

# Material and Component Specifications Fixed Focus Automatically Tracked Elliptical Dish (Scheffler)



Prepared by  
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Under UNDP-GEF market development &  
promotion of solar concentrator based process  
heat application in India

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# Preface

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This booklet outlines the material and component specifications of Fixed Focus Automatically Tracked Elliptical Dish (Scheffler) for process heat application. The purpose of this booklet is to lay out the material and component specifications of key components of the Scheffler system to serve as a reference document to maintain quality in the field by manufacturers supplying and installing the system.

The booklet is intended to serve as a guide for stakeholders interested in Concentrated Solar Thermal (CST) system based on this technology for applications in process heat for industry and help them set up a durable system which meets the necessary safety and quality standards. It is one of a series of such booklets produced to cover the field of commercially available CST systems marketed for process heat applications in India.

The specifications for key components and sub-components of the Scheffler Dish system and their relevant parameters are outlined in an easy to understand tabular format. Wherever applicable, images of the components and schematic diagrams have also been presented for an easy identification of the components. The booklet has been compiled with technical inputs from the developers and manufacturers of this technology. Inputs and suggestions of experts in the domain of concentrated solar thermal systems and users have also been taken in the compilation of this booklet.

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# Background

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India has a very good potential for solar energy, with average solar irradiation around 4-7 kWh/m<sup>2</sup>/day. This abundant solar radiation can be used to meet the demand of low to medium process heat required by various industries and institutions. Concentration of solar radiation to produce the temperature in the range of 100 to 450°C or more is called concentrated solar thermal (CST) technology. This technology offers sizable potential across diverse range of industries and commercial establishments in India.

There are six CST technologies commercial available in India, namely,

- Fixed focus automatically tracked elliptical dish (Scheffler)
- Dual axis tracked paraboloid dish
- Fresnel reflector based dish (ARUN dish)
- Single axis tracked parabolic trough concentrator
- Non-imaging concentrators
- Linear Fresnel reflector

## About the Scheffler dish Technology

Scheffler dish is a small lateral section of a paraboloid, which concentrates sun's radiation over a fixed focus, with an automatic single axis tracking.

## Underlying principle

*Scheffler dish is made of number of flat shaped mirrors or reflective films which are mounted on a structural frame. The dish rotates about north-south axis parallel to earth's axis to track the sun's movement. The axis of rotation passes through the centre of gravity of the reflector and that's how the reflector always maintains its gravitational equilibrium. The scheffler reflector also performs change in inclination angle while staying directed to sun, in order to obtain sharp focal point. Focus is fixed at distance of focal length of the paraboloid along the axis of the paraboloid. Receiver at a fixed location captures the concentrated heat and transfers it to water/thermic fluid to generate hot water/hot thermic fluid or high pressure steam.*

### ***Key components of Scheffler dish***

Key components of Scheffler dish based system can be classified on the basis of their individual functions:

#### SCHEFFLER Reflector

- Reflector dish
- Receiver
- Dish stand
- Tracking System

#### BALANCE OF SYSTEM

- Piping and Insulation
- Instrumentation and Safety Mechanism
- Heat Storage System

