SOLAR DISTILLATOR ENHANCEMENT USING NANOPARTICLES

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***Abstract*—The experimental investigation has been performed in the month of April, 2019 at Kharghar, Maharashtra, India with latitude of 19.047321 N and longitude of 73.069908 E. The aim of this project is to analyse the effect of CuO Nano-particles on the operation of a traditional solar still. a single slope solar still is used in this experiment because of its manufacturing simplicity and cost effectiveness. In this project the conventional solar distillation process is improved by the use of CuO Nanoparticle mixed with black paint. For the experimentation purpose, CuO nanoparticles of 10nm size are mixed with black paint. Nano particles increases the surface thereby increasing the heat rate. While the traditional distillation process could yield maximum output for a period of 2-3 hours. The employment of Nano-particles increases the productivity The time period of experimentation was of 12 hours (from 8am to 8pm).Although a further water quality study needs to be performed, the experiment reveals promising results for next generation solar distillation process.**

Keywords- Solar Distillation, Nano-particle, CuO.

I. Introduction

Water, food and air is the general necessity of every human being. Lakes, rivers and underground water reservoirs are the main sources of fresh water. Of the total earth's surface 71% is covered by water, yet 96.5% of it is covered by oceans, 1.7% by groundwater, 1.7% by ice caps and the glacier and air as vapor and clouds accounts for 0.001%. Out of the total Earth's water 2.5% is freshwater and out of which 98.8% is covered by groundwater and ice. Out of remaining fresh water 1% or less is covered by atmosphere, lakes and rivers. water purification is generally done through various process and one among those process is distillation, since sunlight is general need of heat source in distiller and abundant of its availability makes this process important . To have a common belief that boiling the water is necessary to make it distill. But Simply elevating factors like temperature will adequately improve the evaporation rate. In fact, boiling will force unwanted residue to enter into the distillate, and it also effect the purification of water. Solar Distillation is the least costly and most reliable method of obtaining 99.9% of pure form of water from contaminated water. Mostly in developing nations like India where fuel is expensive and scarce. Solar distillation is preffered to produce pure form of water which are used for laboratories, hospitals, lead acid batteries and also in producing commercial items like rose water, etc. Consumption of conventional boiling distillation is near about three kilowatts which is required for every gallon of water and on the other hand solar distillation uses power of the sun which reduces the operating cost.

Bhupendra Gupta [1] mainly focused on various parameter, material and techniques to improve the productivity of the solar still and he was able to achieve it by using CuO nanoparticle and sprinkler attached to it. And from its experimentation the water productivity was nearly increased by 37.9% and along with it the efficiency was increased by 54.54% Raghvendra sharma [2] in order to increase the overall efficiency of the solar still he painted the side walls with white paint in order to reduce heat loss. Kolilraj Gnanadason [3] he experimented on a triangular basin and he used copper sheet instead of cast iron sheet to improve the heat transfer rate Z.M.Omara [4] analyzed the different methods of glass cover cooling used to improve the solar still performance. After the result he noticed that the solar still's daily production depends upon the difference of saline water temperature.Manoj Kumar Sain [5] used Al_2O_3 nanoparticles on productivity of single slope solar still and he noticed that the production and the efficiency of solar still water depth 0.1 m. with nano particles

with 3.48 and 38.65% respectively.There was 12.18% increment in the thermal efficiency.

The main aim of the project is to increase the overall productivity of the solar distillator by increasing, temperature difference between the water and glass by adding nanoparticles, in addition to these we plan to make the solar distillator compact and portable

II. Experimental Details and Measurement

Table No. 1: Material Description

	Raw Material /component	Dimension/properties	Description/uses
1	Water-resistant plywood	18 mm thick	Insulation purpose and for support
2	Aluminium sheet	2mm thick	Aluminium has a better reflective property than other material while it is non-reactive to water so no corrosion problem
3	Asphalt paint	Black in color	As a medium to spread the nanoparticle uniformly on the basin and also its absorptive properties are higher than any other color
4	pipes and fitting	PVC material	Easily available and also the pipe is heat resistant
5	Non-reflective glass	5 mm	The non-reflective glass is used to trap the heat from sunlight inside the still.
6	CuO nanoparticles	99.99%	It increases the surface area and thus thereby increases the heat transfer rate

The solar still consist of a basin and two water container (salt-water and fresh water). The basin is made up of water-resistant plywood (6mm thick) and base dimension of 50cm x 50 cm = 2500cm^2. The base is covered up by aluminium sheet (2 mm thick). The upper face of the still has slope of 23° with the height of 11cm and 32cm at each ends respectively. The sides walls of the stills are painted with white color in order to increase total internal reflection. The base of the still is painted with a mixture of black paint and CuO nanoparticles(10% of weight). The mixture of black paint and nanoparticles increases surface area and thereby improving the heat transfer rate. As a result of these the productivity of the solar still increases.

