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Development of Multipurpose Commercial Solar Furnace - A Review

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ABSTRACT

In Current situation many industries used coal furnace, electric furnace but our approach is to design solar furnace which works on Renewable energy source, i.e. Solar Energy. Challenging part of the project would be to produce nearly same high temperature as it is being produced for multipurpose commercial use. The heat produced by solar furnace is very clean with no pollutants. The furnace makes use of a large parabolic reflector concentrating the sun into an area the size of the common furnace. Solar radiation is considered to be one of the most prospective sources of energy. It can be design to perform tests that require high radiant flux, strong gradients and very high temperatures, and will be devoted for material treatment at high temperature, under vacuum and controlled atmosphere conditions. This multipurpose furnace is design in a such that it can be used for commercial purpose and used as portable.

Keywords: Solar energy, furnace, parabolic collector, Collection of solar heat

I. INTRODUCTION

Solar energy travels from the sun to the earth in the form of electromagnetic radiation. In this course properties of electromagnetic radiation will be discussed and basic calculations for electromagnetic radiation will be described. Several solar position parameters will be discussed along with means of calculating values for them. The major methods by which solar radiation is converted into other useable forms of energy will be discussed briefly. Extraterrestrial solar radiation (that striking the earth's outer atmosphere) will be discussed and means of estimating its value at a given location and time will be presented. Finally there will be a presentation of how to obtain values for the average monthly rate of solar radiation striking the surface of a typical solar collector, at a specified location in the United States for a given month. Numerous examples are included to illustrate the calculations and data retrieval methods presented.

Strictly speaking, all forms of energy on the earth are derived from the sun. However, the more conventional forms of energy, the fossil fuels received their solar energy input eons ago and possess the energy in a greatly concentrated form. These highly concentrated solar energy sources are being used as such at a rapid rate that they will be depleted in not-too distant future.

There are four primary sources of energy is, petroleum, natural gas and natural-gas-liquids, coal and wood. Excepting wood, all these common sources have finite supplies. The life-time is estimated to range from 15 years for a natural gas to nearly 300 years for coal. Therefore, as these non-renewable sources are consumed, the mankind must turn its attention to longer-terms, permanent type of energy sources. The two most significant such sources are nuclear and solar energy. Nuclear energy requires advanced technology and costly means for its safe and reliable utilization and may have undesirable side effects. Solar energy, on the other hand, shows promise of becoming a dependable energy source without new requirement of a highly technical and specialized nature for its wide spread utilization. In addition, there appear to be no significant polluting effects from its use.

1.1 Solar Furnace

A solar furnace is a unit that uses the sun to produce heat. It works with the use of mirrors. When the sun shines *on* the mirrors the light is concentrated on a single point and a large amount of heat is generated. There are a variety of sizes of solar furnaces available.

A solar furnace is a structure that uses concentrated solar power to produce high *temperatures*, usually for industry. Parabolic mirror or heliostats concentrate light (Insolation) onto a focal point. The temperature at the focal point may reach 3,500 °C (6,330 °F),

1.1.1 Mechanism

A solar furnace is any device that creates heat by concentrating sunlight through the use of reflectors.

1.1.2 General Features Of Solar Furnace

It is generally parabolic in shape with mirrors are attached on its surface.

The temperature which can be obtained depends upon the size and curvature of plate surface.

1.1.3 Applications

This heat can be used to generate electricity, melt steel, and make hydrogen fuel or nonmaterial.

1.1.4 Types of Solar Furnace

Direct beam solar radiation data are presented for four concentrator types: one axis tracking parabolic troughs with a horizontal east-west axis, one axis tracking parabolic troughs with a horizontal north-south axis, one-axis concentrators with the axis oriented north-south

and tilted from the horizontal at an angle equal to the latitude, and two-axis tracking concentrator systems. Direct beam radiation comes in a direct line from the sun and is measured with instruments having a field-of-view of 5.7 ^{0}C.

Solar concentrator is a device that allows the collection of sunlight from a large area and focusing it on a smaller receiver or exit. A conceptual representation of a solar concentrator used in harnessing the power from the sun to generate electricity is shown in Figure 1. The material used to fabricate the concentrator varies depending on the usage. For solar thermal, most of the concentrators are made from mirrors while for the BIPV system, the concentrator is either made of glass or transparent plastic. These materials are far cheaper than the PV material. The cost per unit area of a solar concentrator is therefore much cheaper than the cost per unit area of a PV material. By introducing this concentrator, not only the same amount of energy could be collected from the sun, the total cost of the solar cell could also be reduced. Arizona Public Service has concluded that the most cost-effective PV for commercial application in the future will be dominated by high concentration collector incorporated by high-efficiency cell.