### ***Key design variants***

Scheffler dish is currently available in two design variants, namely

- 16 m<sup>2</sup> Scheffler Dish
- 32 m<sup>2</sup> Scheffler Dish



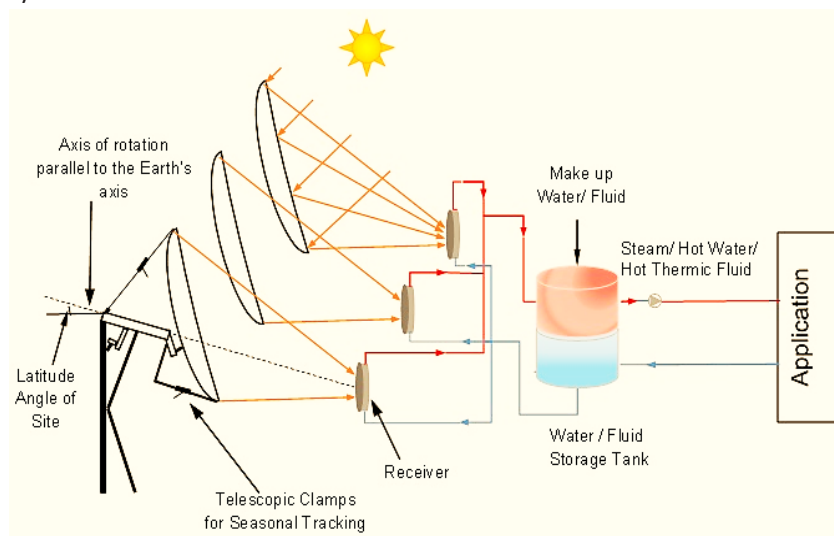
*Scheffler 16 m<sup>2</sup> Dish*

The important characteristics of these designs are as follows

Parameter	16 m <sup>2</sup>	32 m <sup>2</sup>
<i>Average Aperture Area</i>	11.65 m <sup>2</sup>	23.3 m <sup>2</sup>
<i>Shadow Free Area</i>	35 m <sup>2</sup>	60 m <sup>2</sup>
<i>Thermic medium</i>	Steam, hot water, thermic fluid	Steam, hot water, thermic fluid
<i>Delivery capacity</i>	Up to 12 bar pressure, Up to 180°C temperature	Up to 12 bar pressure, Up to 200°C temperature
<i>Weight</i>	Minimum 400 Kg	Minimum 800 Kg

### **End-use application**

Scheffler dish is used for the low-medium process heat applications. This dish can attain the temperature up to 150-200°C as per the specific requirements in industries, commercial & residential complexes, religious places, etc. A typical 16 m<sup>2</sup> Scheffler Dish has thermal capacity equivalent to 30,000 Kcal/ day to 35,000 Kcal/day depending on the manufacturing precision and DNI on a clear sunny day.



*Schematic diagram of CST based System with Scheffler Dishes (Courtesy: CSH India)*

Some of the typical application areas of Scheffler dish are:

- Food processing
- Community cooking
- Solar-assisted comfort cooling
- Laundry
- Pharmaceutical
- Drying and dying

The design configuration of an industrial process heat solar system depends on the specific application. It may consist of one or more number of Scheffler dishes in a system. Scheffler dishes have been installed in various thermal applications across the industries including laundry in hotels, cooking in religious and educational institutions, comfort cooling in offices, boiler feed water heating in chemical process industries amongst others. There are 9 manufacturers of this technology and more than 70 case specific examples of Scheffler dish systems installed across India. List of few installations is given in **Annexure**.

Development of the Scheffler dish requires component and material standards to be followed for maintaining the quality in the field by the manufacturers and assurance of the quality to the end-user.

The following section covers detailed specifications of various components and materials of scheffler dish.

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# Material and Component Specifications

## SCHEFFLER DISH

### Collector

The collector of Scheffler Dish is an assembly of flat shaped solar grade glass mirrors or Aluminium mirror reflectors arranged on a structural steel framework. The mirrors are arranged to give a paraboloidal shape and reflect the incident solar radiation to a common point, i.e. the receiver.



Aluminium Mirror

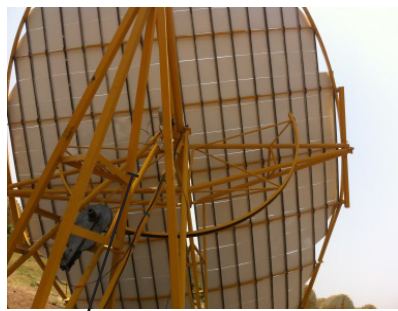


Solar Grade Mirror

### Specifications

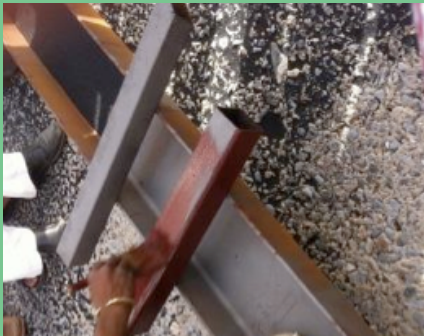
Mirror	
Parameter	Specification
Type	Solar grade mirror with low iron content or Aluminium reflector with glass like finish for an outdoor use. Aluminium reflectors should have a proper back support for the precise reflective surface area.

