Solar energy for domestic and small industries with help ofparabolic trough solar concentrator

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Abstract

The energy or power generation is big issue, the solar power is clean and available free of cost after one time investment and solar energy required basic technique of focusing at the line or point. To use the solar energy the parabolic trough of steel and silicon glassesare more important, those are easily and cheaply available in market as the present work is mainly for domestic application and small power industries. We get temperature reading at the receiver tube is 228 ^{0}C, that is sufficient to fulfil the basic needs of domestic purposes. Andalso the manufacturing process of this type of solar setup is easy as summarised in our work.

***Keywords*:**, Parabolic Trough Solar Collector, Silica Glass.

1. Introduction:

Solar thermal systems play an important role in providing non-polluting energy for domestic and industrial applications. Concentrating solar technologies, such as the parabolic dish, compound parabolic collector and parabolic trough can operate at high temperatures and are used to supply industrial process heat, off-grid electricity and bulk electrical power. In a parabolic trough solar collector, or PTSC, the reflective profile focuses sunlight on a linear heat collecting element (HCE) through which a heat transfer fluid is pumped. The fluid captures solar energy in the form of heat that can then be used in a variety of applications.

An attractive feature of the technology is that PTSCs are already in use in great numbers and research output is likely to find immediate application. Smaller-scale PTSCs can be used to test advances in receiver design, reflective materials, control methods, structural design, thermal storage, testing and tracking methods.

1.1 Types of concentrating collectors:

Solar thermal energy systems are among the most promising of the renewable technologies. Three such concepts for bulk electricity production are the parabolic trough solar collector, and two others are, parabolic dishes and central receiver.

1.1.1 Parabolic trough collector: A high-temperature (above 360K) solar thermal concentrator with the capacity for tracking the sun using one axis of rotation. It uses a trough covered with a highly reflective surface to focus sunlight onto a linear absorber containing a working fluid that can be used for medium temperature space or process heat or to operate a steam turbine for power or electricity generation.

1.1.2 Parabolic Dishes: Parabolic dishes give in principle a point focus, the reflecting surface is a parabolic. 2D focusing gives a much higher concentration factor and mechanically stable.

1.1.3 Central Receiver: Also known as a power tower, a solar power facility that uses a field of two-axis tracking mirrors known as heliostat (A device that tracks the movement of the sun). The effect of many heliostats reflecting to a common point creates the combined energy of thousands of suns, which produces high-temperature thermal energy.

2. Literature Review:

An attractive feature of the technology is that PTSCs are already in use in great numbers and research output is likely to find immediate application. Shortis, M. R. *et al.* (1996) has described the use of close-range photogrammetry to measure a range of solar concentrator components, from EuroTrough fabrication jigs, to concentrator sub-frames, to trough mirror facet surface deviations under varying gravitation loads, to structural distortions arising from differential thermal expansions in the structure, to small scale mirror facets and the subsequent processing of the photogrammetric data to provide optical and ray trace analysis of the facet performance. Thorsten A. Stuetzle(2002), A model predictive controller was developed for the SEGS VI plant model. Its task is to maintain a constant collector outlet temperature on different days of a year by adjusting the heat transfer fluid volume flow rate while solar radiation changes. The control algorithmic, which is based on Rawlings and Muske (1993), was introduced on the example of a simplified model. Lüpfert, E. *et al.* (2004) summarizes results in collector shape measurement, flux measurement, ray tracing, and thermal performance analysis for parabolic troughs. It is shown that the measurement methods and the parameter analysis give consistent results.Mokhtaria A. *et al.* (2007), the parabolic trough collector of Shiraz power plant with hot oil generation system is investigated experimentally over in summer period. The system operates under closed loop mode by recirculating the oil through a hot oil expansion tank. Variations of collector oil inlet and outlet temperature are measured and the maximum beam radiation during the experimental period was 735mW.

3.Details of experimental set up:

The components of experimental setup are fabricated structure, plane mirror, and receiver tube as below in experimental setup picture1.

Fabricated structure: The structured is fabricated by mild steel hollow bar having square cross section .the toughness of this structure is very high and thermal expansion is very low which can bear high load and temperature .we have remind all the precaution during the fabrication of this structure, Some specified tolerances also we considered while manufacturing .

Plane mirror: The mirror we used for focusing the sun rays having high reflectivity (r=.99), it can reflect the sun rays very efficiently on the receiver tube .the dimension of this glasses have specified in this thesis later.

Receiver tube: We have wide range for receiver tube material such as copper, aluminium, mild steel etc. the major constraints during the selection of receiver tube is low melting point and low thermal conductivity of the metal so we have to select a metal which can bear high temperature and should have high thermal conductivity.

3.1 Dimension of parabolic trough:

1. Projected Area = $12.54*10^6$ mm^2

2. Dimension of glass (plane): Length=305mm, Width =76mm and Thickness =4mm

3. Dimension of receiver tube: Length =305mm, Dia. =76mm, and Thickness=4mm

4. Material of glass-Silica

5. Material of receiver tube-mild steel

3.2 Permanent installation of glass may create major problem during focusing, because solar geometry affect the incident angle so we have to refocus glass again. We developed new method for installation of glasses in which we can refocus glass with very light effort with the help of flexible mounting and L-section as in fig2.

