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Assessment of Profile Error for Efficient Solar Parabolic Trough

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Assessment of Profile Error for Efficient Solar Parabolic Trough

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I. 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.

a) *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.

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b) *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.

c) *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.

d) *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.

II. 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.

III. Experimental Set up and Procedure

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, aluminum, 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.

a) *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

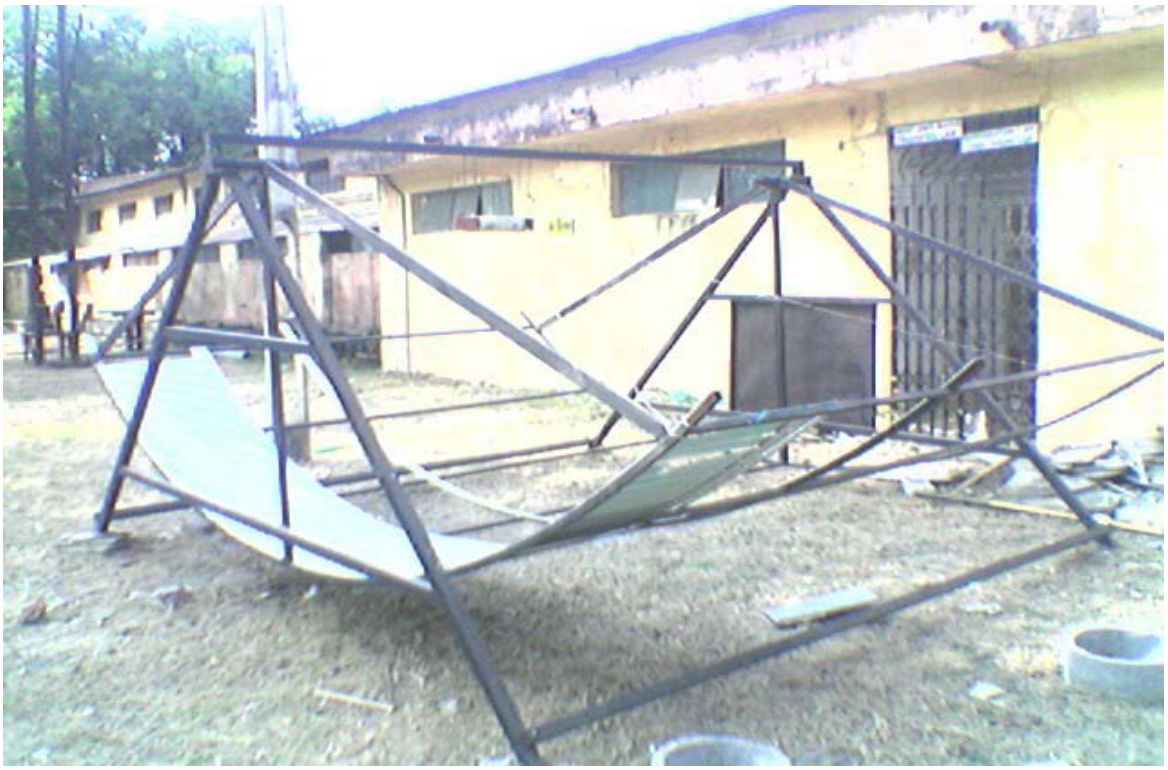

Figure 1 : Experimental Setup

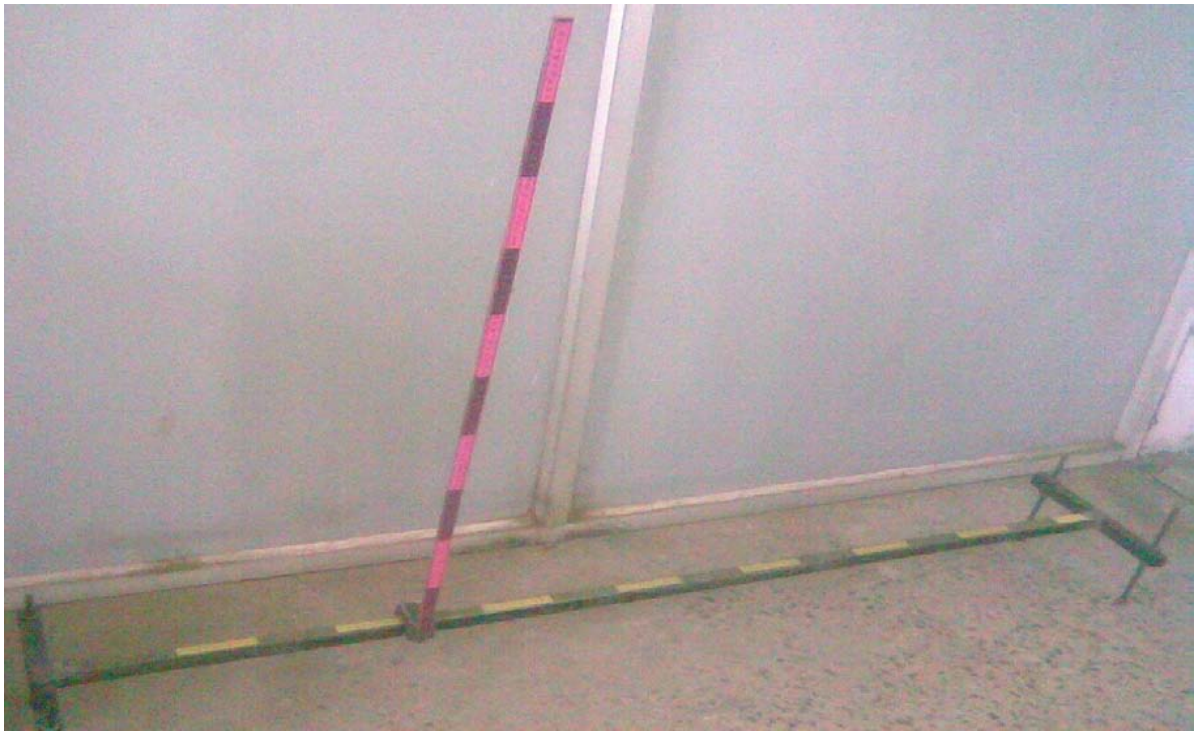

Figure 2 : Linear scales for measurement of parabolic profil

b) Manual method

We have fabricated a scale which can measure the error easily. In this setup we used two linear scales which measure the dimension horizontally and in vertical dimensions. The data collected during measurement, compared with standard data, and get error of parabolic trough.

c) Brief Procedure

First of all we level the scale and parabolic trough in a parallel plane with the help of leveling gauge (water level) than we set the center of parabola and the zero of scale and note down the 'y' coordinates corresponding to the **'x'** coordinates. And finally we made table of x and y coordinates.

IV. Results

Analytical equation for parabolic profile $x^2 = 4*1500*y$

Table 1 : Comparison between Theoretical and Measured Parabolic Profile

S. No.	X –Coordinate (mm)	Analytical Y-Coordinate (mm)	Experimental Y-Coordinate (mm)	Error(mm)
1	0	0	0	0
2	800	107	80	27
3	1500	377	345	32
4	2200	803	790	13
5	-800	107	96	11
6	-1500	377	354	23
7	-2200	803	764	39