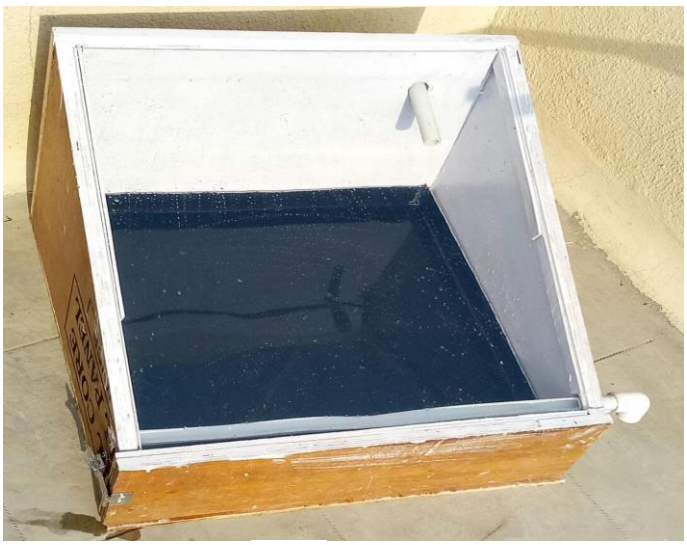


Fig..1. Solar still

III. PROCEDURE

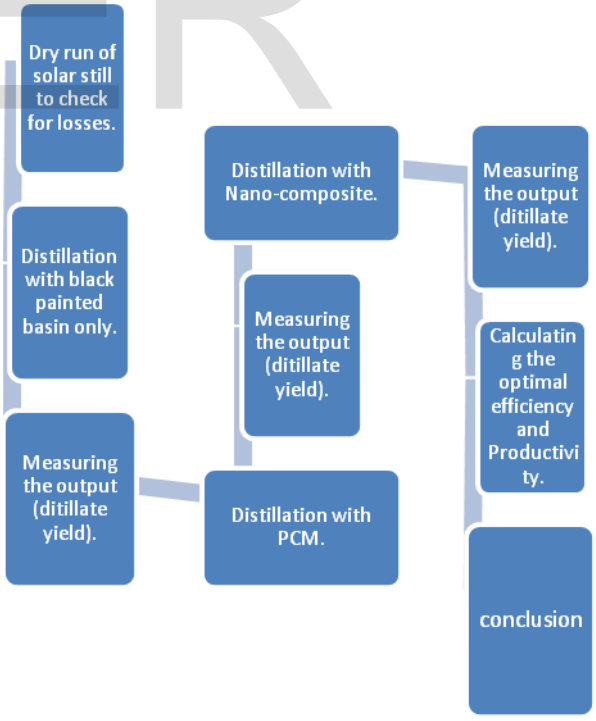


Fig.2. Overall methodology

Enhancement in working of the solar distiller is made by coating the nanoparticle to the aluminium sheet which will eventually increase the productive rate. CuO here is used as a nanoparticle as it had a highest efficiency and pure aluminum is used here as it consists of the reflective property and also it is non-reactive to water thus there is no corrosion problem. An aluminium sheet is taken of 2mm thickness and size of (50cm x 50cm) then it is coated with a solution which consists the mixture of nanoparticle and asphalt as paint cannot be mixed totally with CuO thus we use asphalt. By coating the solution to aluminium sheet it develops the high absorbing property of heat which plays key role in Distillation process. A water resistance plywood is used of 12mm thickness for the rest in the distiller other than glass and aluminium sheet which with be coated with white paint there by enhancing the property of reflector thus assembling all heat and aluminium sheet. A non-reflective glass of 6mm thickness is fitted on the edges of the plywood inclined at 23. This is done because due to inclination maximum amount of sunlight can be trapped and approximately 23 is crucial for it. Dimension of the plywood estimated are Rear portion-(32mm x 50mm) and Front portion-(11mm x 50mm), Left-side portion and Right-side portion-(32mm x 50mm) with non-reflective glass at 23^{o} When the sunlight falls on non-reflective glass where max amount of transmission of sunlight takes plays then from all the side walls of plywood due to white paint maximum reflection takes plays and all sunlight assembles on the base aluminium sheet where due to black asphalt mixture maximum absorption of sunlight takes place. Water is entered from the top corner of the distiller then due to absorption of sunlight heat by the aluminium sheet this heat is used by the aluminium sheet, this heat is used by this water and also the heat which is transmitted through the glass is also used by water thereby changing the phase from liquid to vapor and this vapor gets deposited on the glass and after sometime this vapor is condensed to liquid form and dur to inclination this distilled water gets collected to pipe which are then transmitted outside the distiller useful for other means. These pipes are made from PVC material as they are heat resistant. Advancement is made here by enhancing the productivity by use of nanoparticles.