Parameter	Specification
Material	Tempered and toughened Solar grade glass/Glass infused Aluminium/Aluminium tested for scratches and durability.
Shape	Flat mirror cut in required sizes for different models
Size	All dimensions of a mirror should be less than the diameter of the receiver
Thickness	2-3 mm for Solar Grade Mirror/ 0.5mm for Aluminium Reflector
Reflective Coating	High quality silver back coating
Reflectivity	At least 90%
Protective Coating/ Edge sealing (on cutting of mirrors for different Sizes)	Standard weather protection coat on all the sides after grinding the corners with the help of emery paper and application of appropriate coating on solar grade mirrors  Special weather protection coat to be applied for back side of mirrors to be used in the coastal and industrial region with high pollution levels.
Durability	At least 10 years for Solar Grade Mirrors and 10 years for Aluminium mirrors



*Mirror Support Structure*

## Specifications

Mirror Support Structure	
Parameter	Specification
Design	Cross bar structure consisting of square bars and angle sections to form a shape of parabola with metal channels bolted above the square bars for fixing mirror
Material	All sections & bars made of Standard mild steel and channels of Aluminium
Shape	Parabolic Shape
Thickness of structural components	Various hallow sections have variable thickness.
Protection from corrosion	<p>Application of two layers of red oxide paint over the cleaned bars and sections followed up by application of two layers of enamel paint</p> <p>OR</p> <p>Application of red oxide followed by application of a layer of primer plus two layers of epoxy paint and one layer of PU (Polyurethane) coat on bars and sections cleaned with copper slag</p> 
Strength & Durability	Designed to withstand 160 Km/hr. of wind speed with a life span of 20 years

Fixing of mirrors on  
Support Structure

On the base structure with the help of industrial adhesive and fasteners after ensuring equinox position of the support structure



## Receiver

The receiver of scheffler dish is placed at the focus of the dish so as to capture the incident solar radiation and transfer it to the thermal medium used in the system. The critical component is generally a dome type absorber fixed on to the structural steel frame. The receiver works on thermo siphon principle in which cold water sinks down from header and hot water/steam moves up to the header. The receivers are designed according to application of end user and also the size of receiver depends on the size of the focus and storage requirement.



*Dome Type Receiver*

## Specifications

Receiver	
Parameter	Specification
Design	Spherical Dome type receiver
Material	Boiler grade Mild Steel / SA516 ASTM <sup>1</sup>
Size & Thickness	Diameter is based on the thermic fluid flow rate required as per the process Thickness is based on the pressure required in the system 350-400 mm diameter; 8 mm thick plate for dome type receiver
Strength	Subjected to hydro test as per the applicable pressure rating of the system
Durability	With normal use as per prescribed operation and maintenance manual, the receiver is designed to last for 15 years
Statuary Requirements and Standards	IBR (Indian Boiler Regulation) and ASTM Standards as applicable to be followed
Receiver Insulation	<ul style="list-style-type: none"> <li>• Insulating material with wire mesh and cladding covering the back and the side of the receiver</li> <li>• Insulating Material – Light Resin Bonded (LRB) Mattress OR Rockwool OR Ceramic Wool Cladding Material – Aluminium/Stainless steel</li> <li>• Insulation Thickness – 60 mm Cladding Thickness – 22 SWG</li> <li>• Durable up to system life of 10 years</li> </ul>

<sup>1</sup>American Society for Testing and Materials



*Receiver Insulation*



*Receiver Support Structure*

### *Specifications*

Receiver Support Structure	
Parameter	Specification
Design	Steel structure of standard IS sections and angles fixed on a cement concrete structure
Material	Mild Steel structure and Cement Concrete
Strength & Durability	Designed to withstand 160 Km/hr. of wind speed with a life span of 20 years
Fixing of receiver on Support Structure	Fixed on the Mild Steel angle structure with help of nut bolts and positioned at focal point with receiver plane making an angle equal to latitude angle of the location with vertical.

### **Dish stand**

The basic framework of the dish stand is a steel structure. The structure is designed to withstand wind speed in operating conditions as well as in parked stage as per the applicable structural design code. The overall system rests on a civil foundation. The rotary support, counter weight and other equipments like an electric motor for tracking are attached on the Dish stand.



