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# A Review on Solar Still with Nano Material Coating on Absorber Plate for High Performance

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**ABSTRACT**

The purpose of this research is to design a water distillation system that can purify water from nearly any source, a system that is relatively cheap, portable, and depends only on renewable solar energy Improved sun-oriented stills are contrasted with a newer type of sun-based still in this dissertation. Coated absorbers are used in the solar still, which makes use of reduced graphene oxide /Copper oxide nanoparticles. The solar still's absorber plate and walls are coated with a commercial black paint that contains the hybrid nanomaterial. Researchers have identified and analyzed areas of the solar-powered stills where energy was lost. Alternate sunlight-based stills have faster dissipation and higher exergy compared to regular ones.

Keywords **: -** Water Distillation System, Solar Still, Nanomaterial, Coating, Exergy

## I. INTRODUCTION

Solar water distillation is simple distillation replicates the way nature makes rain. The sun's energy heats water to the point of evaporation. As the water vapour rises, condensing on the glass surface for collection. This process removes impurities such as salts and heavy metals as well as eliminates microbiological organisms. Water can be purified for drinking purpose by following methods

- Distillation
- Filtration
- Chemical Treatment
- Irradiative Treatment

Water and energy are the two essential components that impact the nature of cultivated life. Water utilization is expanding all around the world because of quick increment of populace and the farming undertakings. This causes a genuine interest on the new water. New water is a need for the congruity of life. The most important uses of water are in three sectors, namely

- Domestic,
- Agriculture and
- Industrial.

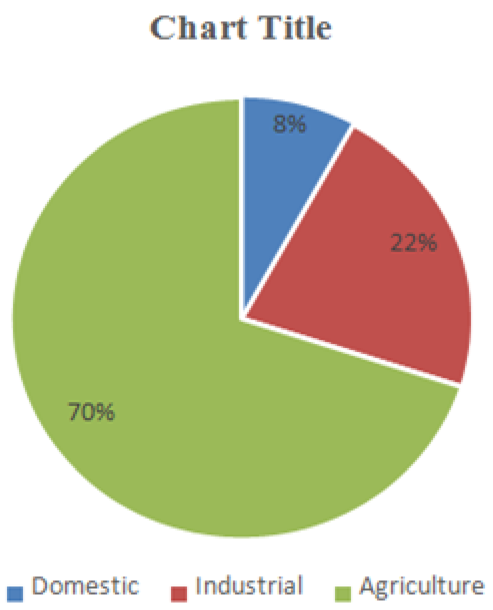


**Fig. 1:** Percentage of world water use by different sectors

**Solar Distillation:** The term Sun based Refining alludes to the vanishing and progressive precipitation of crude water, in this manner filtering it. Fundamentally, there are two standards to be recognized: direct sun powered refining, which is described by its nearby utilization of sunlight based energy to dissipate crude water; and backhanded sun powered refining, which utilizes more complex energy change procedures for crude water warming. Sun oriented refining furthermore isolates the dissipation and buildup measures spatially to raise the distillate yield.

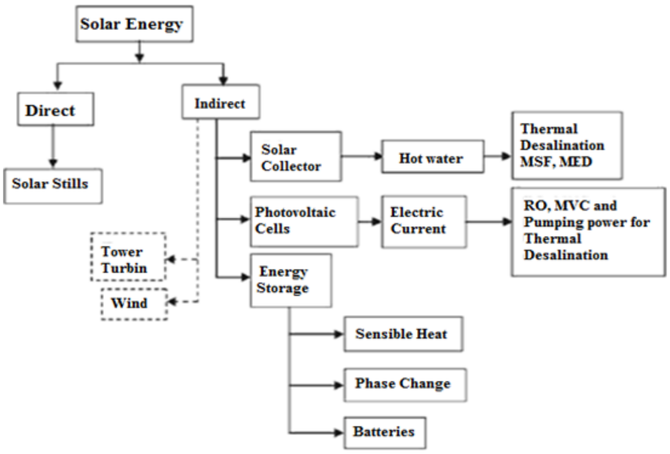


**Fig. 2:** Classification of solar distillation systems

**Passive Distillation:** Fig.3 shows the simple type of a sun based inactive still which is the single-slant, bowl type. This plan joins simple assembling with low material expenses (utilization of nearby or reused material conceivable); the disservice is its low distillate yield of two to six liters each day for every square meter - relying upon the area and applied energy-increase measures. This kind of sun powered still just has somewhat higher material expenses, as it requires the utilization of a greater number of glass sheets. The general energy efficiencies of these kinds of sun based stills fluctuate in the range of 25 and 45% for usually fabricated models with the single-slant still. As per in contrast with the single bowl still, the distillate creation increases by 29.6%.

