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Effect of rim angle to the flux distribution diameter in solar parabolic dish collector

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Abstract

Solar energy application through parabolic dish collector is promising finite green energy such as electric generation. A study of solar parabolic dish collector had been carried out on the geometry and flux distribution at focal region. Rim angle is an important parameter to determine the imaging and non-imaging diameter of the flux radiation. The imaging and non-imaging geometry were simulated using the ray tracing simulation and 2D computer aided drawing. The flux distribution was then tabulated on coordinated graph to obtain the diameter. The imaging diameters are in the ranges of 17mm to 286mm while the non-imaging diameter values are in the ranges of 23mm to 345mm. Reflex rim angle yields small imaging and non-imaging diameters which values are 37 mm and 53mm respectively. An acute rim angle yields larger imaging and non-imaging diameter. It shows that the optimum parameter of the parabolic dish is important to achieve high intensity of focus point.

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Keywords: Solar parabolic dish; flux distribution; imaging and non imaging diameter; rim angle.

1. Introduction

Solar parabolic dish converts the thermal energy of solar radiation to mechanical energy. The parabolic dish is mainly used to concentrate solar radiation for low, medium and high temperature usage [1]. Following the shape, a solar parabolic dish have concentration ratio in between 600 to 2,000 and can achieved temperature of 1,500°C [2].

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The parabola has a unique property aims to collect solar radiation and concentrated to a small area which increase the density several hundred times. An approximately parabolic surface is produced by putting reflector strips of a chosen width on the parent parabola. The definition of an imaging concentrator is one that will produce an image at its focus of the light sources situated at a large distance from it [3]. In this paper, the study of flux distribution at focus point is important to know the concentration ratio of the solar collector determines the intensity of the solar radiation received by the receiver. The focal region area is smaller than that of the reflective surface capturing the energy, thus allowing for the same amount of radiation that would have been spread over a few square meters to be collected and concentrated over a much smaller area allowing for higher temperatures to be obtained [4].

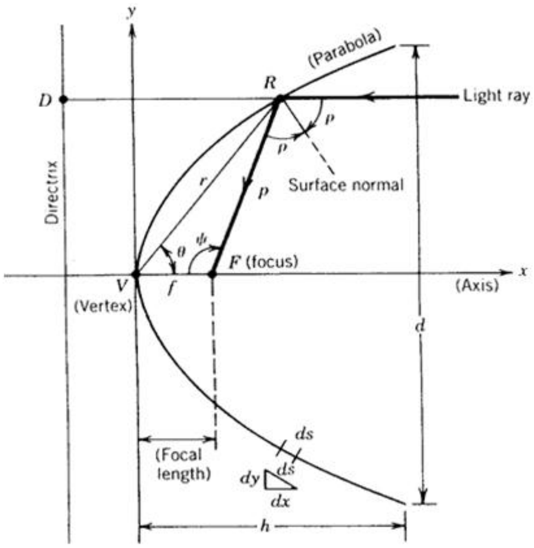

Fig. 1. The parabolic geometry.

1.1. Ideal parabolic dish

In Fig. 1, a parabola is the locus of a point that moves so that its distances from a fixed line and a fixed point are equal. The fixed line is called the directrix and the fixed pointF, the focus. The line perpendicular to the directrix and passing through the focus F is called the axis of the parabola. The basic equation of the parabola is:

$$y^2 = 4fx \tag{1}$$

where f is the focal length and x is the distancefrom the vertex to the focus [4]. The focal length of the parabolic dish can be derived from Equation 1.

$$f = \frac{D^2}{16d} \tag{2}$$

where f is focus point of the dish, D is diameter of the dish and d is depth of the dish [5]. The analysis is covering the projected areas of both the sun and the concentrator. Bundles solar flux from each solar elementare made incident with a unique incidence angle on each of the concentrator elements. This technique can be reasonably applied because the simple receiver geometry allows a closed form mapping from the concentrator to the receiver.