For the past four decades, there have been a lot of developments involving the designs of the solar concentrators. This paper presents some of the distinguish designs which have shown significant contribution to the solar technology. They are:

• Parabolic Concentrator
• Hyperboloid Concentrator
• Fresnel Lens Concentrator
• Compound Parabolic Concentrator (CPC)
• Dielectric Totally Internally Reflecting Concentrator (DTIRC)
• Flat High Concentration Devices
• Quantum Dot Concentrator (QDC)

II. LITERATURE REVIEW

J. Rodrígueza et al. [1] had work on PSA vertical axis solar furnace SF5.A new high-flux vertical axis solar furnace has been constructed and is fully operational at Plataforma Solar de Almería (PSA). This new system is able to deliver up to 5 kW power at peak concentration ratios exceeding 6000.

They used following component to construct this setup:
- Heliostat
- Concentrator
- Attenuator
- Test table

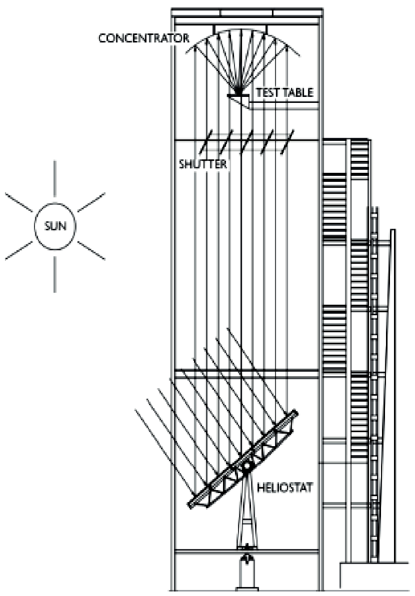

Figure 1 Vertical axis solar furnace[1]

This system, called SF5 -Solar Furnace 5, by its 5 kW power-, reaches concentrations above 6000 suns andismainly devoted for materials treatment at high temperature, under vacuum and controlled atmosphere conditions.

R. Perez-Encisoa et al.[2]had work on Three-dimensional analysis of solar radiation distribution at the focal zone of the solar furnace of IER_UNAM.and they get following results by their experimental setup. It was possible to obtain the set of proto surfaces of radiative flux intensities from interpolation of orthogonal planes to the optical axis of the concentrator both theoretically and experimentally.

Figure 2 Three-dimensional analysis of solar radiation distribution [2]

The profiles of radiative flux obtained theoretically through the raytracing, correspond to actual radiative flux obtained from the experiment.

Aaron Brown et al. [3] work on Community Development: "EZ HEAT" Westwood Solar Furnace Project. And they get following result from the setup. To demonstrate the technology, students from MSU Denver zzpilot test at Re:Vision's (a local NGO working in Westwood) office. held a focus group with community leaders("promotoras") for discussion about the pilot unit, calculated energy and cost savings for the design, and developed a plan to continue the project from pilot stage to community implementation and installed 4 demonstration units on family households. The paper addresses the capacity and risk analysis for this design, the design itself, the implementation plan, the monitoring and evaluation plan which are the natural next steps in the project.

B. Andrade da Costa ¤;1;2 J. M. Lemos¤;2 had work on temperature control of a solar furnace formaterial testing.

This paper describes part of the work that was developed during the Sol Control project under the Solface- PROMES-CNRS program, to design, implement and test a control system for the 6kW solar furnace of the Odeillo Processes Materials and Solar Energy Laboratory, for applications in thermal stress testing of hightemperature resistant materials (e.g. silicon carbide and alumina).

Ayush Khare1et al. [5] had made experimental on parabolic solar collector and the hand get following results. Dramatic technology break through to make parabolic-trough solar water heating economically attractive in areas with less sun or for facilities they have low cost conventional energy available are unlikely, incremental improvements in mirror and absorber coasting, however, are quite likely, and will make parabolic through increasingly efficient for the situations where the already are attractive. Any major cost reductions would come from economies of scale associated with substantially, or an increase in conventional energy prices. Climate change gas emission reduction the outlook is quite good the technology is more limited geographically to areas of high solar resources and to larger facilities than are other solar water heating technologies, but the economics are better.

