A NEW APPROACH OF ELECRONIC FEED CONTROL DESALINATION SYSTEM BASED ON NANO MATERIAL ALUMINIUM OXIDE BED WITH ENVIRONMRENTAL PROTECTION OF GREEN ATMOSPHERE

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ABSTRACT

Solar energy is no polluting energy and is also a free renewable source of energy. The quality of drinking water is a fundamental need of human life. So good and clean water are necessities for human beings for food, drinking and washing purposes. Various methods are available for converting saline water into good drinking water. Those methods are such as desalination, vapour compression, reverse osmosis and electro dialysis. Solar water desalination is one of the most popular solar technologies. In this technology, the pure water is produced without salt content from the salty water including the bore water and seawater. When compared with the various energy storage materials such as glass balls, pebbles, gravels, and nano materials, the nano material gives more yield than other heat-absorbing materials. The best slope of the glass cover is 450 and the water depth of still is 0.050m. The maximum day yield for saline water with nano materials was 7.480 L /m2/day without thermocol insulation and the maximum day yield for saline water from nano materials was 7.920 L /m2/day with thermocol insulation and the maximum yield efficiency of solar still is 61%.

Keywords: Solar still, Energy storage materials, Desalination, Aluminium oxide

1. INTRODUCTION

1Abdul- Enein et al. (1998) evaluated the different parameters affecting the solar desalination process . The investigation of a single-basin solar still with deep basins has improved the solar still and also increased solar still production. They discussed the daily still yield for different parameters like depth of saline water, insulation thickness and various cover angles and also the daily still yield was approximately 2.5 kg/m2 for 40 mm depth, 3.5 kg/m2 for 50mm depth and 2.8 kg/m2 for 80mm depth under the maximum solar intensity of 1016W/m2 in the month of July 1996.

Nafey et al. (2001) conducted several experiments to improve solar still productivity. The modified solar still by using black rubber sheets and black gravel are used as storage materials for absorbing and storing the more solar heat energy. They experimented with different sizes of gravel, and they achieved the daily still yield of approximately 3.5 kg/m2. They conducted experiments on varying the sizes of gravel with different quantities of saline water in the solar still.

Shukla et al. (2005) conducted experiments on both single slope and double slope solar still by keeping the jute cloth in a horizontal position and immersed in the saline water basin. In this still, the daily yield during the summer was 2.0 kg/m2 and for the double slope still it was increased to 2.5 kg/m2 . Lafdi et al. (2008) suggested that the carbon material has increased the thermal conductivity more in the solar desalination process. Graphite foams infiltrated with phase change materials as an alternative material for space and terrestrial thermal energy storage applications. Carbon materials can have thermal conductivities as high as 470 W/(m K), and are also used in thermal energy storage systems. Velmurugan et al. (2008) suggested that sensible heat storage materials increased the solar desalination process production. The sensible heat storage materials placed along with solar still basin and also absorption of solar energy was more and improved the solar desalination process production. The design of fin-type solar still with sensible heat storage materials such as pebbles, coals and sand increased the productivity of the solar still. Hitesh Panchal et al. (2011) experimentally designed a single-basin single-slope solar still and analyzed the sensible heat storage materials like cow dung cakes along in the solar still basin. They found that the heat transfer coefficients were considerably higher and increased the yield of solar still. The performance of solar still when using cow-dung cakes was 25% more. Colangelo et al. (2012) conducted several experiments on the heat conductivity of nanofluids based on diathermic oil for high-temperature applications. They found that the thermal conductivity enhancement of the nanofluids with diathermic oil is higher than that with water, with the same nanoparticles and at the same conditions. They also found that the thermal conductivity is reduced with increasing the size of particles.

