REVIEW OF SCHEFFLER REFLECTOR

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Abstract

Scheffler reflector is one of the various methods of harvesting the solar energy. Scheffler fixed focus concentrators are successfully used for medium temperature applications in different parts of the world. These concentrators are taken as lateral sections of paraboloids and provide fixed focus away from the path of incident beam radiations throughout the year. Parabolic Scheffler Reflectors can provide us high temperature heat for all types of cooking, steam generation and many other applications. In this paper different Scheffler systems are reviewed.

Keywords: Scheffler Reflector, Solar Cooker, Radiation, Solar Energy

Introduction

Wolfgang Scheffler launched the idea of oblique paraboloidal solar reflectors, now known as Scheffler concentrators. The fixed focus of the concentrator makes it ideal for direct cooking applications. 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.

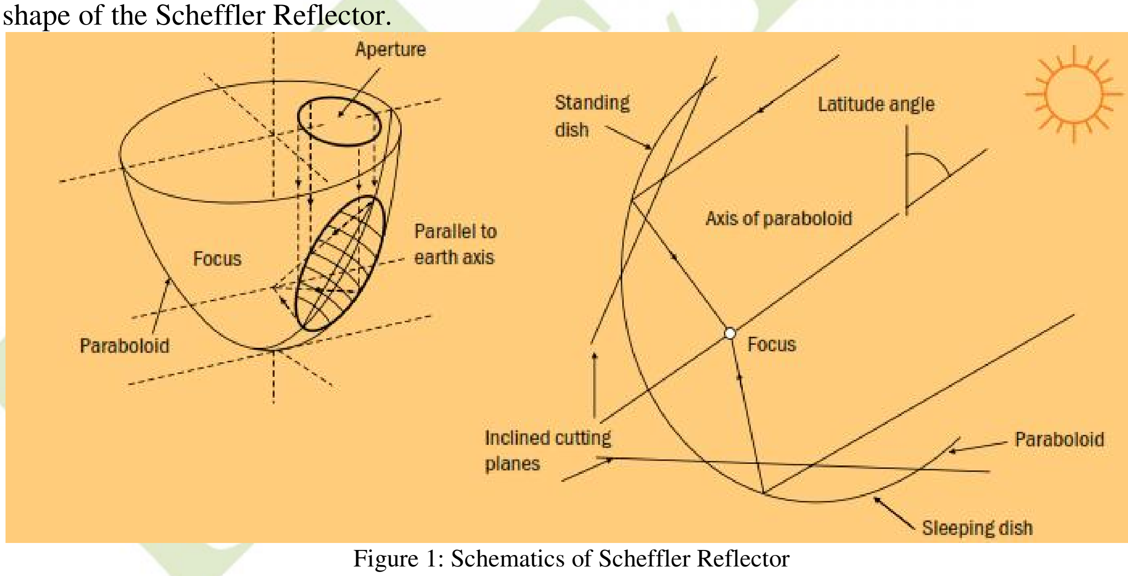

Figure 1: Schematics of Scheffler Reflector

Literature Review

Munir et al. descried about the design principle and construction details of an 8 m^2 surface area Scheffler concentrator. The mathematical calculations to design the reflector parabola curve and reflector elliptical frame with respect to equinox by selecting a specific lateral part of a paraboloid are tabulated. Crossbar equations and 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 northern hemisphere. Simple tracking mechanism is used for daily and seasonal tracking of sun. The design procedure is simple, flexible and does not need any special computational setup, thus offering a huge potential for application in domestic as well as industrial configurations.[1]

Jose Ruelas et al. developed and applied a new mathematical model for estimating the intercept factor of a Scheffler-type solar concentrator (STSC) based on the geometric and optical behaviour of the concentrator in Cartesian coordinates, and the incorporation of a thermal model of the receptor is performed using numerical examinations to determine the technical feasibility of attaching the STSC to a 3 kWe Stirling engine. In experimental set up sterling engine is placed at the focal point which converts eat energy into electricity. Mathematical modelling is verified with the help of experimental results. The results allow for the determination of the focal length, which demonstrates that the largest concentration using the STSC with a rim angle of 45_ is similar to the concentration achieved with a parabolic dish, but the receptor improves the efficiency by 7% compared with parabolic dishes that operate with a lower error of concentration.[2]

Rupesh J. Patil studied the performance of Scheffler reflector of 8 m^2 with the help of single large diameter drum of 20 litre capacity which serves the dual purpose of absorber tube and storage tank.The performance of Scheffler reflector was analysed by average power and efficiency in terms of boiling test conducted at Bangalore. The maximum temperature attained by water is 94 °C on clear sunny day and ambient temperature varies from 28° C to 31° C. Dimensional analysis and mathematical modelling was done to correlate dependent and independent variables. [3]

