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A Review of the Experimental Results of the Performance of a Single Slope-Solar Still Desalination System Employing Nanofluids

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Abstract: *Even though more than two-thirds of the planet is covered in water and the remaining third is made up of land, the number of people who have access to potable water is constantly shrinking. The majority of human illnesses are brought on by contaminated or unpurified water. Nowadays, due to pollution brought on by human activity, every country is struggling with a severe water shortage. A basic need for all humans on this planet is the ability to drink water that is reliable and of acceptable quality. The amount of fresh water that can be retrieved from rivers, lakes, and ponds is diminishing as a result of industrialization and population development. Because it is economical and environmentally benign, solar-powered water purification is gaining popularity. A common water purification device that uses no energy for water distillation is a solar still. A cheap way to make drinking water from brackish or poor-quality underground water is through solar distillation. This strategy might help with the world's water shortage problems. According to a peer-reviewed study, uniform dispersion of nanoparticles in the base fluid increases the solar still's productivity and efficiency while also improving solar absorption. A complete overview of the most recent advancements in the usage of nanofluid in various types of solar stills is provided by this in-depth analysis of the literature. Variable water depth and a proposed concentration of nanofluid are used to measure performance.*

Keywords: Solar still, nanofluids, potable water, glass, thermocol.

Introduction

Water is considered as one of the most important natural resources that plays a crucial role in developing nation’s economy. It covers about 70 % of the Earth’s surface and it is classified into a sea and fresh water. Clean water is the basic component for the life continuity over the Earth planet and it is very essential for economy, agriculture, domestic and industrial applications. One of the major challenges nowadays is how can get a fresh and healthy water in a reasonable cost especially in the under developed and developing countries or in regions where the water quality is not in a good nature, water demand is very high and the solar energy is highly available It is important to mention that in the world around 97 % of the water in the ocean and it is of course salty, around 2 % of the water is stored as glaciers and icebergs in the polar region, that leaves us with only 1 % of fresh water (on the Earth surface or underground) available for different human, animal and plantation needs. Although this is very small ratio is believed to be enough to satisfy the needs of all different kinds of life and vegetation on our planet. But, this amount of the available fresh water is reducing day by day, while its utilization is increasing dramatically due to the fast and uncontrolled increasing in the number of the population (daily typical amount of drinking water is 5 L per person per day), climate change, improved living standards, pollution of water sources and the huge economic cycle. In addition, the fresh water sources are disproportionately spread on the earth and many countries suffer from water shortage problem.

In fact, the freshwater demand was increased dramatically from 75 to 100 L per day in the twentieth century. From the other side, the lack of the fresh drinking water is the main reason of the most severe diseases, which face the humankind, and unfortunately, around four million people die yearly due to diseases those related to water like diarrhoea, cholera, typhoid, guinea worm disease and shortage of good quality potable water. For example, in India about one million children die yearly due to drinking contaminated water and living in unhealthy conditions. Moreover, it is estimated that more than one billion people on the earth have no access to the clean fresh water. By the year of 2030, it is estimated that 50 % of the world population will suffer from the water scarcity.

Recently, more than one third of the African country's populations are suffering high water stress. Therefore, it is very necessary to search about other methods to produce the fresh water locally by desalinate saline water. This can be achieved by using renewable energy sources such as the solar energy. Solar distillation is one of the best available ways to satisfy efficiently this mission. The current literature review presents a rich overview about the current progress related to the application
of the nanotechnology in single slope solar stills. Research reviewed including theoretical, numerical and experimental up to date works related with the nanofluid applications in various types of the solar stills. This paper gives a detailed survey about the single slope solar stills. The most important conclusions are deduced.

Water is a basic necessity of man. Fresh water resources are considered to be rivers, lakes and underground water reservoirs. The use of water from rivers, lakes and underground is not always possible, especially because of the polluted environment. So search for other sources becomes a must. To overcome this problem, there are various methods to produce fresh water from sea water, saline water or brackish water. Desalination processes have received great attention as an alternative solution for fresh water production. Desalination is one of the methods which is suitable for potable water. The demand for reliable and autonomously operating desalination systems is increasing continuously. These systems are meant for a basic need of drinking water and fresh water supply. Solar distillation seems to be a promising method and alternative way for supplying fresh water. Several solar still designs have been proposed and many of them have found significant applications throughout the world. Solar desalination systems have low operating and maintenance costs and require large installation areas and high initial investments.