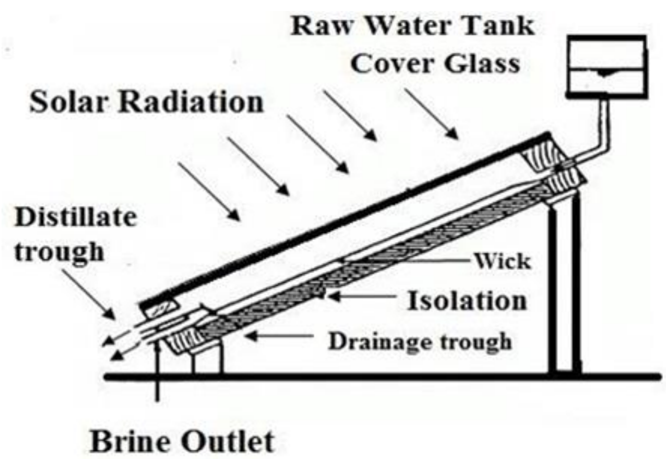


**Fig.3:** Solar still designs for passive distillation

**Working Process:** The stills were constructed by bending a sheet of galvanized iron (GI), since it was cost effective and easily available. To absorb the incoming radiation and prevent corrosion the inside walls painted with black paint. The dimensions on the back and sides were adjusted so that the top cover was inclined at the desired angle. All the experiments were done at an angle chosen was 15º, which is the latitude of Jaipur. This choice ensures that the sun's rays will be closest to normal incidence averaged over one year. The distilled water was collected in a channel along the front side. Impure water is put in the tank through the inlet pipe and solar still is hanged on the tripod stand in such a way that solar still is on the focus point of the reflector , when sun light is reflected through the reflector.

**Source:** Anirudh Biswas et al. /VSRD International Journal of Mechanical Auto & Pro. Engg. Vol-2 (5), (2012)

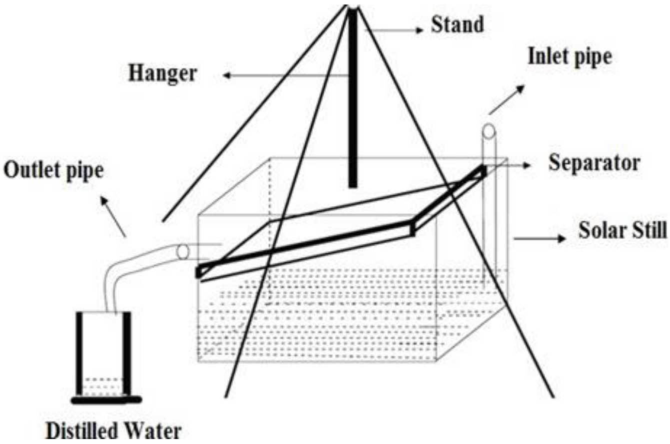


**Fig.4:** Shows the systematic view of the working

**Advantages:** The advantages of the solar water distillation are listed below-

- It produces water of high quality.
- Negligible Maintenance.
- This process can purified any type of potable water.
- No electricity is required to operate this system and does not involve any movingparts to operate.
- Minimum wastage of water.
- Efficiently produces minimum 2 gallons of potable water per day.
- Can purify water from virtually any source, including the ocean.
- Relatively inexpensive therefore accessible to a wide range of people.
- Easy to use interface.
- Intuitive setup and operation.
- Provides clean drinking water without the need for an external energy source.
- Reasonably portable and compact.