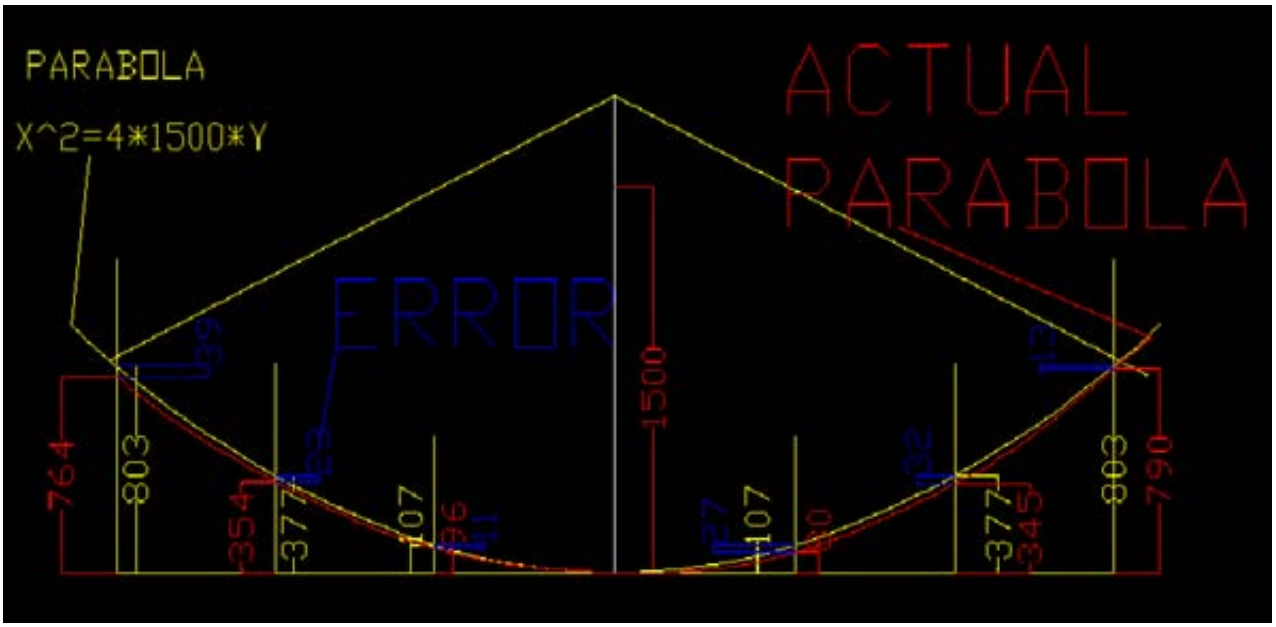

Figure 3 : Graphical Comparisons between Theoretical and Measured Parabolic Profile

V. Conclusions

Measurement of error is very important function because of efficient working. This type of measurement processes is very cheap and easy to work. As we move away from center of parabola error increases in negative x-axis but there are no certain trends in positive axis, so we can conclude that this error depends on the human skills and manufacturing process. This error can be minimized by developing a high precise manufacturing process. Tracking of the trough should be precise for that thermocouple installed at periphery of receiver tube to maintain the higher efficient solar power.

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References Références Referencias

1. Goswami D Yogi et al. Jan, (2000) Principles of Solar Engineering, Taylor and Francis, ISBN1560327146.
2. Patoda Lalit et al. (2014) Solar Energy for domestic and small industries with help of parabolic trough solar concentrator, International Journal of Engineering Research & Technology (IJERT).
3. Lüpfert, E., et al. (2004) Comparative flux measurement and raytracing for the characterization of the focal region of solar parabolic trough collectors, Proceedings ASME 2004, Portland, OR, July 11–13, ASME Paper No. ISEC2004–65157.
4. Mokhtaria A., et al.(2007) ,Thermal and optical study of parabolic trough collectors of shiraz solar power plant, International Conference on Thermal Engineering, Amman, Jordan.
5. Rabl, A. (1985) Active Solar Collectors and Their Applications, Oxford University Press, New York.
6. Shortis, M. R., et al. (1996) Photogrammetry an Available Surface Characterization Tool for Solar Concentrators, ASME J. of Solar Energy Engineering, 118, pp. 146-150.
7. Soteris A. Kalogirou, (2004), Solar thermal collectors and applications, Higher Technical Institute, P.O. Box 20423, Nicosia 2152, Cyprus Received 18 June 2003.
8. Tariq Muneer, (2004), Solar Radiation and Daylight Models, Elsevier Butterworth Heinemann, ISBN0750659742, 9780750659741.
9. Thorsten A. Stuetzle (2002) Automatic Control of the 30 MWe SEGS VIParabolic Trough Plant, Mechanical Engineering, University of Wisconsin Madison.
10. Yadav R., (1992) Heat and Mass Transfer, Central Publishing House, ISBN8185444382.