Vishal R Dafleet al. designed, developed and analysed experimentally the performance of 16 m^2scheffler reflectors for 2 bar pressure and 110° C temperature. The system was mainly designed for hostel with 500 students at Shivaji University for hot water for bathing and steam for cooking.Scheffler along with mild steel absorber plate was evaluated in February. It was observed that radiation varies from 620 W/m^2 to 937 W/m^2 and maximum temperature attained by steam is 107 °C. It was concluded that achievement of concentrating solar thermal devices using Scheffler technology for water heating and low pressure, temperature steam applications in industries as textiles, dairies, food industry etc.[4]

Rupesh J Patil et al. carried out work on scheffler reflector for experimental data based modelling to establish relationship in different variables of Scheffler reflector. Scheffler reflector was studied with a typical experimental plan of simultaneous variation of independent variables. Experimental response data was analysed by formulating the dimensional equations. The models have been formulated mathematically for the local conditions. Results obtained from experimental data, mathematical model and ANN simulation were tabulated. It was observed that that the mathematical models can be successfully used for the computation of dependent terms for a given set of independent terms. The trends for the behaviour of the models demonstrated by the graphical analysis and sensitivity analysis are found complimentary to each other.[5]

A C Kashyap et al. Scheffler reflector has been designed to supply sufficient heat energy to the crematorium by concentrating solar energy. It was assumed that 100 kg of wood is required for cremating a single corpse in 1 to 2Hrs if heat loss is optimized to minimum value by effective insulation of combustion chamber. Since calorific value of wood is 19700kJ/kg. The "P" power (in MJ/hr) required to burn completely the body in combustion chamber is determined. From this reflector was designed to cremate a dead body in 2hrs. It was observed that scheffler reflector is In conclusion, we will definitely be able to cremate a corpse through solar crematorium built with a well-designed Scheffler reflector and an efficient combustion chamber.[6]

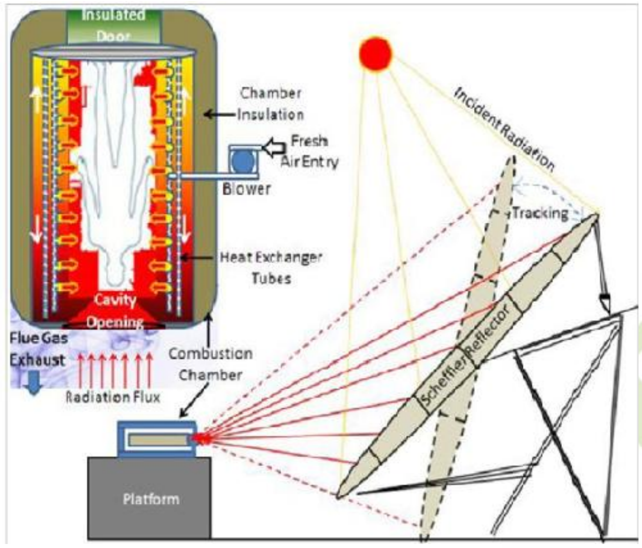

Figure 2: Block Diagram of solar Crematorium

Mangesh R Phate et al. studied the performance of 2.7 m^2Scheffler reflector. Vessel stores 10 litre of water for the purpose of experimentation. Performance analysis of the reflector revealed that average power and efficiency in terms of water boiling tests to be 550 W and 19%. Dimensional analysis and mathematical modelling was done to correlate dependent and independent variables. Comparative analysis of theoretical values and experimental values was done with the help of graphs. The dimensional analysis shows that generated water temperature is determined primarily by ratio of product of angle and Dish area to the wind speed.[7]

AnjumMunir et al. developed 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 the distillation still for the extraction of essential oils. Complete mathematical description has been explained to design different components of solar distillation system. The research concluded that different kind of medicinal and aromatic plants could be processed effectively using solar distillery. The results conclude that the high temperature at the fixed focus was capable of maintaining the required constant temperature inside the distillation still for continuous processing of the medicinal and aromatic plants.[8]

