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# Study and Analysis of Scheffler Reflector for Multiple Purposes in India

**Vijay Kumar[1] and Chandrashekara M[2]**

*[1,2]Department of Mechanical Engineering National Institute of Technology Kurukshetra Haryana-136119, India*
*E-mail: [1]vijay_3133702@nitkkr.ac.in, [2]chandru3rvce@gmail.com*

**Abstract—***Solar energy can generally be described as a way to use the sun's heat and light for different applications. Despite its multiple benefits as a clean, modular, simple source of energy, the implementation of solar energy is not as widespread as one would hope. But today solar energy is becoming a ray of hope for Indians growing energy need.*

*This paper shines a new light on the different applications of scheffler reflector in India. Fourcasesarepresented whereSchefflerreflectorsare installedamongcommunity kitchen, laundry, electricity generation plant and bakeries.*

*The design of scheffler reflector is simple,flexible and does not need anyspecial computational setup, thus offering the prospect of potential application in domestic as well as industrial configurations. Scheffler reflector has wide range of application where medium and high temperature is needed.*

**Keywords:** *Scheffler Reflector, solar radiation, solar tracking, solar application.*

## 1. INTRODUCTION

In the last decades, the increasing energy crisis in developing countries and climate change hazards has created awareness to promote the renewable energy technologies. A number of studies have been done on different types of solar collector and solar reflectors. Beyond the low temperature applications, there are several fields of application of solar thermal energy at a medium and medium–high temperature level. From a number ofstudies on industrial heat demand, several industrialsectors have been identified with favourable conditions forthe application of solar energy.

Few experiments were carried out to utilizethe solar energy at medium temperature range using scheffler reflector to increase the temperature at medium–hightemperature range.A. Muniret. al[1] The paper presents a complete description about the design principle and construction details of an 8 $m^2$surfacearea Scheffler concentrator. Thefirst part of the paper presents the mathematical calculations to design the reflector parabola curve andreflector elliptical frame with respect to equinox (solar declination =0) by selecting a specific lateral part of a paraboloid. Crossbar equationsand their ellipses, arc lengths and their radii are also calculated to form the required lateral section of the paraboloid. Thereafter,the seasonal parabola equations are calculated for two extreme positions of summer and winter in the northernhemisphere (standingreflectors). The slopes of the parabola equations for equinox (solardeclination = 0), summer (solar declination = +23.5) and winter(solar declination = -23.5) for the Scheffler reflector (8 m2surface area) are calculated to be 0.17, 0.28, and 0.13 respectively.The design procedure is simple,flexible and does not need anyspecial computational setup, thus offering the prospect of potential application in domestic as well as industrial configurations.A. Munir and O. Hensel [2] The study was initiated to develop an on-farm solar distillation system for functional, environmental and economic reasons. A Scheffler fixed focus concentrator is used for the solar distillation system. The system comprises a primary reflector (8 $m^2$ area), secondary reflector, distillation still, condenser and Florentineflasks. The average power and efficiency of the solar distillation system were found to be 1.548 kW and 33.21% respectively. Different medicinal and aromatic plants like Melissa, Peppermint, Rosemary, Cumin, and Cloves etc were processed successfully by using the solar distillation system and their process curves were drawn.José Ruelaset. al [3] Develops and applies a new mathematical model for estimating the intercept factor of a Scheffler type solar concentrator (STSC). A thermal model of the receptor is performed using numerical examinations to determine the technical feasibility of attaching the STSC to a 3 kWeStirling engine. Fndings show that the highest concentration was obtained with an edge angle of $45^0$, which was observed in the parabolic dish as well, but the STSC receiver shows a 7% increase in the thermal efficiency compared with the efficiency of the parabolic dish receiver.G. Angrisaniet. al [4] A new concept of a system based on a Stirling engine for the combined production of heat and electric power is presented. The system uses two renewable energy sources, direct solar (thermodynamic solar) and biomass (indirect solar energy). Biomass combustion is conducted using a fluidized bed combustor. A Scheffler type mirror is adopted to allow irradiation of the system infixed focal point. A Stirling engine, integrated into thefluidized bed, converts heat into electricity. Two main conclusions can be derived from the model results. Firstly, the possibility to adopt a medium, the