## II. LITERATURE REVIEW

**1. M. Elashmawy** [17] shows a detailed review of current developments in SSs with nano/micro materials was presented. Firstly, nanoparticles can enhance the productivity of SS and barely increase the cost. The daily productivity of nanoparticles-based SSs can be from 3 to 7 L/ $m^2$ and from 4 to 9 L/$m^2$, for passive and active SSs respectively. Adding nanoparticles can enhance the productivity up to 93.9% for passive SS and 285% for active SS, as compared to conventional stills. The cost of freshwater with nanoparticles can be around 0.01–0.027 $/L and 0.021–0.05 $/L, for passive and active SSs respectively. The main reason for the improvement by nanoparticles is the enhancing of both the thermal conductivity of base fluids and solar absorptivity, which improves the evaporation process in SS. Secondly, porous materials are suitable for enhancing the solar evaporation process due to the effective heat localization on the evaporation surface. Various porous materials, such as paper-based film, artificial aerogel or hydrogel, and natural biomaterials utilized in the solar evaporation system can be used for improving SS. The key factors to achieve high performance by porous materials include high solar absorptivity, low thermal conductivity, hydrophilic surfaces, as well as optimized thermal design. It can be concluded that the materials with the nanometric design usually outperform those materials with only micrometric design. The outperformance of nanomaterials is mainly due to their better manipulability in the aspect of heat and mass transfer, light-absorbing, surface property, and so on. However, some studies have reported that the evaporation rate under one sun via porous nanomaterials may reach 4 kg/(m2·h) which is much higher than the theoretical upper limit value of 1.5 kg/(m2·h) and have not been duplicated/validated by others. And the reasonability and mechanism of that the evaporation rate may be higher than the upper limit remain controversial and questionable. Hence, it needs further validation and investigation in the future.

***2. A. E. Kabeel** [18] described the solar desalination test plant in Abu Dhabi, UAE and gave a summary of its first year performance and economics. The plant has been operating successfully for 18 years supplying fresh water to the city of Abu Dhabi. The plant was commissioned in September 1984 and was running until the year 2002 when it was dismantled after fulfilling its objectives. The aim of the plant was to investigate the technical and economic feasibility of solar **desalination of seawater** in providing fresh water to remote communities in the Middle East and to obtain long-term performance and reliability data on the operation of the plant. The plant has proved its technical feasibility and proved to be reliable in operation with few minor maintenance problems that required slight plant modification. Maintenance routines were established to maintain high plant performance.*

***3. A. E. Kabeel et al.** [19] concluded that the double slope FRP solar still was most economical for domestic applications mainly for drinking and cooking purposes while the active solar still was more suitable for commercial applications.*

**4. A. S. Abdullah et al.** [20] designed this study to develop an efficient and cheaper solar-still, which could be used in Tsunami affected areas. The work reported here was concentrated on a solar still which would work automatically utilizing the capillary action of materials to pump water from the reservoirs. For this the experiments were conducted to find the best wick material to use in the solar-still having the vertical absorption ability and the inclined transferability of various wick samples. The most efficient tilt angle was found by measuring the distillated output from different angles. The temperature variation of the cover glass plate, wick material and the atmosphere were monitored in order to find the optimal time period of the day in which the solar- still can be used. Various water samples including Tsunami affected areas were purified and the conductivity, turbidity and pH values of the samples were measured before and after distillations to check whether the distillated water has achieved drinkable standards or not.

**5. S. M. Shalaby et al.** [21] designed a solar still and tested in Mubi, Adamawa State of Nigeria. The radiation from the sun evaporates water inside the solar still at a temperature higher than the ambient. The principle of operation was based on greenhouse effect. Energy balances were made for each element of the still; solar time, direction of beam of radiation, clear sky radiation, and optical properties of the cover, convection outside the still, convection and evaporation inside were accounted. Theoretical analysis of the heat and mass transfer mechanisms inside this solar still were developed. The measured performance was then compared with results obtained by theoretical analysis. The results clearly depicted that the instantaneous efficiency increases with the increase of solar radiation and with the increase of feed water temperature. The distillation efficiency of the still was 99.64% in comparison to the theoretical analysis.

**6. M. S. Yousef et al.** [22] carried out investigations under the open environmental conditions of Egypt on single slope solar still inclined 20º of one direction. The experimental unit's composed three main components: solar distillation unit water leveling unit and preheating feeding tank. The solar distillation unit consisted of two main components: transparent glazing cover of 0.006 m thickness and steel basin. The dimensions of steel basin were 0.80m length, 0.50m width, 0.10m height and 0.002m thickness. The absorbing material type used was matt black fiberglass and the basin water depth was kept at 0.5cm. Heat losses from the solar still were also considered. The highest still average productivity was obtained at August compared to May, June and July, as no productivity was obtained on June.

**7. H. Aburideh et al. [23]** designed to evaluate some different units of solar stills constructed as follow a: (control unit, preheating unit, air blower unit and air suction unit). They studied parameters, which effect on the productivity of solar still units, such as brine depth, slope angle of glass cover, feed water and cover material. The results showed that the highest productivity was with preheating unit (6030cm$^3$/m$^2$.day) with brine depth 2 cm, cover slope angle 20°, and feed water time every two hours.