Anburaj et al. (2013) investigated the experimental performance of a new type of inclined solar still with rectangular grooves and ridges in absorber plate, tested for different inclination angles with different wick materials like black cotton cloth, waste cotton pieces, jute cloth, clay pot and mild steel pieces at actual solar conditions. They found that 300 inclusion is the optimum one and black cotton cloth wick material enhances the production rate by 12%. Elango et al.(2015) analyzed energy storage materials like nano material to enhance the yield of single basin single slope solar still. They conducted experimentally with different nano fluids like iron oxide, aluminium oxide, Tin oxide and Zinc oxide. They found that the aluminium oxide nanomaterial was enhancing the performance of solar still. The enhanced yield rate of aluminum oxide was 29.95% more than for the other nano materials. Samuel Hansen et al. (2015) experimentally conducted with new design of inclined solar still for increase the yield of solar still. They analyzed different types of wick materials, like wood pulp paper wick, wicking water coral fleece material and polystyrene sponge for improve the performance of solar still. They found coral fleece material with wire mesh stepped absorbent plate gave more yield than the other materials.

2. OBJECTIVE OF THIS RESEARCH WORK

The objectives of this research are described as follows.

1.Saline water and sea water are converted into good drinking water using the solar energy with single basin single slope solar still. 2.Solar still basin materials such as wood, plastic, galvanized iron, concrete, aluminum, asbestos cement, masonry bricks, black lime stone are analyzed and best material is found out. 3.The effective solar stills basin water depth to be found from the level of 0.005m to 0.030m. 4.Solar still with various energy storage materials glass balls, gravels, pebbles and nano-materials are analyzed and optimum storage material is to be find out. 5. Improving the performance of solar still.

3. METHODOLOGY

This methodology is carried out through the experimentation of the parameters such as solar radiation, energy storage value and solar still basin top glass cover inclination. These parameters enhanced the production rate of solar still. The solar still is a single basin and single glass covered device, which can convert available saline water into good drinking water by using solar energy. The solar still is a simple, low-cost pure water processing device. In the desalination method, the saline water is stored in the solar still.The stored saline water is heated by solar energy. More solar energy is absorbed by the saline water using some storage materials. Energy storage materials are used to store the thermal energy and release it very slowly after sun shining. The heated saline water is evaporated by the sensible heat and the water vapor rises, and it comes in contact with the cooler inner surface of the cover. Then the water vapour is condensed in the top of the still-sloping glass and slides down along the glass cover's bottom surface due to gravity. The condensed pure water is collected in the water collector and taken out from the solar still as good drinking water.

3. 1 Energy Storage Materials

The single-basin, single-glass-covered passive type solar still is fabricated with black lime stone (cuddappa stone) and the performance of the solar still is to be compared with different energy-storing materials, such as glass balls, gravels, pebbles and nano-material like aluminum oxide. The energy materials are used to absorb and store the solar energy and that energy enhances the production rate of solar still. At the same time, the solar still basin material, black lime stone, also stores solar energy and that energy is also used to increase the yield of solar still.

3. 2 Construction Details of Solar Still

The solar still is constructed by single basin, glass cover, energy storage materials, condensate drain cover, storage tank and collecting jar. The basin contains brackish or sea water. This is enclosed in a completely air tight envelope and a transparent cover at top. The basin absorbs the maximum part of the transmitted radiation through the glass cover. The glass cover is top of the black basin. The glass cover is single inclined type. The glass cover thickness is 0.004 m and its inclination is 30^0. The effective depth of the water level in solar still is 0.020m.

4. EXPERIMENTAL SETUP

The experimental set-up was performed and all the experiments were taken at Mahakavi Bharathiyar College of Engineering and Technology, Vasudevanallur, Tamilnadu, India (south) (9°11' N 77052' E). This is still placed in a south-north direction, because the sun's path is in the south-north direction. The overall size of the basin is 1.060m x 0.725m x 0.890m (longer side) 0.275m (shorter side). The top of the solar still is covered with transparent glass.In the solar still, 0.004m thickness glass is used for solar energy transportation purposes. Some holes are provided in the solar still for inserting the thermo meters. There are 4 thermometers placed on the solar still in different locations, and they are also used for measuring the temperature of the solar still in various parts. The observation readings are taken from 9.00 am to 6.00 pm. The temperature of ambient (Ta), basin water (Tb), basin vapor (Tv), and condensate water (Tc) are noted every 1 hour by thermometers. Simultaneously, the intensity of solar radiation is recorded using a sun meter, the wind speed is measured by an anemometer, and the rate of the hourly desalinated water is measured by a collecting jar. Here the single basin single glass cover solar still has been fabricated with a black liestone base (Cuddappa stone).

