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Research Paper Engineering

Performance Analysis of Solar Water Purification by using Thermal Method

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ABSTRACT

Solar water purification by using the thermal method is used as a principle of solar thermal heating system. Solar thermal systems convert sunlight into heat. "Flat-plate" solar thermal collectors produce heat at relatively low temperatures (80 to 140°F [27 to 60°C]), and are generally used to heat air or a liquid for space and water heating or drying agricultural products. Concentrating solar collectors produce higher temperatures. They are most often used where higher temperature heat is desirable, there are large thermal loads, and/or where there are limitations in the area available for installing solar collectors, since they provide more energy per unit of collector surface area. They can also be applied in the production or refining of chemicals and fuels or to produce mechanical or electrical energy. The following is a discussion of concentrating systems for space or water heating. Such collectors can also be used to produce heat for absorptioncooling.

KEYWORDS : solar water heater,parabolic trough,thermal method, low cost,solar water purification.

INTRODUCTION

Parabolic trough technology is currently the most proven solar thermal electric technology. This is primarily due to nine large commercial-scale solar power plants, the first of which has been operating in the California Mojave Desert since 1984. Large fields of parabolic trough collectors supply the thermal energy used to produce steam for a Rankine steam turbine/generator cycle.There are two basic types of parabolic trough solar heating collectors that have been commercially developed: cylindrical parabolic troughs and compound water heaters. A standard cylindrical parabolic trough has a fixed receiver/absorber positioned in the middle of the trough at or slightly above the radius across the edges of the reflector. The shape of the trough (rim angle) determines the focal point, and thus the position of the receiver. The reflector surface is usually polished aluminum, aluminized plastic, silvered glass, or stainless steal.

The receiver usually has an absorber tube coated with a selective material that has a high absorption for the solar spectrum and low emittance for infrared radiation. The absorber tube may be enclosed in glass with a vacuum to reduce heat loss due to convection and radiation. Receiver temperatures can reach 750°F (400°C).Man relied mostly on the sun for his energy needs. With increasing in population of the world and especially our country, coupled with the desire for a higher standard of living and better quality of life, it is imperative that the basic energy needs are met.

However, about 250 years ago, the picture changed radically by the invention of the steam engine and the increasing use of fossil fuels for producing electricity and for industrial purposes. The recent rapid escalation in the cost fossil fuels, the awareness regarding environmental pollution issues, the finite size of the fossil resources, and the ever increasing demand to satisfy better standard of living resulted in harnessing alternate energy source to supplement and eventually replace fossil fuels. The number of conceivable ways to collect, store, convert, distribute were carried out and finally the use of solar energy to immense.

COMPONENTS AND DESCRIPTION

The main components of this project are,SolarKettle,Reflector,Tilting-Mechanism, Cooker, Frame stand and Filter.Figure 1 shows the solar water purification using thermal method.

Figure:1 Solar water purification by using thermal method.

Solar kettle

The most common types of concentrating solar thermal heating collectors are based on the parabolic trough. Parabolic troughs are U-shaped, concentrators that focus sunlight onto a linear receiver tube located along the focal line of the trough. The receiver may be enclosed in a transparent glass tube to reduce heat loss from the absorber and maximize absorption of solar energy. They generally have single-axis tracking shown in figure .In our project, the type of concentrating system that is possible to use in a heating application is the parabolic dish. This has a bowl shaped reflector that focuses the sun onto a relatively small receiver. For optimum performance they require dual axis tracking and the receiver moves with the reflector. This complicates their practical application for water and space heating. Most parabolic dish systems are very sophisticated systems used for electricity generation or very simple systems for cooking food on a small-scale.

Reflector

One side coated glass mirror is used as a Reflector. The reflector is used to reflecting the sun rays to the collecting chamber is shown in figure. The Glass thickness is 2.4 mm. The Glass is one side coated by the mercury.

