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# Design, Fabrication and Performance Analysis of Scheffler Reflector

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## ABSTRACT

**Scheffler Reflector is fixed focus concentrators are used for medium temperature applications in the different parts of the world. This concentrator provides fixed focus away from the path of incident beam radiations throughout the year. This paper reports design, development and performance analysis of Scheffler reflector of 2.7 $m^2$ surface area. The Scheffler reflector studied with typical experimental plan of simultaneous variation of independent variables. Experimental response data is analyzed by formulating dimensional by formulating dimensional equations. The test were carried out in the month of May, 20 liter of water was kept at the fixed focus. The experimental data were recorded during fixed time interval. The performance analysis reveled average power and efficiency in terms of boiling test.**

*Keywords***—** **Scheffler reflector, solar radiations, boiling test, fixed focus.**

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## I. INTRODUCTION

The Scheffler Reflector is a parabolic fixed- focus reflector, mainly used for cooking, baking, water hearing. Recently other applications of the thermal power delivered by the reflectors have come up, most of them using the reflectors as steam generators. The reflector is a small lateral section of a much larger paraboloid. This section of the paraboloid, which is used as a reflector, lies away from the axis of the parabola, as shown in Figure 1 below. The inclined cut produces the typical elliptical shape of the Scheffler Reflector. Inclined cuts on either side of the axis produce two reflector dishes focusing at a single focus on the axis of the paraboloid. A line passing through the focus and perpendicular to the axis of the larger paraboloid forms the axis of rotation for the Scheffler dishes. This axis of rotation is kept parallel to the axis of the earth. Hence, the inclination of axis of rotation at the site of installation makes an angle equal to the latitude angle of the location with the horizontal.

The scope of the research is to establish design data for Scheffler Reflector with the help of most influencing design parameters on functioning of Scheffler reflector. In the present work experimental study of Scheffler Reflector water heater consisting single storage tank as an absorber mounting in side curved reflector trough has been carried out. This will add to enhancement of technology in the solar energy sector and Scheffler reflector can be better understood from design point of view. The paper is focused on the performance analysis of Scheffler Reflector water heater for average power and efficiency in terms of water boiling test conducted at Deorukh in Ratnagiri.

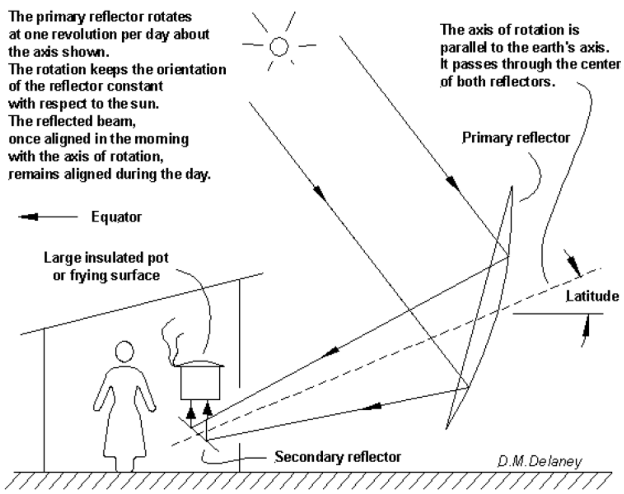


**Figure 1: Schematics of Schffler Reflector**

## II. FABRICATION OF SCHEFFLER REFLECTOR

The solar system comprised of a primary reflector having 2.7 $m^2$ surface area and secondary reflector. The main components of the primary reflector are elliptical reflector frame, a rotating support, tracking channel, reflector stand, and daily and seasonal tracking devices. The primary reflector is designed by considering the lateral part of a specific paraboloid. Seven crossbars were designed and used in the elliptical frame to form the required section of the paraboloid. These crossbars were equally distributed along minor axis with one crossbar at the center and others were located at a distance of from the preceding on both sides. These crossbars were checked with the help of a jig specially designed for the profiles checking of the Scheffler reflector. The rotating support was fabricated as an integral part of the primary reflector comprising of an axis of rotation (constructed of a steel pipe), a tracking channel (channel bent in semi-circular form and welded around the axis of rotation with supports). The reflector stand was grouted vertically on the site with its foundation firmly bolted with the steel plates and reinforced by welding. The journal bearings assembly was welded with the reflector frame along the line parallel to the polar axis by setting it in north-south directio. At the end, the axis of rotation (steel pipe) of the reflector assembly was inserted into the journals bearings to complete the reflector.