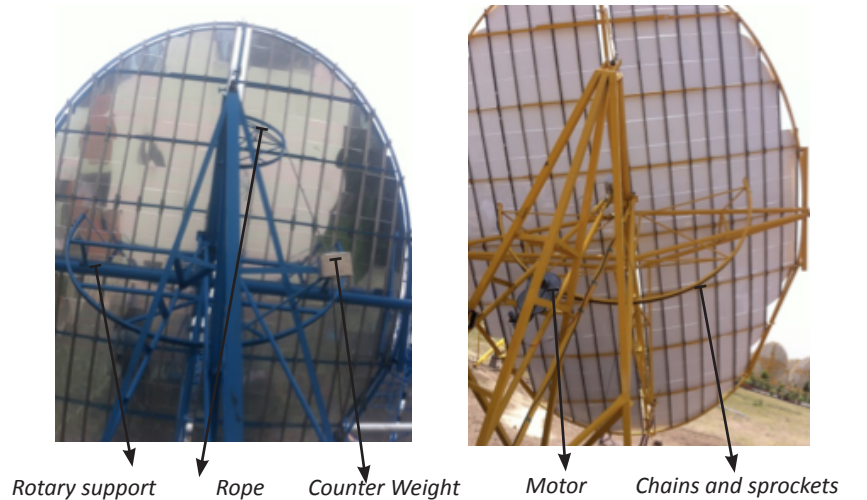
### *Specifications*

Dish Stand	
Parameter	Specification
Design	Rectangular/Triangular conical shape steel structure consisting of standard IS (Indian Standards) sections, pipes and angles fixed on a cement concrete column
Material	Mild Steel structure and cement concrete
Protection from corrosion	Application of two layers of red oxide paint over cleaned bars and sections followed up by application of two layers of enamel paint OR Application of red oxide paint followed up by application of a layer of primer plus two layers of epoxy paint and one layer of PU coat on bars and sections cleaned with copper slag
Strength & Durability	Designed to withstand 160 Km/hr. of wind speed with a life span of 20 years

### **Tracking System**

Tracking system enables the dish to be focused towards the sun to capture maximum possible direct radiation during the day. It also tracks the sun as it changes its position during the seasons.

Tracking system may include the following set of equipments – Electrical motor, Gearbox, Sprockets and chains, Counter weight with rope, Screw shaft, solar radiation sensor, Wind sensor and Timer



*Specifications*

Tracking System	
Parameter	Specification
Mechanism	Automatic mechanism (Microprocessor based/Timer based) for daily tracking and manual mechanism for seasonal tracking in 16m <sup>2</sup> scheffler dish system  Automatic mechanism (Timer based) for daily tracking and Semi-Automatic mechanism with the help of switches for seasonal tracking in 32 m <sup>2</sup> scheffler dish system
Features	Automatic reversal in the evening to bring it back to the morning position Accuracy: +/- 0.2 °
Weather Protection	Standard weather protection box for all outdoor tracking components.




Parameter	Specification
Strength & Durability	All the standard pieces of equipments related to the tracking system are designed to withstand 160 km/hr. of wind speed with a life span of 20 years
Equipment used	<ul style="list-style-type: none"> <li>• Standard Electric Motor, Rope with counter weight, Gear box, Chain, Timer and Threaded Bars for timer based daily tracking</li> <li>• Set of photo sensors, chains, motors, gears and actuators for microprocessor based daily tracking</li> <li>• Screw shafts on top and bottom for the seasonal tracking</li> </ul>





### **BALANCE OF SYSTEM**

Balance of plant normally includes a number of components such as heat transfer pipes & support structure, instrumentation & safety mechanism and storage tank (optional) to control the fluid flow and temperature. The heat transfer pipes carry fluid and transfer the heat received by it to an end use application. Fluid circulates in the system at a certain desired rate.

#### *Specifications*

Heat Transfer Pipe	
Parameter	Specification
Design	As per IBR schedule 40 for high temperature and pressure

Parameter	Specification
Material	<ul style="list-style-type: none"> <li>• MS pipes or SS 304/SS 316 pipes</li> <li>• Tantalum pipes or Glass lined pipes for acidic fluid condition</li> </ul>
Size	<ul style="list-style-type: none"> <li>• Diameter of pipe depends on the flow rate of fluid</li> <li>• Thickness is based on the pressure required in the system</li> </ul>
Working Fluid	Water/Thermic Fluid
Temperature & Pressure Range	<ul style="list-style-type: none"> <li>• Up to 180°C temperature &amp; Up to 12 bar pressure for 16 m<sup>2</sup> dish</li> <li>• Up to 200°C temperature &amp; up to 12 bar pressure for 32 m<sup>2</sup> dish</li> </ul>
Strength & Durability	IBR standards as applicable to be followed
Insulation	<ul style="list-style-type: none"> <li>• LRB mattress with an aluminum cladding over the pipe</li> <li>• Insulation Thickness – depending on temperature changes</li> <li>• Cladding Thickness – 22 gauge</li> <li>• Durable up to system life of 10 years</li> </ul> 