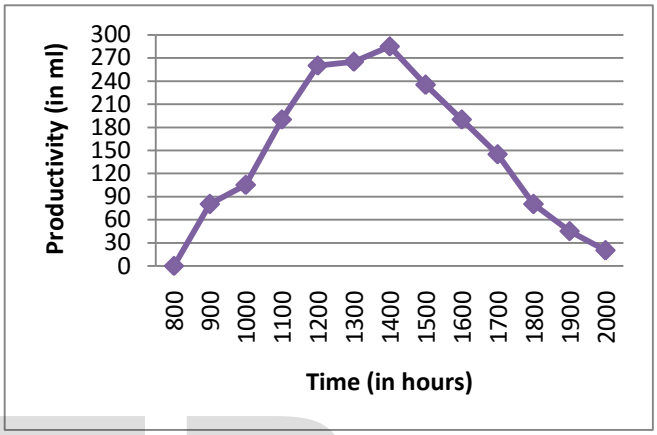
IV. Results

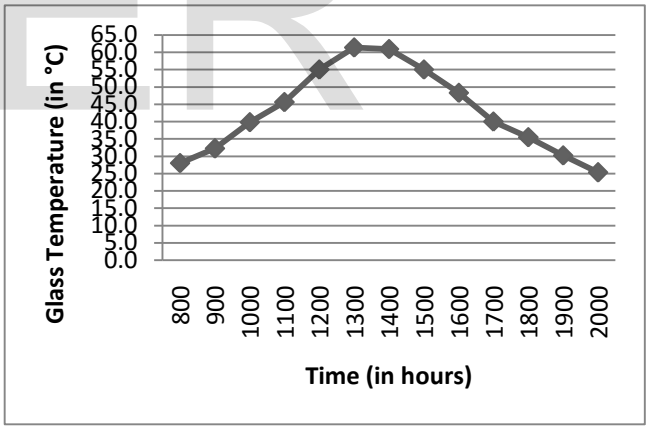
The observations in case of conventional solar distillation process are as follows:

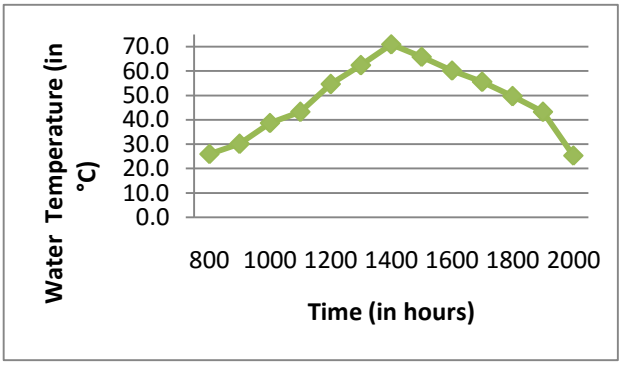
Table No. 2: Observations for conventional distillation

Sr. No.	Time	Productivity (in ml)	Glass Temperature (in °C)	Water Temperature (in °C)
1	8:00 am	0	28.0	26.0
2	9:00 am	80	32.2	30.1
3	10:00 am	105	39.8	38.7
4	11:00 am	190	45.6	43.2
5	12:00 pm	260	55.0	54.6
6	01:00 pm	265	61.4	62.3
7	02:00 pm	285	60.9	70.9
8	03:00 pm	235	55.0	65.8
9	04:00 pm	190	48.3	60.2
10	05:00 pm	145	40.0	55.5
11	06:00 pm	80	35.5	49.6
12	07:00 pm	45	30.2	43.2
13	08:00 pm	20	25.3	35.8

From the above observations we can see that the maximum total distillate yield obtained was 1880 ml/day.



