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Conceptual Design of a Microcontroller Based Solar Water Purification System Using a Sliding Parabolic Cum Circular Reflector

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Abstract: *Scarcity of pure water exists in almost all countries around the globe. Hence water has to be purified before it is consumed. Therefore in this paper, we have designed a solar water purification plant that operates around the clock to supply fresh water to the society. A nickel-chromium alloyed wire reinforced black body has been used to heat the impure water and it condenses on a thermally insulated condenser. Two solar panels have been attached the sides of the reflector that moves along with it to trap the solar energy and store it in a battery. During night and at times of low sun rays, this electric energy can be used to heat the nickel-chromium alloyed wire reinforced black body. These functions are controlled by a microcontroller.*

Keywords: *All day solar water purifier, Reflector handle, nickel-chromium alloyed wire-chromium wire reinforced black body, Parabolic cum circular reflector.*

I. Components Of The Solar Water Purifier

1.1 Reflector Handle for solar tacking

The reflector handle is used to hold the reflector and move the reflector in the pre defined path according to the direction of the sun rays. It has a pulley and rope attachment that pulls the reflector on the reflector handle. A stepper motor is used to rotate a set of pulleys attached to the inner rim which in turn moves the rope. It has two rods on the top to hold the black body.

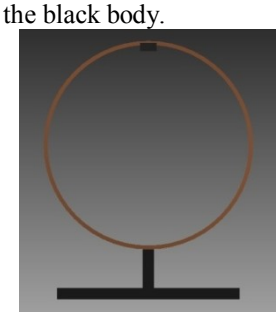

Fig. 1 The reflector handle with the stepper motor at the top

The most efficient way of tacking the solar power is by using a solar tacking system. The power that is obtained during tacking is far higher than a system without it. It is shown in the graph below.

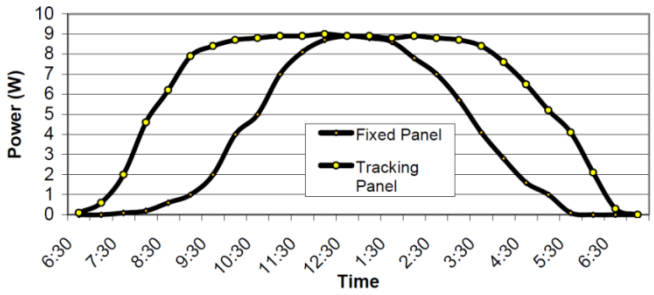

Fig. 2 A graph between power and time [1]

1.2 Nickel-chromium alloyed wire reinforced Black Body

A black body is used to receive the sunrays reflected from the reflector and heat the impure water. It has a nickel-chromium alloyed wire reinforced in it so that it can act as a heating element during night times. It has a condensed over it to condense the water vapor. It has a water inlet pipe attached to the top and a cleaner

pipe at the bottom that is used during cleaning purposes. It has a special bend in the sides to collect the condensed water.

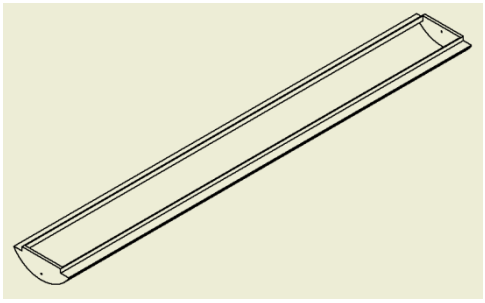

Fig. 3 A Black Body with holes on the inlet and outlet holes on sides

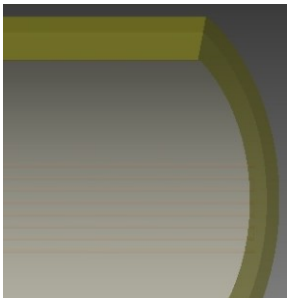

Fig. 4 A Black Body with nickel-chromium alloyed wire reinforced in it

1.3 Condenser

A specially designed condenser is used to condense the water vapor and take it down to the sides where it is taken out. It is made of a thermally insulated material so that it does not take in heat. It has an outlet pipe at the side to take out the condensed water.