Student Development of a Five kW Solar Furnace for Solar Thermal Chemistry Research This five kW solar furnace. It is an instrument used to test technology that uses highly concentrated solar radiation as a source of process heat at temperatures in excess of 900 °C. The major components of the solar furnace are a heliostat, louvers, concentrator, reactor table, and associated controls and instrumentation. The heliostat, which holds 36 m2 of solar mirrors, is located in front of the main building. It rotates on two axes to track the sun, reflecting sunlight into the building which houses the remaining furnace components. The louvers, an assembly of rotatable panels comparable to venetian blinds, regulate the furnace power level by attenuating some of the light reflected from the heliostat. The concentrator focuses the admitted light to a spot in front of the mirrors. An adjustable table assembly positions the aperture of a receiver into the concentrator’s focal point.

The concentrator is approximately 18 foot in diameter and consists of 305 adjustable hexagon-shape solar mirrors. They are supported by one nylon and two fiberglass brackets and are constrained within a slot machined in the brackets. The fiberglass brackets are rigid and are used to support the mirror from below.

John m. Davis and Eugene S. Cotton had made Design of the quartermaster solar furnace. This solar furnace erected in Natick, Massachusetts for the purpose of producing a radiation flux which burn any material shorter then in one second. The concentrating element for furnace consists of an spherical surface and the pieces of glass arranged in so that all image are super imposed on super target. Since a continues reflecting surface are not require. a mass number of mirrors are set on it with including a cost saving. Using this solar furnace we get power 25-30 kw in normal condition.

Malay K. Das (ME) et al. [8] had work on solar energy research enclave. Here propose to initiate a solar energy research enclave with the following objectives: It will establish a technology demonstrator.1 MW (peak) solar power station in two phases. It will supplement electricity requirement of IITK campus during day time (8 hrs.) and thus help in reducing dependence on grid power. This will also generate useful data for future implementation of such projects in the region. Modules in the solar power station will be used for research and as test platforms for large scale solar energy technologies. We will initiate new and augment the existing programs for long term research &development in solar power generation, storage, distribution, management and policy making in the institute.

This initiative will provide practical input for graduate and undergraduate teaching programs. In addition, it will provide training and human resource development in the area of renewable energy Finally, it will increase the awareness of green technologies amongst the public.

Gaurav A. Madhugiriand S. R. Karale had work on High solar energy concentration with a Fresnel lens.The effective way of utilizing sunlight with solar energy concentration technology and recent developments of its applications using Fresnel lens is reviewed in this paper. The present status of application, the on-going research and development works suggest that Fresnel lens solar concentrators will bring a breakthrough of commercial solar energy concentration application technology in the near future. The paper was focused on the Solar Energy high temperatures using parabolic solar concentrator, Fresnel lens, Reflecting materials and solar tracking. It identified their level of performance. This paper will provide an up-to-date review of solar concentrators and their benefits to make solar technology affordable.

A. C. Kashyap et al. [10]had work on designing a Solar Concentrator for Crematorium using Solar Energy. A special concentrator has been designed to supply required sufficient heat energy to the crematorium by concentrating solar energy. Its speciality is a flexible surface curvature and simultaneously with a non-moving focal area.

The basic concept of solar crematorium is to ignite the dead body locally anywhere and anyhow with the help of a huge concentrating reflector having very high CR and to maintain the combustion of dead body by supplying the fresh atmospheric air with the help of blower. Once combustion of dead body starts within the cremation chamber, it also releases heat which automatically in combination with solar energy obtained from concentrating reflector maintains continuous burning of dead body until complete dead body gets converted into ash.. A system of solar crematorium can be divided into following components:

1. Solar Concentrator

2. Tracking System

3. Cremation Chamber

III.CONCLUSION

The following conclusions are drawn from the present study:

1. A primary application of solar furnace is it can be used for change phase of material.
2. It was possible to obtain the set of protosurfaces of radiative flux intensities from interpolation of orthogonal planes to the optical axis of the concentrator both theoretically and experimentally.
3. The profiles of radiative flux obtained theoretically through the ray tracing, correspond

to actual radiative flux obtained from the experiment

4. A controller which is used in solar furnace can control the temperature variation range according to use.
5. It is finally recommended that such systems should be highly promoted to conserve energy and foster a cleaner environment.

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