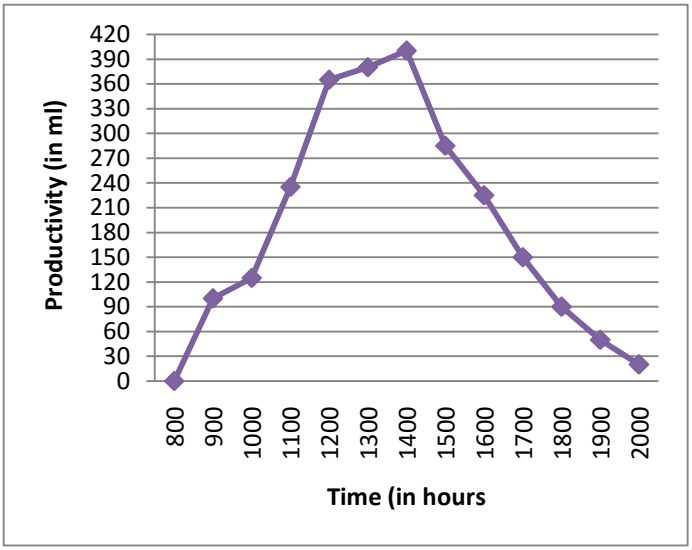


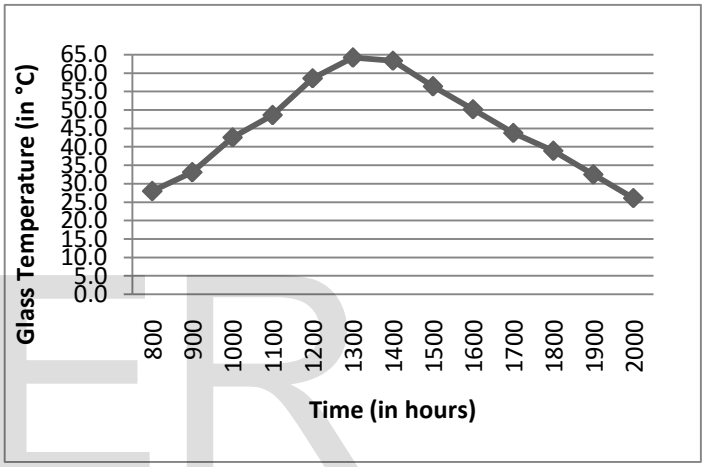


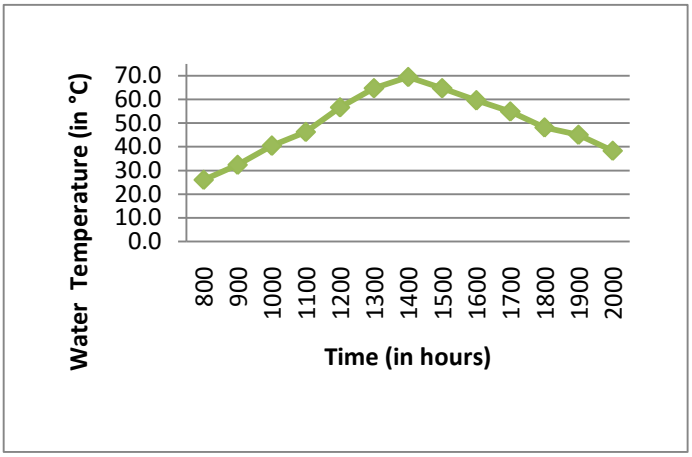
In the second stage of the experiment, distillation is carried with CuO nanoparticles mixed with black paint (10% by weight). The observations recorded in this stage were as below:

Table No. 3: Observations for modified solar distillator

Sr. No.	Time	Productivity (in ml)	Glass Temperature (in °C)	Water Temperature (in °C)
1	8:00 am	0	28.0	26.0
2	9:00 am	100	33.1	32.4
3	10:00 am	125	42.6	40.4
4	11:00 am	235	48.6	46.3
5	12:00 pm	365	58.6	56.7
6	01:00 pm	380	64.2	64.8
7	02:00 pm	400	63.4	69.5
8	03:00 pm	285	56.4	64.8
9	04:00 pm	225	50.2	59.6
10	05:00 pm	150	43.8	54.9
11	06:00 pm	90	38.9	48.2
12	07:00 pm	50	32.5	45.1
13	08:00 pm	20	26.1	38.3







V. CONCLUSIONS

The following conclusions were incurred upon after the three stage experimental process:

- The overall distillate yield of the conventional solar still has been found out to be increased using nano particles mixed with black paint
- Computed daily distillate output for the solar distillator painted with the mixture of nanoparticle and black paint, was 2425 ml/day as against 1880 ml/day. The productivity was found to be increased by 28.98%.
- Above results indicate that the modified solar still painted with the mixture of nano-particles and black paint shows improvement in the productivity than the conventional solar still.

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