fluidized bed, ensuring heat transfer coefficients about one order of magnitude greater than that typical of systems recovering the heat from the gas phase, greatly helps in achieving a high utilization of the SE. Secondly, the utilization of the SE adopting the biomass fuel as energy source, is greatly influenced by the size of the sand adopted for the bed.PiaPiroschkaOtte [5] This paper shines a new light on the cultural dynamicsofcooking byshowcasingthe social acceptance of solar cookers. Six cases are presented from two differentcountries, Burkina Faso and India where a particular type of solar cooker (Scheffler reflectors) wasinstalledamong bakeries, sheanut butter producers, and steam kitchensThestudyconcludes that by implementing solar cookers as part of a n existing socio-cultural framework, solarcookersmoveaway from an image of a mere foreign technology to an integrated part of the target society.AnjumMunir [6] research is focused to develop an on-farm solar distillery for the processing of different plant materials. The system comprises of a Scheffler reflector and a complete set of distillation system. An 8 $m^2$'projected area of the Scheffler solar concentrator was coupled with thedistillation still for the extraction of essential oils. The efficiency of solar distillery was calculated to be 33.21% with 1.548 kW thermal power available for processing in the distillation still. The research concluded that different kind of medicinal and aromatic plants could be processed effectively using solar distillery.José Ruelas [7] This study presents the geometric aspects of the focal image for a Scheffler-type solar concentrator (STSC) using the ray tracing technique to establish parameters that allow the designation of the most suitable geometry for coupling the STSC to a Stirling engine of 3 kWe. The results of the ray tracing software are validated through thermographic images of the STSC solar concentration after modifying the image to establish the geometric areas with the highest temperature. It was found that the most suitable solar image geometry has variations within an elliptical area of 14.25 $cm^2$ on average with a circular aperture area reflector.

The objective of this paper is to study and analysis of scheffler reflector for multiple purpose in India.

## 2. SCHEFFLER REFLECTOR

The reflector is a small lateral section of a much larger parabola. The inclined cut produces the typical elliptical shape of the Scheffler reflector. The sunlight that falls onto this section of the parabola is reflected sideways to the focus located at some distance of the reflector. The focus is located on the axis of rotation to prevent it from moving when the reflector rotates. The tracking of the scheffler should be done continuously. Tracking is done by various mechanisms such as by mechanical clock, servo motor and using sensors.

Main Parts of scheffler reflector are:

- Reflector Frame
- Rotating support (Tracking device)
- Receiver
- Stand

### 2.1 Reflector Frame

Reflector frame is a lateral section of a large parabola. It the most important part of the scheffler reflector. The sun radiations after reflecting from the frame are focused at the focal point. The area of reflector frame is different based on the application.

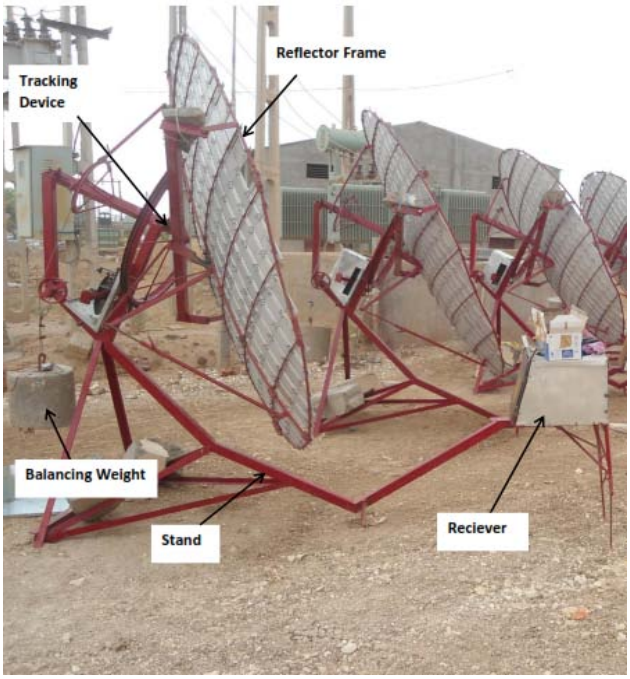


**Fig. 1: Basic photograph of scheffler reflector**

### 2.2 Rotating support (Tracking device)

It is the system through which the scheffler reflector rotates and tracks the sun. It canuse dead weight mechanism or some servo motor to rotate it.