5. EXPERIMENTAL RESULT

5.1 Day Yield Comparison for Saline Water

The Table 1 shows that the day yields of saline water with energy storage materials in without thermocol insulation and with thermocol insulation. The day yield is more with thermocol condition than without thermocol condition.

Table 1 Day yield for saline water with energy storage materials

Sl.No.	Content	Day Yield (ml)	
		Without thermocol Insulation	With thermocol Insulation
1	No energy material	840	970
2	Glass ball	2320	2480
3	Glass ball + colour dye	2380	2590
4	Pebbles	3540	3730
5	Pebbles + colour dye	3600	3820
6	Gravels	3980	4240
7	Gravels + colour dye	4120	4350
8	Nano material	7390	7810
9	Nano material + colour dye	7480	7920

Table 2 shows that the night yield of saline water with energy storage materials in without thermocol insulation and with thermocol insulation of solar still basin. The day yield is more with thermocol condition than without thermocol insulation.

Table 2 Night yield for saline water with energy storage materials

4Sl.No.	Content	Night Yield (ml)	
		Without thermocol Insulation	With thermocol Insulation
1	No energy material	40	50
2	Glass ball	80	110
3	Glass ball + colour dye	85	115
4	Pebbles	105	150
5	Pebbles + colour dye	110	155
6	Gravels	260	300
7	Gravels + colour dye	265	310
8	Nano material	440	490
9	Nano material + colour dye	450	500

6. RESULT AND DISCUSSION

Different energy storage materials are used in the basin along with water to improve the heat capacity, radiation absorption capacity and enhance the evaporation rate. The solar still basin optimization water level and yield of the solar still are analyzed under the conditions of without thermocol and with thermocol conditions. The nanomaterial absorbs more solar energy and increases the storage of solar energy more. The nano material yield more than the other energy-absorbing materials.

6.1 Rate of Production

The production rate also depends on the intensity of solar radiation. The minimum solar radiation gives a reduced production rate. At the beginning of the process, the lower intensity of solar radiation leads to a slower rate of production of desalinated water. The maximum production rate is between 1.00 pm to 2.00 pm. The maximum day yield is 7920 ml/m2/day for saline water with thermocol conditions. The maximum night yield is 500 ml/m2/day for saline water with thermocol conditions. Figure 1 shows the daily production rate of solar still with various energy materials without insulation of solar still basin.

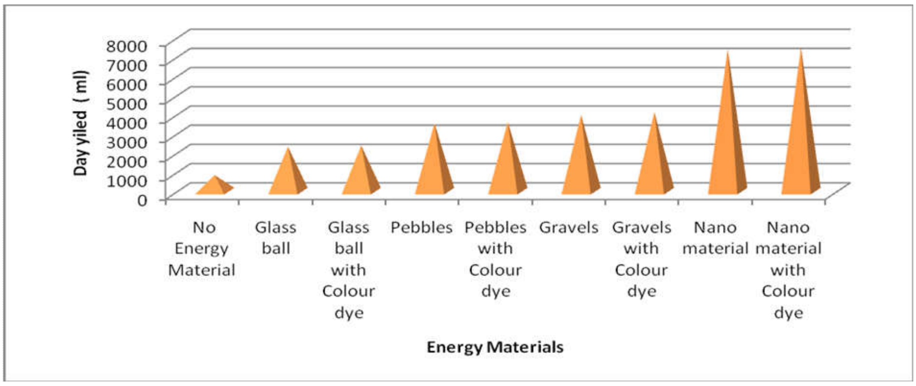

Figure1. Day production rate of solar still without insulation

Figure 2 shows that the daily production rate of solar still for various energy materials with insulation of solar still basin.