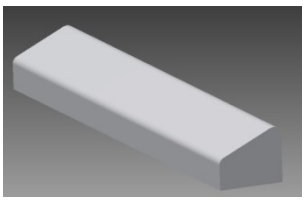

Fig. 5 A specially shaped condenser that is used to condense water vapor

1.4 Parabolic cum circular Line Reflector

A line reflector is used to reflect the sun rays to a focal line so that it heats the black body. The outer surface of the reflector is circular in shape but whereas the inner surface is parabolic in shape. It has two solar panels attached to the sides which move along with the reflector and stores the solar energy in the battery during day time.

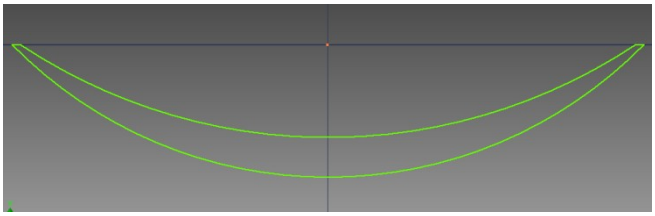

Fig. 6 The parabolic cum circular line reflector in 2D

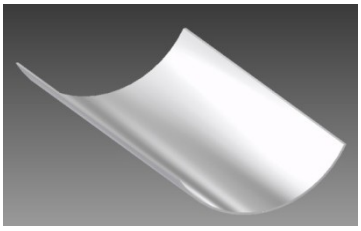

Fig. 7 The parabolic cum circular line reflector in 3D

The reason for using a line reflector is that it has a high temperature to efficiency ratio for this purpose as shown in figure 8.

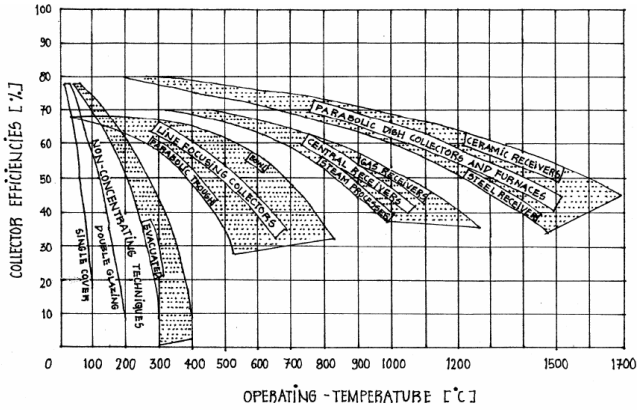

Fig. 8 A graph between collector efficiencies and operating temperature [3]

II. Working Of The Solar Purification Plant

2.1 The Solar Tacking System

A solar tacking system is used to receive maximum power throughout the day. Hence a parabolic cum circular line reflector is used. The advantage of using it is that, we can have a circular outer surface which can slide over the handle's rim and a parabolic inner surface that can focus the sun's rays on the black body. The reflector handle has a set of pulleys that is controlled by a microcontroller based stepper motor on the top. The stepper motor consumes very less power to give a periodic pulse. The various positions of the reflectors are as shown below.

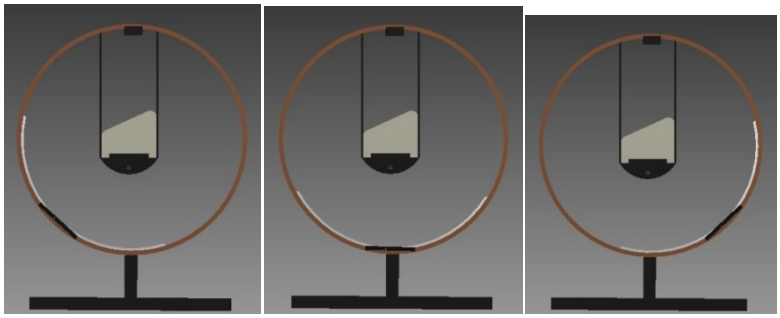

Fig. 9 The reflector sliding from right to left according to the position of the sun

2.2 Water Purification System

It has a black body which absorbs the sun's rays and gets heated. This in turn heats the impure water and the vapor condenses on the condenser. It has a water inlet at a higher position on one side of the black body and a pure water outlet on the other side of the collector. The black body also has an outlet on at the bottom that can be used while cleaning.