Parameter	Specification
Instruments	<ul style="list-style-type: none"> <li>• IBR standard Strainer, Pressure Reducing Valve, Pressure Gauge, Temperature sensors</li> <li>• Aluminium sheet cover to protect the equipment against different weather conditions</li> </ul> <div style="display: flex; justify-content: space-around; align-items: center;">    </div> <div style="display: flex; justify-content: space-around; align-items: center;"> <span><i>Pressure Gauge</i></span> <span><i>Typical Flow Meter</i></span> <span><i>Typical Pressure Valve</i></span> </div>
<h3 style="text-align: center;">Support Structure</h3> 	
Design	Steel structure of standard IS sections and angles fixed on a cement concrete structure
Material	Mild Steel structure and cement concrete
Protection from corrosion	<p>Application of two layers of red oxide paint over cleaned bars and sections followed up by application of two layers of enamel paint</p> <p>OR</p> <p>Application of red oxide paint followed up by application of a layer of primer plus two layers of epoxy paint and one layer of PU coat on bars and sections cleaned with copper slag</p>
Strength & Durability	Designed to withstand 160 Km/hr. of wind speed with a life span of 20 years

## Storage system

The thermal storage subsystem is a part of the circulation system. It extracts heat from the circulating fluid when the temperature becomes too high. Likewise when the temperature is too low, it supplies stored heat to the fluid.



*Storage Tank*



*Storage Support Structure*

### Specifications

Storage Tank	
Parameter	Specification
Design	Dish End type Header Drum
Material	Boiler grade Mild Steel
Size & Thickness	<ul style="list-style-type: none"><li>• Diameter is based on the thermic fluid flow rate required as per the process under consideration</li><li>• Thickness is based on the pressure required in the system</li></ul>
Storage Material	Hot Water/Steam
Strength & Durability	<ul style="list-style-type: none"><li>• Subjected to hydro test as per the applicable pressure rating of the system</li><li>• With normal use as per prescribed operation and maintenance manual, it is designed to last for 20 years</li></ul>
Insulation	<ul style="list-style-type: none"><li>• LRB mattress with Aluminum cladding over the pipe</li><li>• Insulation Thickness – depending on temperature changes</li><li>Cladding Thickness – 22 SWG</li><li>• Should withstand up to system life of 10 years</li></ul>

Support Structure	
Parameter	Specification
Design	Steel structure of standard IS sections and angles fixed on a cement concrete structure
Material	Mild Steel structure
Protection from corrosion	Application of two layers of red oxide paint over cleaned bars and sections followed up by application of two layers of enamel paint OR Application of red oxide paint followed up by application of a layer of primer plus two layers of epoxy paint and one layer of PU coat on bars and sections cleaned with copper slag
Strength & Durability	Designed to withstand 160 Km/hr. of wind speed with a life span of 20 years

## Annexure

### *List of a few prominent Installations*

User	State	System Size (sq. m.)	Application
ITC Maurya, New Delhi	Delhi	128	Laundry
B S Paper & Board Mill, Ludhiana	Punjab	160	Process Heat
JSSM Boys and Girls Hostel, Mysore	Karnataka	1728	Steam Cooking
Shantivan, BrahmaKumaris, Mount Abu	Rajasthan	772.8	Steam Cooking
Mahindra Vehicle manufacturers, Pune	Maharashtra	1120	Space cooling application with the help of VAM
Purple Creations, Pune	Maharashtra	480	Process Heat application for steam ironing
Ramakrishna Mission, Narainpur	Chhattisgarh	326	Steam Cooking
Education Trust, Junagarh	Gujarat	326	Steam Cooking
Govind Bhawan Mess, IIT Roorkee, Roorkee	Uttarakhand	112	Steam Cooking
Jawahar Navodaya Vidyalaya, Leh, Ladakh	J&K	80	Steam Cooking

### **Manufacturers**

There are six Scheffler Dish manufacturers in India at present. Details of the manufacturers can be found on MNRE website.



**Contact:**

For more details on the manufacturers/suppliers, government support, applications, technologies and successful installations please visit: [www.mnre.gov.in](http://www.mnre.gov.in) OR [www.cshindia.in](http://www.cshindia.in) OR contact Project Management Unit UNDP-GEF CSHP, Ministry of New and Renewable Energy, Block 3, CGO Complex, Lodi Road, New Delhi-110003. Telefax: 011-32314365/24363638, Email: [singhalak@nic.in](mailto:singhalak@nic.in)

Toll Free Helpline No. 1800 2 33 44 77 could be accessed Monday through Friday between 9:30am to 6:30pm and on Saturday 9:30am to 1:30pm

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