased from 6.9 kg/m^2 to 8.9 kg/m^2 .

Fathyet al. [17] in their experimental study they conducted real-time experiments with double slope solar still. In their study saline water is used as working fluid and these experiments are conducted at Egypt for the latitude of $26.33^{\circ}N$ and longitude of $31.41^{\circ}E$. In their experimental setup the daily yield of 8.53 kg per m^2 per day. The basin material is made of galvanized iron sheet. This system explains the performance of coupling parabolic trough collector with double slope solar still investigation. It is inferred that in the summer and the depth of saline water is 20 mm, the daily efficiency of the conventional still, still with fixed parabolic trough collector [PTC] and still with tracked, PTC are 36.87, 23.26 and 29.81%.

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Jamilet al. [18] in their experimental study they conducted real-time experiments with single slope solar still. In their study saline water is used as working fluid and these experiments are conducted at Aligarh for the latitude of 27.89°N and longitude of 78.08°E . In their experimental setup the daily yield of 2–3 L per m^2 per day. The basin material is made of galvanized iron sheet. The system has explained the effect of specific height on solar still productivity for constant water depth. It is inferred that the productivity of the solar still significantly increases by decreasing the specific height of the still.

Rajamanickamet al. [19] in their experimental study they conducted real-time experiments with double slope solar still. In their study surface water is used as working fluid and these experiments are conducted at Annamalai Nagar, Tamil Nadu for the latitude of 11°N . In their experimental setup the daily yield of 3.07l per m^2 per day. The basin material is made of galvanized iron sheet. This paper presents the effect of water depth on the internal heat and mass transfer in the single basin double slope solar still. The results show that the decrease in the depth of basin water, increase in productivity of the solar still.

Ansari et al. [20] in their experimental study they conducted real-time experiments with single basin solar still. In their study brackish water is used as working fluid and this experiment are conducted at Errachidia city for the latitude of $31^{\circ}58'\text{N}$ and longitude of $4^{\circ}20'\text{W}$. The basin material is made of PCM. In this system, the performance of the still improved by flat plate collector integrated with glass–glass photovoltaic module. The results indicate the excess energy produced during sunshine times is stored in a phase change material [PCM] is using later during night time.

Badranet al. [21] in their experimental study they conducted real-time experiments with single basin solar still. In their study brackish water is used as working fluid and these experiments are conducted at Jordon for the latitude of 30.5852°N and longitude of 36.2384°E . In their experimental setup the daily yield of 2-4L per m^2 per day. The basin material is made of glass. This system shows the study of enhancement parameters on a single slope solar still productivity. The study shows that the daily production of solar still can be increased by reducing the water depth in the basin.

Shalabyet al. [22] in their experimental study they conducted real-time experiments with single basin solar still. In their study saline water is used as a working fluid and this experiment is conducted at equal latitude of Tanta. In their experimental setup the daily yield of 2.889 kg per m^2 . The basin material is made of PCM. The work explains an experimental investigation of a v-corrugated absorber single-basin solar still [VSBSS] using PCM. The hourly production of the v-corrugated absorber single-basin still with and without of the PCM or with wick and PCM depends strongly on the basin water glass cover temperature difference.

Tanaka et al. [23] in their experimental study they conducted real-time experiments with single basin solar still. In their study distilled water is used as a working fluid and these experiments are conducted in Japan. In their experimental setup the daily yield of 1.19 kgm^2 per m^2 per day. The basin material is made of stainless steel. The system shows the experimental study of a basin type solar still with internal and external reflectors in the winter season. The result shows that the daily productivity of a solar still can be increased by about 70% to 100% with a simple modification using internal and external reflectors.

Gupta et al. [24] in their experimental study they conducted real-time experiments with single basin passive solar still. In their study saline water is used as working fluid and these experiments are conducted at Jabalpur for the latitude of $23^{\circ} 10' \text{N}$ and longitude of $79^{\circ} 59' \text{E}$. In their experimental setup the daily yield of 2814 ml per m^2 per day. The basin material is made of grey cast iron sheet. In this work, the heat transfer rate increased by using nanoparticles. Nanoparticles are mixed with basin water which increases the thermal conductivity, convective heat transfer coefficient and hence the evaporation rate. They worked as heat storage material and releases energy to water and increase productivity at night.

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Panchalet al. [25] in their experimental study they conducted real-time experiments with double basin solar still. In their study saline water is used as working fluid and this experiment is conducted at Mehsana for the latitude of 23° 59' N and longitude of 72° 38' E. In their experimental setup the daily yield of 875 ml per m² per hour. The basin material is made of aluminum sheet. In this work, there are three conditions used to determine the performance of solar still like double basin solar still, double basin solar still with black granite gravel, double basin solar still with vacuum tubes and double basin solar still with vacuum tubes and black granite gravel. The result reveals that the daily output increases by coupling the vacuum tubes and by vacuum tubes coupled with black granite gravel to 56% and 65% respectively.

III.SUMMARY

This section presents the highlighted observations inferred from the literature survey. They are as follows:

1. Reduction in the height between the glass cover and the still basin leads to the performance enhancement.
2. Provision of fin inside the still leads to the higher distillate production.
3. It is possible to increase the performance of solar distillation still by using the phase change material.
4. Proper mixing of nanoparticles with the basin water leads to the improvement in performance.
5. Increasing the basin water temperature simultaneously leads to the improved performance of the solar distillation still
6. The overall performance of the solar still is more sensitive to wind velocity, solar irradiance, latitude, longitude and humidity.
7. Integration of control system with the solar distillation still regulates the deviations in the overall performance.

Designing Internet of Things (IoT) based process monitoring and control system for the solar distillation still performance is one among the trending research gap.

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