Tilting mechanism

There are two types of tilting mechanism are used for solar thermal

heating system. They are,

- Single axis Tracking (From east to west)
- Double Axis tracking (East to west or north to south)

The tilting mechanism is having a central pipe, guide bush and nut. The parabolic disk is tilted in one direction from east to west. Shown in figure 1.

Cooker
The cooker is fixed to the center of the parabolic dish collector. This is made up of aluminium materials. The reflected sun rays are concentrated on this center of the cooker, so that the substance is heated efficiently.

Frame stand
Frame stand is made up of mild steel round pipe. The diameter of the pipe is 50 mm. The total height of the stand is 900 mm .

Filter
A water filter removes impurities from water by means of a fine physical barrier, a chemical process or a biological process. Filters cleanse water to various extents for irrigation, drinking water, aquariums, and swimming pools.

WORKING PRINCIPLE
In our work, the type of concentrating system that is possible to use in a heating application is the parabolic dish. This has a bowl shaped reflector that focuses the sun onto a relatively small receiver. The glazing is chosen so that a maximum amount of sunlight will pass through it and reach the absorber. For optimum performance they require dual axis tracking and the receiver moves with the reflector. This complicates their practical application for water and space heating. Most parabolic dish systems are very sophisticated systems used for electricity generation or very simple systems for cooking food on a small-scale. Figure2 shows the layout of solar water purification.Other types of concentrating systems have an array of reflectors that individually track the sun and focus sunlight onto a central receiver located on a tower. Development of these systems has focused on electric power generation.

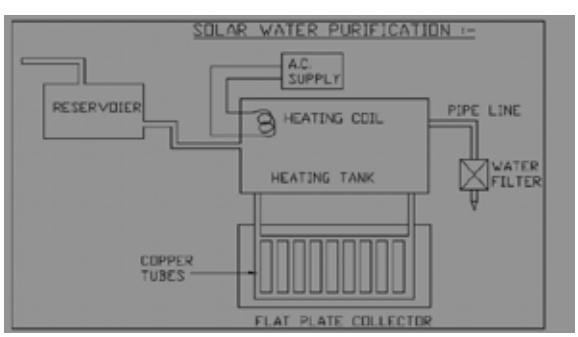

Figure:2 Layout of solar water purification .

RESULTS AND DISCUSSIONS
The thermal performance of solar purification by using thermal method was carried out to evaluate the overall suitability. The developed solar cooker was tested at Chidambaram. The stagnation temperature test, i.e. no load test was started at 11.00 a.m.till the maximum plate temperature was achieved. The reflectors of cooker were shrouded with black cloth during the test. Figure 3 illustrates the diurnal variation in ambient temperature in an empty solar cooker with reflector shrouded with black cloth.The maximum absorber plate temperature attained was about 55°C. Figure 4illustrates the diurnal variation in so-

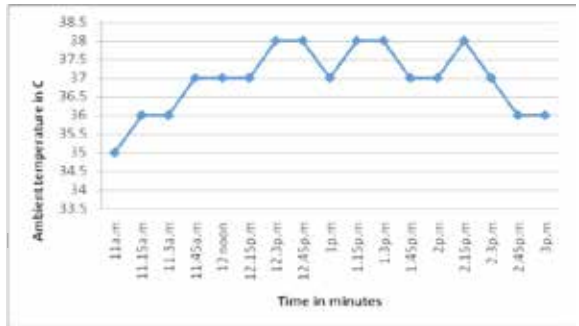

Figure:3 The diurnal variation in ambient temperature

The low value of first figure indicated the higher convection and radiation losses from the side walls made of cardboard and low insulation quality of 3 mm thermacol sheet. The sensible water heating test of solar cooker was carried out by placing the known quantity of the water in the cooking pots and placing the solar cooker in an open space facing due south. The variation in water temperature in a loaded cooker with reflectors during the heat up condition test is shown in Figure 5 and 6.