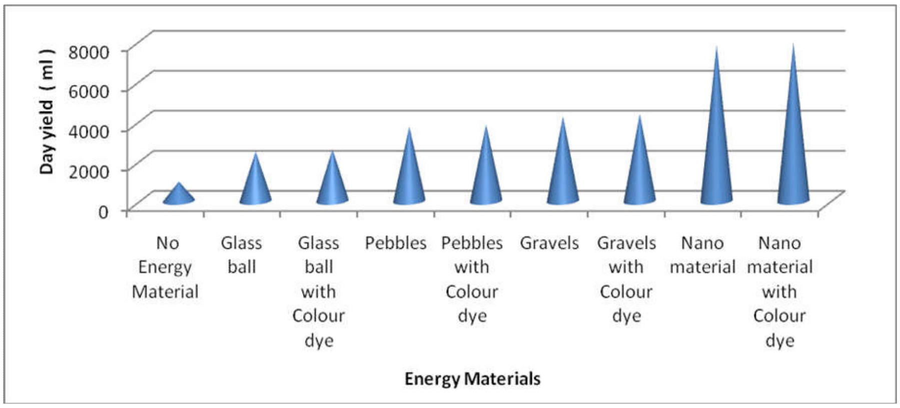

Figure 2. Day production rate of solar still with insulation

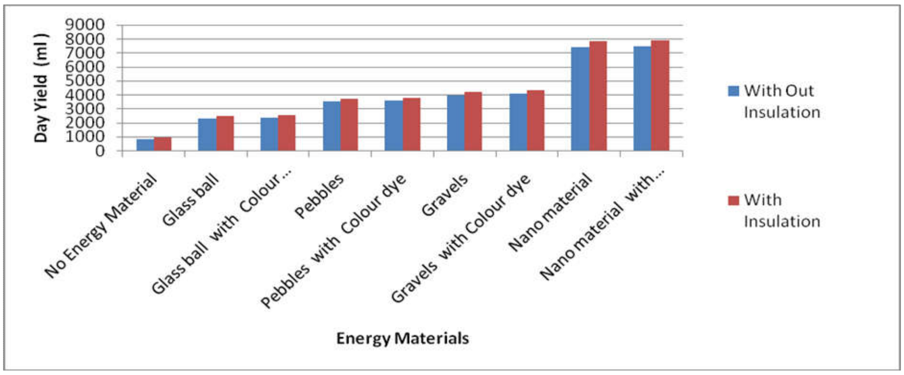

Figure 3. Comparison of day yield rate of solar still with and without insulation

Figure 3 shows that the daily production rate comparison of solar still for various energy materials with and without insulation of solar still basin

Figure 4 shows that the night production rate of solar still for various energy materials without insulation of solar still basin

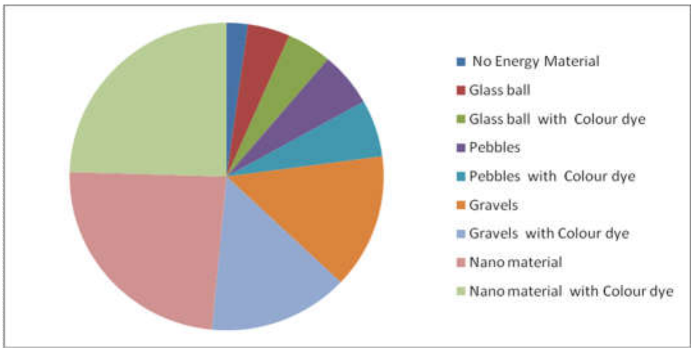

Figure4. Night production rate of solar still without insulation

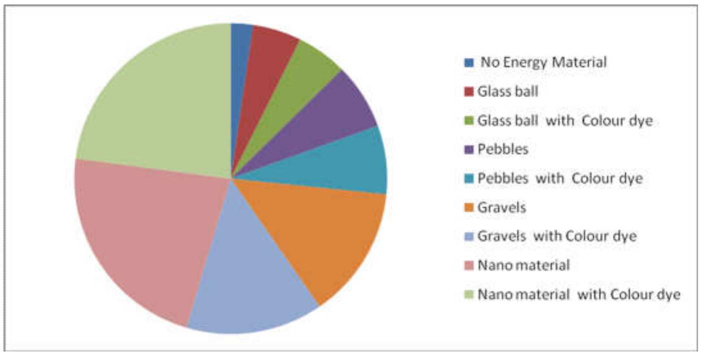

Figure 5. Night production rate of solar still with insulation

Figure 5 shows that the night production rate of solar still for various energy materials with insulation of solar still basin

