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Mechanized Water Conditioning Using Solar Still

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Abstract—solar energy has been serving as a great source for purification of water through distillation, this could be enhanced by employing solar stills with nano particles suspended in water for filtration of impure industrial waste water. The proposed model provides a system where the solar still helps to distill water by evaporation and condensation. It is automated using a microcontroller. By this method the demand for clean water and the retrieval of abundant impure water are both tallied to meet the on growing domestic and industrial necessities. The advantage of this process on a higher end is that the presence of toxic particles in the feed water is eliminated by incorporating nanoparticles namely Silicon carbide. Keeping pollution in mind, this system employs and operates in an eco-friendly manner. The natural nutrient composition of water are retained in the process.

Keywords—Solar energy, Solar still, Nanoparticles

I. INTRODUCTION

The demand for pure water is rising and we have an abundant amount of brackish or saline water which can be used for harnessing usable water to meet the present demand. Solar energy being a cheap source of energy can be utilized for producing fresh water. Solar still works on the principle of solar distillation. A solar still duplicates the way as rain water i.e. evaporation and condensation. Solar still has been employed to treat waste water which contains impurities in addition to salt water. The basin is considered to be made of stainless steel to maintain a higher temperature and therefore increase the rate of evaporation. Sensors to indicate water level to be fed into the basin. A pump configured using a microcontroller to feed water into the basin. Reflecting mirrors to concentrate sun's radiations. For a similar reason the basin is coated in black. The overall design is to add control part to the mechanical still with the use of microcontroller and pump, the whole

system is to be made automated. All the above mentioned enhancements in the design parameters of the still improves the efficiency of the still.

II. EXISTING MODELS

Solar stills have previously been used for desalination process. It has found to be having low productivity when basin is made of wood or low heat absorbing material The experiment when established to desalinate lead to salt depositions at the bottom which indeed blocked the pipe lines. The above could be rectified to obtain better results by adding vinegar to the water fed into the basin. Another reason for low productivity of the existing models is the minimal duration of exposure of the set up to the sun's radiations which is result of design modification which need to be looked up. To increase the exposure to the sun's radiations, we have come up with a design consideration to make use of reflecting mirrors to concentrate maximum of the rays.

III. SOLAR STILL

Solar still is a device that produces pure water without the use of any conventional source of energy. We have non-conventional sources of energy available in abundant amount especially sunlight which can be harnessed for useful purposes. The demand for pure water is rising and we have an abundant amount of brackish or saline water which can be used for harnessing usable water to meet the present demand. Solar energy being a cheap source of energy can be utilized for producing fresh water. It is also an eco-friendly process and does not require any skilled labour for its operation or maintenance. The installation cost is also low. Despite being uneconomical it has proved to be one of the best desalination systems.

Solar still works on the principle of solar distillation.. Brackish water is filled in the black painted basin of the solar still. This is enclosed in a completely air tight surface. A sloping transparent cover is provided at the top. Then solar radiations are allowed to fall on it. Solar radiation is transmitted through the cover and is absorbed in the black lining. The distillator is designed so that an efficient amount of solar radiations get trapped inside it. This increases the internal temperature of still causing the feed water to evaporate leaving behind all the salt contents, insecticides, herbicides, bacteria, viruses etc.

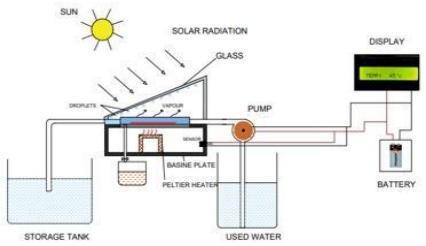

Fig 1. Representation of solar still

IV. PRINCIPLE AND WORKING

Solar still operates on the same principle as of evaporation and condensation. When the water evaporates, useable water is retrieved, leaving all the contaminants behind. Solar stills follows this natural process. The interior surface is blackened to improve absorption of the sun's rays. Water to be cleaned is poured into the still to partially fill the basin. The glass cover allows the solar radiation to pass into the still, which is mostly absorbed by the blackened base. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The base also radiates energy in the infra-red region which is reflected back into the still by the glass cover, trapping the solar energy inside the still. The heated water vapour evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle. Nanoparticles are suspended in the water to remove the toxic contents and hard metals All the above mentioned enhancements in the design parameters of the still improves the efficiency of the still.

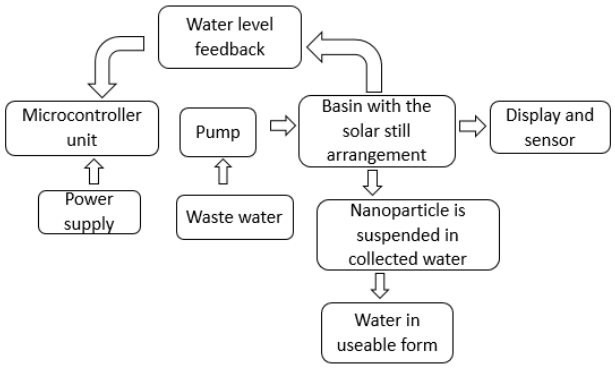

Fig 2. Working of proposed system

A. Componenys Used

Peltier model: Peltier model are electronic devices designed for cooling objects to below the ambient temperature or maintaining objects at a specific temperature by controlled heating or cooling. Here it is used for preheating the water in the basin.

Battery: the lead-acid battery of power 12V and capacity of 1.3Ah is used, It has strong resistance to shock, vibration, chemicals, and heat. The battery acts as a supply for the Peltier module for preheating the water in the basin

Pump: an automatic water pump controller circuit that controls the water pump motor. The motor gets automatically switched on when water in the solar still falls below the lower limit. Similarly, it gets switched off when the still is filled up.