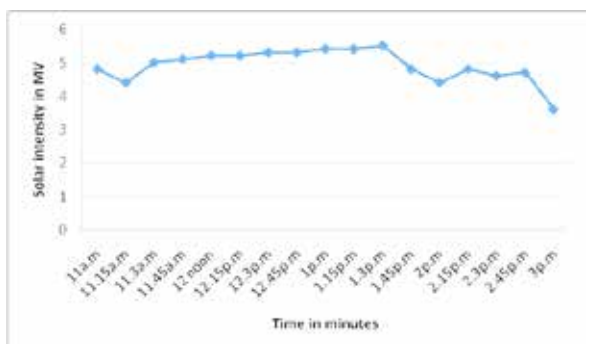

Figure:4. The diurnal variation in solar intensity

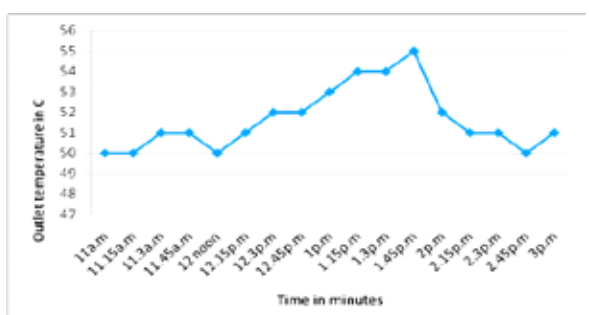

Figure:5 The diurnal variation in outlet temperature.

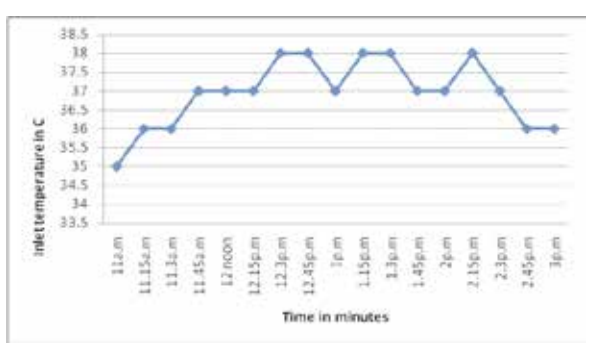

Figure:6 The diurnal variation in Inlet temperature

The thermal evaluation experiment to determine the stagnation temperature of the box-type solar cooker was carried out on 9th May, 2014 and 10th May, 2014, having a suitable clear sky. The developed solar cooker was tested at Chidambaram (11.3997° N, 79.6936° E). The stagnation temperature test, that is, no load test started at 11.00 am local time till the maximum plate temperature (55°C), which occurred at 13.45 pm, was achieved. The following measurements were taken: solar radiation, ambient air temperature, Inlet and outlet temperature at a regular interval. This test was performed in order to determine the first figure of merit of the cooker and compare it with the standard. The initial temperature and final temperature /time data pair was selected from the data of water heating in solar cooker as per IS test code. The time duration for raising water temperature from 50.0°C to 55.0°C was about 165 minutes.

ADVANTAGES

- Less maintenance cost.
- No transportation from long distance
- No rent for electricity utilized
- No fuel required for operation
- No moving parts, thus long life
- Noiseless operation
- No person required to operate the system
- Simple in construction, so easy to fabricate
- No heavy materials are used
- Pollution free
- Less chance of accidents

Limitations

- High initial installation cost
- Care should be taken for Cooking
- Need large size of solar panel area for high power output.

Applications

- Domestic Applications
- Industrial thermal heating Applications
- Federal hospitals, prisons, or barracks

CONCLUSION

This work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, computing and machining while making this work. We feel that the work is a good solution to bridge the gates between institution and industries. We are proud that we have completed the work with the limited time successfully. The Solar water purification by using the thermal method is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done with our ability and skill, making maximum use of available facilities. In conclusion remarks of our work, let us add a few more lines about our impression work.The chief advantage of our system is that, simple, portable type low cost solar water purification by using thermal method when compared to other solar collectors which are available in the market.The Operating principle of solar water purification by using the thermal method is also very easy. We can move the solar water purification by using thermal method from one place to another place very easily.

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