**8. M. Arslan [24]** described a new water distillation method and apparatus operating at low temperature and sub-atmospheric pressure that can produce water at different scales, for large cities or remote rural communities. The system is low cost. The system could be configured to use waste heat from power plants, allowing co-generation of fresh water with electricity. Though using waste heat allows for water production efficiency which is better than the current leading technologies, the process could also be made to run with other sources of low quality heat and alternative energy sources.

**9. T. Arun kumar et al. [25]** devised a model which converted the dirty/saline water into pure/potable water using the renewable source of energy (i.e. solar energy). The basic modes of the heat transfer involved were radiation, convection and conduction. Dirty/saline water was evaporated and fetched out as pure/drinkable water. The designed model produced 1.5 liters of pure water from 14 liters of dirty water during six hours. The efficiency of plant was 64.37%. The TDS (Total Dissolved Solids) in the pure water was 81ppm.

**10. R. Sathyamurthy et al. [26]** designed a single asymmetrical, automatic feed solar distiller was designed to take advantage of the solar energy available in these regions, such as Somalia and Africa. During this process, factors that will optimize single day productivity while minimizing costs were explored. All aspects that affect clean water output were analyzed including: effect of surface area on productivity, material selection and analysis, internal air circulation, overall thermal efficiency, and the potential effectiveness of an automatic water feed system. Factors that directly impact overall build cost per unit were also evaluated, such as material selection, size, and simplicity. Final design added numerous features to increase the efficiency of a basic asymmetrical solar still.

**11. N. Rahbar and J. A. Esfahani [27]** fabricated four solar stills of different capacities and tested for water distillation. The distilled water production rate performance (PRP) was analyzed. The highest rate of PRP was recorded between 11.30 am and 12.30 noon in all the solar stills studied. It was 0.0287 L/m$^2$/hr. in unit I, 0.0288 L/m$^2$/hr. in unit II, 0.0279 L/m$^2$/hr. in unit III and 0.0267 L/m$^2$/hr. in unit IV. The pH of distilled condensate was 7.0 indicating neutral character. The TS, TDS, TSS, sulphates, phosphates and chlorides were reduced to zero after the solar distillation in all the four solar stills. It ensures that the distilled water was 'Pure' water.

**12. K. Sampath kumar [28]** designed a water distillation system that could purify water from nearly any source, a system that is relatively cheap, portable, and depended only on renewable solar energy. From the results of project calculations a truthful estimate was made to prototype the most effective geometries of the distiller and trough concentration system, one that will maximize evaporation/condensation and re capture waste heat to minimize thermal losses. To achieve this goal, they designed a parabolic solar trough coupled with a custom designed distillation device. The incoming solar radiation from the sun was focused and concentrated onto a receiver pipe using a parabolic trough, heating the incoming impure water, at which point it is sprayed into custom designed distillation device where it evaporates and was re-condensed into pure potable water.

**13. G. Singh et al.** [29] described the design and performance of a solar-powered still. It was based on the simple principle of using solar energy to evaporate water, and then condense it on an inclined glass surface. They considered many parameters for improving its performance while keeping the constraint of a low cost. The optimized still had an area of 0.4 m2, and can produce about 1.5 liter of pure water per day. The cost of making the still at retail prices was about Rs. 2000. Muddy rainwater and super-saturated salt water were purified using the still. Tests conducted on the output samples showed that it was completely potable.

**14. Y. Taamneh et al.**[30] designed and constructed five single basin solar stills with varying angles of inclination of the covers but having the same aperture area of $0.24m^2$ were designed and constructed. Angles of inclination of 4º, 7º, 10º, 13º and 15º were chosen arbitrarily. Measurements of temperature, solar radiation and, volume of water produced were carried out for eight days. The data was used to compute the efficiencies of the stills. The still with an angle of inclination 15º had the highest efficiency of 0.585 and also produced the highest mean volume of water produced of $62.9cm^3$. The results indicated that the optimum angle of inclination for simple basin solar stills for Makurdi location is greater than 15º as shown by the characteristic trend lines for the water volume/efficiency against cover inclination. This was useful observation which erased the usual tendencies of utilizing low angles as efforts to optimize still productivity in Makurdi continue.

**3. Conclusion:** In this paper, we concluded that at present time, it is difficult to obtain pure drinking water, since the pollution is increasing day by day with the increased use of technology, be it air, soil or water everything has become polluted. In this context our main concern is to evolve technology which can provide safe drinking water to people and highly polluted water can be treated to an extent that is not potable it can be used at least for agricultural purposes. Moreover the majority of the population cannot afford expensive technologies for purifying water. So we need to evolve a technology which is cost effective also. The design of distillation plant using solar energy could be a solution to a large extent.

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