II. Literature review

Venkatesarperumal et al. [2020] the use of SiO_2 nanoparticles considerably enhance the heat transfer rate and evaporation rate in the single basin single slope solar still while increasing the percentage in the water, hence the yield is improved.[1]

Mohammad et al. [2020] the effect of placing sand within the basin of simple basin type solar still on its performance and observed that the presence of sand within the basin of the still increased its water productivity and thermal efficiency by 21.16%.[2]

Guru karthik et al. [2019] improved the performance of still by coating nano ferric oxide as thermally conductive material. Nano ferric oxide is used as thermally conductive material so the evaporation rate of the still is improvised in this method.[3]
Agrawal et al. [2019] multiple V- shaped floating wicks are used to enhance heat absorption and thereby increase productivity. these multiple floating wicks are made from black jute cloth wrapped in V-shaped pieces of thermocol because of their V- shaped profile, the evaporative surface area of modified solar still is 26% larger than that of conventional solar still.[4]
Verma et al. [2018] the use of solar energy as a source for producing usable water from water of local source. To remove impurities and making water usable for drinking, this can be done by natural phenomenon of evaporation and condensation.[5]
Sharshir et al. [2017] the effect of graphite and copper oxide nanoparticles containing nanofluids on desalination with solar still and observed 44.91% and 53.95% improvement in the performance of solar still respectively.[6]
Rabhi et al. [2017] used pin finned wick and condenser provided externally to improve the still efficiency. The gain in production of fresh water of 32.18% is observed when condenser is connected externally to the solar still. Hollow fins in the shape of circle and square is used in single basin.[7]
Kumar et al. [2016] enhances still performances by using a condenser connected externally to solar still. The increase of 39.14 % obtained in output yield using this experimental setup.[8]
Hitesh Panchal [2016] glass cover is very important component for the efficient design of the solar still. Selection of the proper glass cover is always based on transmittance and it is depends on thickness of the glass cover. It is found that 4mm and 5mm glass cover thickness increased average distillate output of 27 % and 12 % compared with 6mm glass cover thickness.[9]
Elango et al. [2015] have made an experimental analysis in in still operated using naturally obtained solar energy with one basin and one slope by the usage of different Nano water fluids. They used various nano particles which are oxides of aluminium, zinc, iron and tin of various proportions.[10]
Kabeel et al. [2014] made an experimental analysis to check the solar still performance with usage of nanofluids and they used condensation process to happen externally. The performance analysis of still with nano fluids show enhancement in the characteristics of transfer of heat and evaporation rate. The solar still with modification of using nano fluids increased the yield efficiency by 134 %.[11]
Shrivastava et al. [2013] mounted porous fins in the basin water of a solar still. These fins were covered by blackened old cotton rags and were partially dipped in the basin water. They introduced their modification for the solar still has a simple and economical method to improve the efficiency of still.[12]
Rahbar et al. [2012] estimated the convection heat transfer co-efficient in a single slope solar still. This results showed that the Nusselt number drops with an increase in the aspect ratio at a constant value of Rayleigh number.[13]
Abdullah et al. [2009] experimented single slope solar still by using different types of absorbing materials like metallic wiry sponge and black volcanic rocks in four identical single slope solar stills, there result show that uncoated sponge has the highest water collection during day time followed by black rocks then coated metallic wiry sponge.[14]
Omar et al. [2007] the thermal performance of single slope still is examined and evaluated through implementing different insulation thickness, water depth, solar intensity, overall heat loss coefficient, effective absorbitibity and water, ambient and vapour temperature.[15]

III. Objective

1. To increasing the productivity and the efficiency of solar still at different depth with or without adding Nanofluids.
2. To investigate the reliability of utilizing Nanofluids in solar still.
3. Comparative analysis of productivity of water with or without using Nanofluids.

IV. Proposed methodology

Impure water is filled inside an airtight insulated basin covered with a transparent glass in the basin style still solar. The rays are transmitted from the cover to the absorber surface at the bottom when the silos are exposed to the light, thereby heating the water. Then the hot water heats the air inside, leaving it unsaturated. The water evaporates and saturates the air that surrounds it. which is being circulated inside the still due to the temperature difference between the water surface and the cover lower surface.

1. Solar units of the single basin type are produced with certain design parameters and tested under field conditions.
2. The basin was made of wooden block with a 0.95 m x 0.9 m base, which was positioned for support on the metal stand.
3. In order to increase the absorptive of the basin surface, it is painted black. Glass of 4 mm thickness covers the single slope still with an inclination with horizontal. A pyranometer was used to measure the insolation on the still.
4. The distillate output was measured by means of a measuring cylinder, at half hour interval. All the observations & readings on experimental setups will be taken.
5. The time duration for observations of solar still is from 10:00 AM to 4:00 PM for experimental setups of arrangement of only Black Coating with reflector arrangement.

V. Conclusion

According to the studies that were examined, distributing the nanoparticles evenly throughout the base fluid leads to an increase in solar absorption, which in turn leads to an increase in the productivity and efficiency of the solar still. When nanoparticles are mixed with the water in a basin, the thermal conductivity of the water, the water temperature, and the coefficient of convective heat transfer all tend to increase. As a direct consequence of this, the pace at which water evaporates also increases. Additional work needs to be done to explore the viability of using nanofluids in solar stills from both an economic and environmental point of view. Because its optical absorption spectrum and the solar radiation spectrum match up so well, nanofluid has the unique capacity to directly absorb the sun's rays. Due to their exceptional compatibility, this is possible.

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