## III. TESTINGPROCEDURE AND EXPERIMENTATION

The Scheffler reflector used is having an area of 2.7 $m^2$. At the focus it has a container to hold 10 liter water. The parameters measured were Water temperature, Solar Radiation, Wind speed, ambient temperature. RTD is used to measure water temperature which has a Range of 0°C to 300° C. Wind speed is measured by battery operated digital Anemometer, It has a Range 3.6 to 90 km/hr. Same Anemometer had a facility to show ambient Temperature. A solar power meter is used to measure the radiation. The experimentation was carried in the month of May and June 2015.The readings were taken at different time zones between 10 AM to 2 PM for various days. All readings were taken at the interval of 10 minutes. More than 300 observations were recorded.

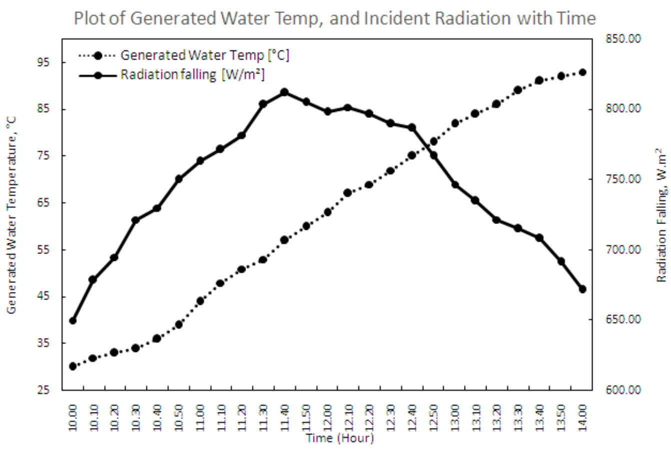


FIGURE NO 1

Variation of solar radiation and water temperature

## IV.PERFORMANCE EVALUATION

The energy efficiency η based on the first law is defined as the ratio of cooker output energy (increase of energy of water due to temperature rise) to the energy input (energy of solar radiation). Thus, the instantaneous energy efficiency is given by.

$$\eta = \frac{mc_p(T_{fw} - T_{iw})}{IA\Delta t}$$

Where m is the mass of water in the pot, $T_{iw}$ and $T_{fw}$ are the initial and final temperatures of water in the time interval Δt and A is the area of the reflector. The specific heat of water $c_p$is taken equal to 4200 J/kgK. The average energy is given by equation,

$$Ep = m_w c_p \, \Delta T$$

Where $m_w$ *is* the mass of water used. $C_p$is the specific heat at constant pressure and ΔT [K] is the change in temperature for a specific time. The average power available, $P_{avg}$, during the experiment is given as

$$P_{avg} = E_p / t_p$$

Where $t_p$ is the total process time

## V. RESULTS

TABLE NO.1

Performance of Scheffler Reflector

| Time of day | Ambient Temp [°C] | Radiation falling [W/m²] | Generated Water Temp [°C] | Input Energy [KJ] | Output Energy [KJ] | Energy efficiency [%] |
|---|---|---|---|---|---|---|
| 10.00 | 34 | 650.00 | 30 | | | |
| 10.30 | 36 | 721.67 | 34 | 3331 | 334 | 10.0 |
| 11.00 | 37 | 763.33 | 44 | 3606 | 837 | 23.2 |
| 11.30 | 38 | 803.33 | 53 | 3805 | 753 | 19.8 |
| 12.00 | 39 | 798.33 | 63 | 3890 | 837 | 21.5 |
| 12.30 | 40 | 790.00 | 72 | 3853 | 753 | 19.5 |
| 13.00 | 40 | 746.67 | 80 | 3732 | 669 | 17.9 |
| 13.30 | 41 | 715.00 | 89 | 3550 | 753 | 21.2 |
| 14.00 | 41 | 671.67 | 92 | 3367 | 251 | 7.5 |

## VI. CONCLUSION

This study also concludes that these types of innovative solar concentrators can open solar based systems. In addition, other benefits like reduction of fossil fuels consumption and global warming cannot be ignored. The study also suggests that such types of systems must be equipped with necessary mountings and instrumentations to monitor and control the desired thermal parameters during temperature sensitive industrial processing. In order to utilize the non-polluting and freely available source of reversible nature i.e. solar energy, its intensity must be maximum. The efficiency of Schefffler reflected is observed to be 23.2% and average power is 466 W. This system mainly finds its application in household cooking.

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