Nanoparticle:

Suspension of Silicon Carbide (Sic) for removal of toxic contaminants and hard metals present in the brackish water, and also they tend to exhibit high anti-microbial properties. The removal of these inorganic contaminants by standard technologies is energy-intensive and expensive.

TDS Meter: A TDS meter is a small hand-held device used to indicate the Total Dissolved Solids in a solution, ionized solids, such as salts and minerals, increase the conductivity of a solution, a TDS meter measures the conductivity of the solution and estimates the TDS from that reading

B. Experimental setup

The basin solar still has a top cover made of glass, with an interior surface made of a waterproof membrane. This interior surface uses a blackened material to improve absorption of the sun's rays. Water to be cleaned is poured into the still to partially fill the basin. The glass cover allows the solar radiation (short-wave) to pass into the still, which is mostly absorbed by the blackened base. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The base also radiates energy in the infra-red region (long-wave) which is reflected back into the still by the glass cover, trapping the solar energy inside the still. The heated water vapourevaporates from the basin and condenses on the inside of the glass cover. In this process, the salts, microbes and other toxic contents that were in the original water are left behind. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle. The still is filled each morning or evening, and the total water production for the day is collected at that time.

V. RESULTS

1. Observation

According to the hourly variation of solar radiation for the solar distillation system the following recordings were noted:

TABLE I OUTPUT FORM SOLAR STILL

TIME(Hr.)	CONVENTIONAL STILL	ENHANCED STILL
10:00	300	350
11:00	450	500
13:00	600	700
14:00	750	800
17:00	400	450

In this present study, several conclusions can be obtained as follows:

- In higher water levels, the maximum temperature of the basin water, vapour and water is recorded in the late afternoon hour between 13 hrs and 14 hrs.
- where as lower levels are attained in the late morning.
- The maximum hourly yield is obtained in the afternoon when the light and heat radiation is more and moisture content in the atmosphere either is very less or absent.

- The lowest maximum hourly yield are noted in the late evening maximum hourly yield of solar still is based on the capacity of basin water which is started from middle afternoon.

B.Purity content of water

The condensed water so collected is checked for purity using the TDS meter which is a small hand-held device used to indicate the Total Dissolved Solids in a solution.
The readings obtained are tabulated below in ppm (parts per million)

TABLE II TDS VALUE

NATURE OF SAMPLE	TDS VALUE (ppm)
Feed Water	800
Condensed Water	220

- It is observed that the Sic nanoparticle dispersed in water helps to absorb the toxic contents of the water fed into the basin, with further enhancements in the structure of Sic we can achieve maximum capability of the condensate to be potable enough.

C. Advantage

- External source is not required for its operation.
- There are no moving parts; it is therefore reliable and almost maintenance free
- Water taste is claimed to be better since the device act as a Solar Water Vaporizer and it doesn't boil the water
- Cost efficiency is low when compare to other purification process.
- The purified water collected at the storage tank is high, compare to single slop arrangement.
- It requires less maintenance.
- Free of charge sun energy (during sunlight it eliminates 500 Watt electric consumption per one hour of sunlight)
- There are no moving parts; it is therefore reliable and almost maintenance free (cleaning is required though)
- Water taste is claimed to be better since the device act as a Solar Water Vaporizer and it doesn't boil the water (resembling rain water)

D. Disadvantages

- Rate of distillation is usually very slow (6 litres of water per sunny day).
- It is not suitable for larger consumptive needs.
- The materials required for the distiller may be difficult to obtain in some areas.

E. Cost Analysis

COST ANALYSIS:
Total cost of steel basin = Rs 2000
Cost of Glass = Rs 500
Cost of Carbon black paint = Rs 200
Cost of Arduino = Rs 800
Cost of Peltier module = Rs 100
Cost of Pump = Rs 70
Cost of Battery = Rs 800
Cost of Temperature sensor = Rs 60
Cost of Nano Particle = Rs 550

Net Cost of the project = Rs 5080

VI. FUTURE SCOPE

At present, the most extensively studied nanomaterials for water and wastewater treatment mainly include zero-valent metal nanoparticles, metal oxides nanoparticles, carbon nanotubes (CNTs), and nanocomposites. Considering the current speed of development and application, nanomaterials look extremely promising for water and wastewater treatment. Since low production cost is crucial to ensure their wide spread applications in water and wastewater treatment, future research should be devoted to improving the economic efficiency of nanomaterial. Besides, with increasingly extensive applications of nanomaterials in water and wastewater treatment, there are growing concerns on their potential toxicity to the environment and human health.

VII. CONCLUSION

Potable water is considered to be a scarce commodity especially in arid and remote regions. While conventional distillation technologies offer an excellent solution to meet water demand, they are considered to be energy intensive processes. Conventional distillation technologies are well suited for large scale applications but they are not-efficient and not suited for small scale water demand. Conventional distillation processes are expensive to operate and require continues maintenance which prevent their utilization in remote areas.
With the ever increasing energy cost and unavailability in the future, there is a need for cost effective distillation system that is well suited for small scale application. Solar distillation is expected to be a promising method to alleviate water shortage. The interests in solar distillation technologies have increased significantly in the last few decades. In order to maximize the utilization of solar distillation, its efficacy needs to be improved further and its cost must be reduced. Solar energy powered by distillation process can have a positive impact on reducing gas emissions and can be considered to be a reliable source for potable water. Solar distillation processes can provide fresh water for remote areas in a sustainable way. Currently, more research

is needed for improving solar based distillation and the treatment of waste water using these units.

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