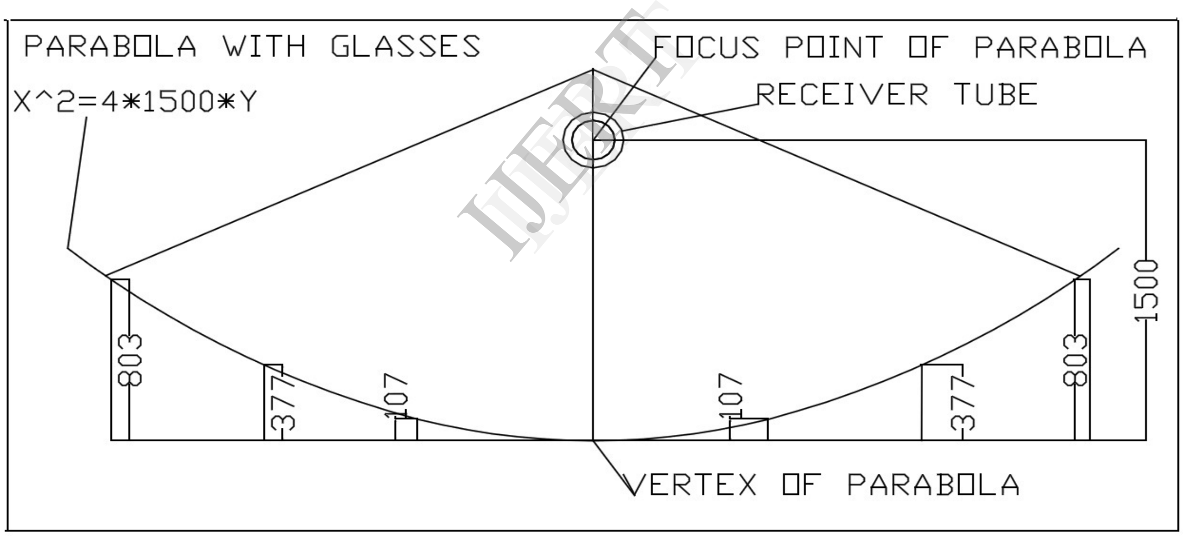

Fig1: Schematic Diagram of setup

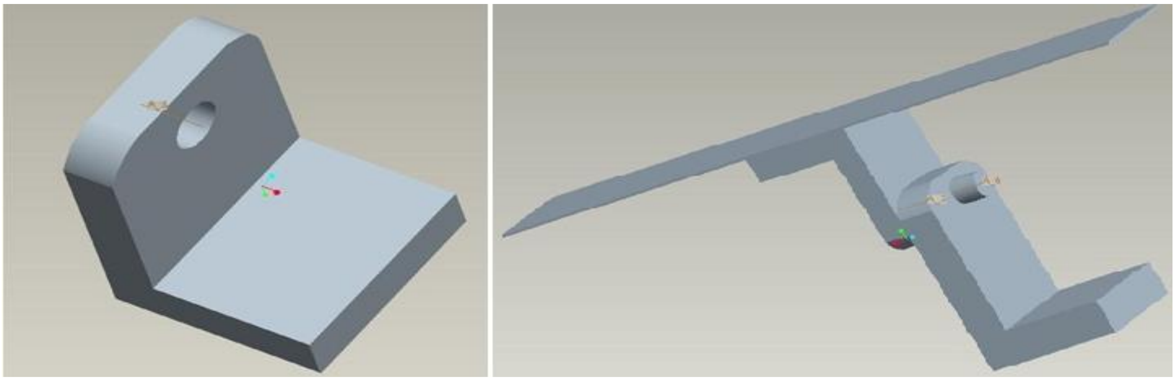

Fig2: L-Section and Flexible mounting for mirror

Picture1: Experimental Setup

4. Results:

The average temperature value obtained at the receiver tube as in table1 is 228^0C. The table1 is also made on the basis of average of temperature of year 2009-2010.

Parabolic Trough:

1. Projected Area = $12.54*10^6$ mm^2

2. Dimension of glass: Length =305mm, Width =76mm and Thickness =4mm

3. Dimension of receiver tube: Length =305mm, Dia. =76mm, and Thickness=4mm

Time	Temperature(^{0}C)
09:00	200
11:00	250
12:00	270
13:00	240
15:00	215
17:00	195

Table1: Time and Temperature variation in a day

5. Conclusions:

The average temperature value obtained at the receiver tube is 228^{0}C, that value of temperature is much more sufficient to use for the domestic purposes and small industrial applications.Generally the solar power is costly but in this case, used technologies are simple and cheap, that can be installed easily for home allowances and industries.

The silicon glasses has around 0.99 reflectivity that means the solar energy value after the glass reflection will be 99% of the incident value and at the receiver tube received energy will be 97%, because there is maximum loss of energy 2% as air is present in between the glasses and receiver tube.

On the basis of the temperature at the receiver tube, approximate rate of steam generation and approximate power generation for the length of ten feet would be 200 ml/min and 400 watt respectively that would be helpful for the domestic purposes and small industrial applications.

The manufacturing of required parabolic shape collector as mentioned in the results can be made with the simple machines and trained operators hence manufacturing of setup is also easy and cheap.

Receiver tube temperature can also be increased by decreasing the width of plane mirror for the proper focusing of mirror and that will increase the efficiency of the process. And higher temperature can be achieved if receiver tube is covered with the glass tube.

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