Fig. 10 The black body with inlet and outlet pipes

2.3 Water Purification during day time

During day time the reflector moves according to the direction of the sun and gives sufficient heat to the blackbody. The reflector has a line focus and the focal line falls at the center of the black body. This therefore increases the amount of heat rays falling on the black body. There are two solar panels which traps enough power to operate in the night time. The various positions of the reflector along with the solar panel is as shown below.

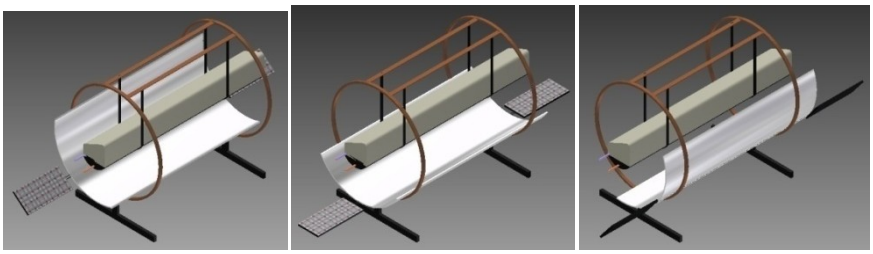

Fig. 11 The various positions of the reflector along with the solar panel

2.4 Water Purification during night time

During night time, the power that is already stored is given to the nickel reinforced black body. The amount of power given is controlled by the microcontroller. Due to this, the black body gets heated and water vapors are formed. This therefore increases the rate of water purification. This system can also be used during days when there is no enough sunlight. At this time, the solar tacking system is not used and is reset to the initial position to reflect the rays the next day.

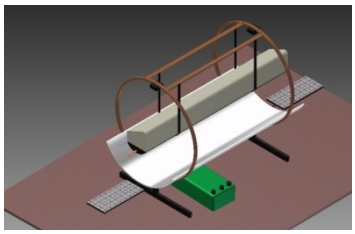

Fig. 12 Powering the plant using the batteries during night time

III. Block Diagram For The Working Of Microcontroller

The micro controller plays an important role in controlling two important factors. They are (1) Controlling the power supplied to the Nickel-chromium alloyed wire reinforced black body and (2) Controlling the periodic pulse given to the stepper motor. The block diagram for it is as shown in figure 13.

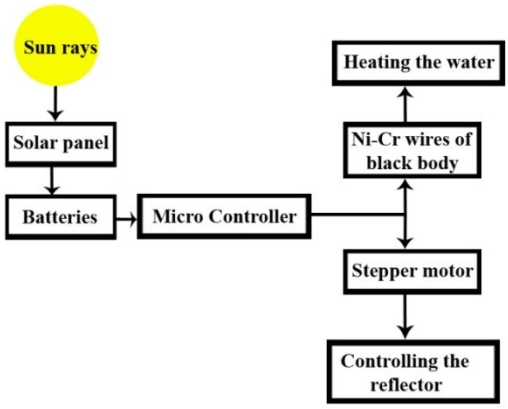

Fig. 13 Block diagram for controlling the solar purification plant

IV. Conclusions

Thus in this paper efforts have been made to create a purification system that works autonomously throughout the day and provides enough water based its size. The reflector that is designed can be easily moved over the reflector handle and thereby enabling maximum power trapping during the day time. A stepper motor controlled by a microcontroller is used here to provide accurate angling of the reflector so that the sun's rays are focused on the black body.

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