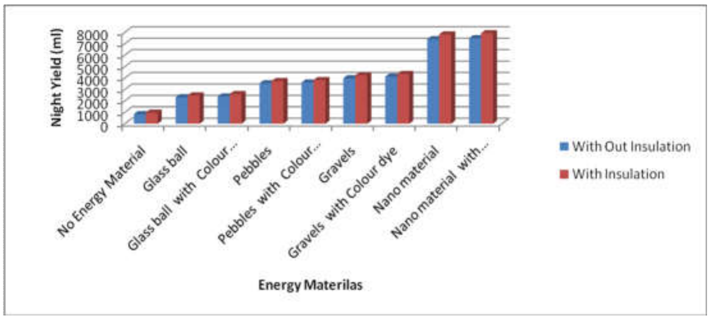

Figure 6. Night yield rate comparison of solar still with and without insulation

Figure 6 shows that the daily production rate comparison of solar still for various energy materials with and without insulation of solar still basin.

7. SOLAR STILL PERFORMANCE CALCULATION

7.1 Performance of Nano particle

The performance of Nano particles is calculated from the expression, $N = \frac{m}{4\pi r^3 / 3 \ X \rho n}$

where N = Total number of Nano particles

m= mass of Nano power in Kg (0.5 kg)

r = Radius of Nano particles in m (30 x10^{-9}m) ρ_n= Density of Nano particles (3970kg/m^3)

From the above formula, the total numbers of Nano particles are 1.114 x 10^{18}

7.2 Total Spherical area of Nano particle

$$A_n = 4 \pi r^2 \text{ x } N$$

where , A_n= Spherical area of the Nano particle

From the above formula the total spherical area of Nano particles are 12592m^2.

7.3 Solar still performance

The performance of solar still is calculated from the expression;

$$\eta = \frac{M \ h_{fg}}{A_{st} \ \varepsilon I}$$

in which η is the efficiency of solar still, h_{fg} is the latent heat of water, which is 2390 kJ/Kg, M is mass of yield in kg, and εI is the total radiation in kJ/m^2 /day respectively.

h_{fg} = Latent heat of water in kJ/kg

M = Mass of yield in kg/day

εI = Solar radiation intensity in kJ/m^2/day

A_{st} = Effective Area of still in m^2

7.4 Contribution of Nano particle bed

1. The Nano bed of aluminium oxide has a higher solar absorption coefficient than conventional solar still. So more solar radiation is converted into thermal heat. The basin water rises in temperature quickly.

2. Since the specific heat of aluminium oxide is lower than the saline water, the Nano particle bed rises to a higher temperature and transfers the heat to the surrounding water. Hence, evaporation is enhanced.

3. Assuming the Nano particles to be spherical balls, the spherical area of each ball transfers the heat to the surrounding saline water. The heat transfers to liquid, which in turn enhances evaporation which yields more distilled water

4. Even after the sun sets, the nano particles release the stored heat to keep the evaporation continuously. In that way, the system also produces additional distilled water. Thus, nano particle aluminium oxide bed enhances the production of distilled water compared to plain solar still.

9. CONCLUSION

From the experimental results, the following conclusions were stated.

1. Observations from the various energy-absorbing materials, the nano-materials-based solar still production rate was higher than the rest materials such as glass balls, pebbles and gravels.

2. The nano-bed of aluminium oxide has higher solar absorption co-efficiency than other materials.

3. From the energy storage materials, the best energy storage materials were found to be nano materials. Because it has more surface area than the other energy storage materials.

4. After the sun sets, the nano particles release the stored heat to keep the evaporation continuously. In that way also the system produces additional distilled water.

5. Thus, a nano-particle (aluminium oxide) bed enhances the production of distilled water compared to plain solar still.

6. The best slope of the glass cover is 450 and the water depth of still is 0.050m. The optimization result of the yield is at midday (1.00 to 2.00 pm). The maximum day yield for saline water with nano materials was 7.480 L /m2/day without thermocol insulation and the maximum day yield for saline water from nano materials was 7.920 L /m2/day with thermocol insulation. The maximum yield efficiency of solar still is 61%.

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