### 2.3 Receiver

The solar radiation after reflecting from the reflector frame is focused at the receiver. The receiver may be different shapes and size depending upon the application

### 2.4 Stand

It the supporting structure to erect the scheffler reflector**.**

## 3. APPLICATIONS OF SCHEFFLER REFLECTORS IN INDIA

- Solar cooking
- Solar dry cleaning and laundry
- Evaporation of water from milk for preparing sweets
- Steam for washing compressor components
- Electricity generation

### 3.1 Cooking using scheffler reflector in India

A case study has been done at two locations in India where community cooking is being done with the help of scheffler reflector.

#### 3.1.1 Om shanti retreat center (Gurgaon)

- 28 Scheffler reflectors (9.2 $m^2$) can cooks in solar steam kitchen for up to 2000 peoples during meditation gathering.

#### 3.1.2 Shantivan complex (Abu road)

- 84 Scheffler reflectors (9.6 $m^2$) can cooks in solar steam kitchen for up to 20,000 visitors.

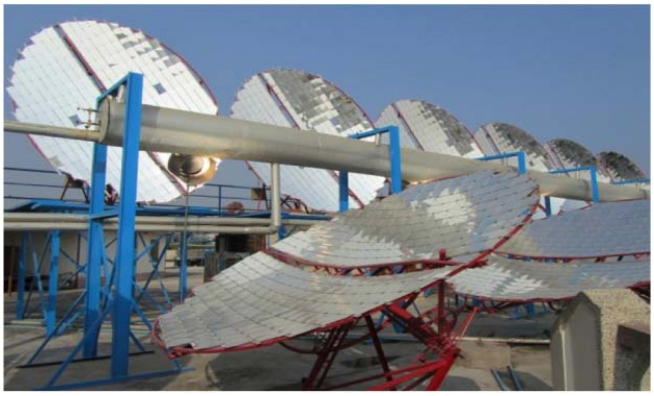

**Fig. 2: Scheffler installed at Om shanti retreat center (Gurgaon)**

**Fig. 3: Steam cooking by scheffler reflector at Shantivan complex (Abu road)**

### Types of cooking using scheffler reflector

- Direct cooking by placing cooking pot on the receiver.
- Indirect cooking by generating steam.

### Advantages

- No need to track cooking pot
- Solar radiations can be focused directly inside the kitchen

### Disadvantages

- The main drawback of scheffler reflector is that only beam radiations are used and the diffused radiation cannot be used.

### 3.2 Solar dry cleaning and laundry

**Gajaraj Cleaners, Ahmadnagar, Maharashtra**

- Steam is generated by using Scheffler reflector for dry cleaning and laundry purpose e.g.
- Capacity: 600 kWh.
- Number of reflectors -15 (16m²)
- Total reflective area: 240m²
- Receiver: 500mm diameter
- Usable pressure: 8 to 12 bar.
- Savings per day: 75 litres of LDO
- Approximate payback period: 3years.
- Payback period with 35% govt. financial help: 2 years

### 3.3 Evaporation of water from milk for preparing sweets

**Ahmadnagar, Maharashtra**

- Number of reflectors: 8 (16m²)
- Total reflective area: 128m²
- Usable pressure: 3 to 10 bar
- Procedure: feeding the solar steam into a jacketed vessel and turning the scrapers for uniform evaporation.

**Fig. 4: scheffler reflector being used for Evaporation of water from milk for preparing sweets**

### 3.4 Electricity generation

- Brahma Kumaris, is setting up a 1.0 MW electricity solar thermal power plant in order to demonstrate and multiply this alternative technology for India.
- 770 scheffler reflectors(60$m^2$) is used for this purpose.
- The budget of this project is 75crs Indian rupees.

**Fig. 5: Electricity generation using scheffler reflector**

## 4. CONCLUSION

India receives about 5 – 7 kWh/m$^2$/day of solar radiation and that too around 300 days are sunny. Solar Energy is the solution for India's increasing energy need.Scheffler reflector has wide range of application where medium and high temperature is needed. The construction and maintenance of scheffler reflector is easy and there is no skill requirement for its operation. A compared to other reflectors and collectors, scheffler reflector has a great advantage over them in terms of performance. Scheffler reflector has wide scope in India.

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