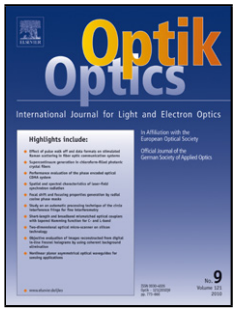

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PII: S0030-4026(17)31100-2
DOI: http://dx.doi.org/10.1016/j.ijleo.2017.09.039
Reference: IJLEO 59647

To appear in:

Received date: 25-5-2017
Accepted date: 11-9-2017

Please cite this article as: Sainath A.Waghmare, Nitin P.Gulhane, Optical evaluation of compound parabolic collector with low acceptance angle, Optik - International Journal for Light and Electron Opticshttp://dx.doi.org/10.1016/j.ijleo.2017.09.039

Optical evaluation of compound parabolic collector with low acceptance angle

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Abstract

An optical evaluation improves overall performance of solar collectors by minimizing the optical losses. It includes study and analysis of solar rays and its behavior when falling and reflecting over collectors. As per collector design criteria, the maximum collection of solar rays must concentrate at the receiver. In this research, the optical analyses are performed on compound parabolic collector with low acceptance angle (6 deg.) to optimize the receiver position. In parabolic trough collector (PTC), all the reflected solar rays gather at the focal line, but in CPC the reflected solar rays concentrates in a region on the central plane. This region of concentrated solar rays is determined by 2D graphical ray tracing analysis and it is experimentally verified by camera target method (CTM). The manufacturing error in collector shape is elaborated and error curve is outlined with the help of data points. The ray tracing analysis is performed on the actual and error curve with the incidence angle 0 deg., +3 deg. and -3 deg. and it is compared with CTM observations. The results obtained from these methods showed the identical behavior of reflected solar rays and it is concentrated below the limiting diameter at the focus.

Keywords: Compound parabolic collector; low acceptance angle; ray tracing; camera target method; optical evaluation;

1. Introduction

Flexibility in design and minimum tracking effort makes compound parabolic collector (CPC) so useful [1, 2]. CPC with low acceptance angle provides large aperture area which contributes high concentration ratio (CR). An acceptance angle of CPC provides angular deviation for incident solar rays which results in less tracking frequencies. This phenomenon is advantageous for CPC over parabolic trough collector (PTC). While operating with PTC, the mandatory condition is that the incoming solar rays must be parallel to the central axis of the collector so that the reflected rays will reach towards a single point i.e. focus shown in Fig. 1 (a). It is achieved with the help of tracking the PTC very precisely and regularly according to the sun. In case of CPC with low acceptance angle, all the reflected rays concentrate below the common focus of parabolas as shown in Fig. 1 (b). It provides more receiver area with almost equal aperture area as that of PTC. Hence, CPC with low acceptance angle acts like PTC in performance with less tracking effort.

Nomenclature

D_l	limiting diameter	*Abbreviations*	