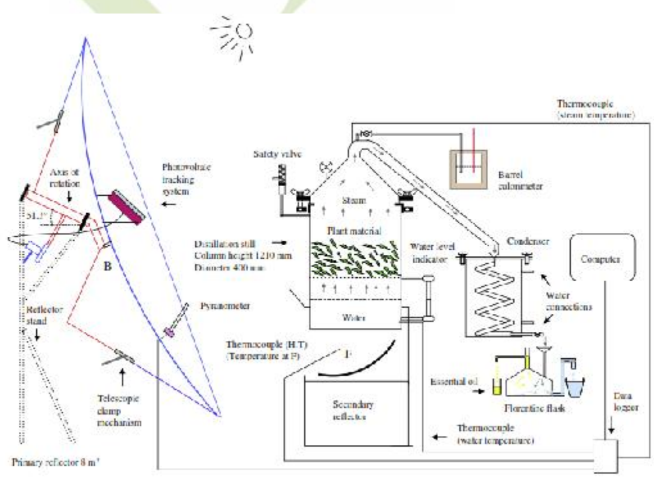

Figure 3: Schematic of solar distillation system

Dr.MichealGotz reveals concept of mobile solar kitchen. It is equipped with two Scheffler cookers of 1.8m^2 each, with a ULOG box cooker, a 'hay box', kitchen utensils, cooking pots and dishes for a limited amount of people. It also has an integrated kitchen sink and a working table. For rainy days, there is a propane gas stove.

Kitchen is free from electric plug.[9] Ajay Chandak et al. Authors designed and experimented with multistage evaporation system for production of distilled water. Two Scheffler concentrators of 16 sqm each were used for generating steam in the first stage at 8 bar pressure and the pressure is gradually brought down to 1 bar, in four stage distillation unit. Heat of condensation in the last stage was dissipated in a solar dryer to enhance its performance. In further testing this heat of condensation in the last stage and also sensible heat of the condensate in all the stages was used for preheating of water in the next batch. Results of the project demonstrated that there exists huge potential of projects of nature for applications like generating distilled water for food processing, pharmaceutical and other industries on moderate scale. The project also has high potential in areas of salt concentration systems, thickening of salt fruit juices, jams, pulps, sauces and similar applications where water is evaporated on large scale. Evaporating water for thickening of effluent of industries is other promising area.[10]

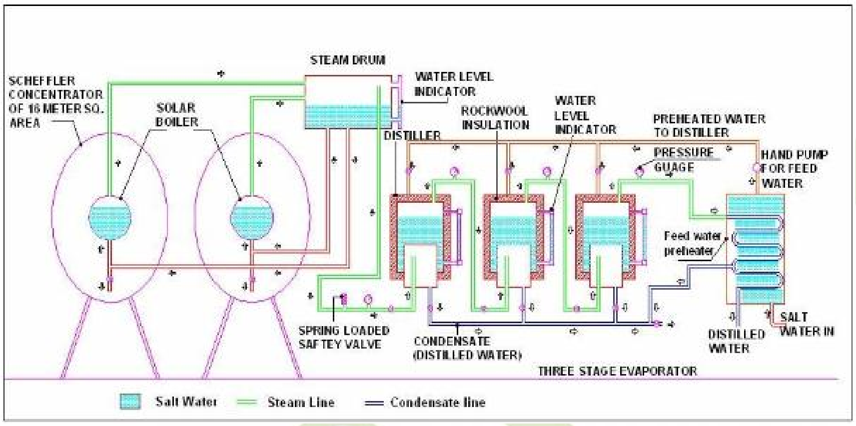

Figure 4: Schematic layout of multistage evaporators with Scheffler concentrators & H.R. unit.

GregorSchapersreveledagave syrup production using the Scheffler reflector. The six Scheffler reflectors of 10 m^2 are installed outside and they woman can cook inside the kitchen. The sun is concentrated to a secondary reflector downside the cooking pot, so the cooking process is the same like in a gas stove. It was not difficult for the women to learn how to cook with the solar energy because the design of the Scheffler reflector allows them to cook like they habitual cook in their gas or fire stoves at home - all the heat is coming from downside to the cooking pot. The solar agave syrup is brighter than the syrup cooked with gas which is darker because more sugar is caramelized. The flavor of the solar agave syrup is sweeter and you can use it for cooking and sweating without changing the original taste of the food. So the new solar-agave-syrup is a really new product with new properties and a better quality and cost of product is lowered.[11]

Christoph Müller reveals the bakery oven is designed for an 8 m² Scheffler reflector. The latitude of the site is 22° south. With a resulting focus height of 78 cm, the oven was put on a base of 40 cm, giving a comfortable access to the baking chamber. The baking chamber measures 60 x 60 x 60 cm³. The oven operates without active ventilation. The temperature measured inside the oven rises up to 360°. To reach working temperature, 1 to 2 hours are needed (depending on the storage capacity of the stones). After a heat up time of 75 minutes two pots with 1 litre oil were heated up in the top and in the bottom tray of the baking chamber. After 45 min the pot in the upper stage reached 200 °C in the bottom tray 170 °C. So there is a gradient of 30 °C in the oven, which can be explained by the fairly slow airflow by natural convection. It was concluded that Through the use of the solar community ovens an immense reduction in fuel is achieved.[12]

Figure 5: Solar community oven powered by Scheffler reflector

Conclusion

Design principal, performance analysis and applications of scheffler reflector have been studied. It is concluded that Scheffler reflector can be used for low as well as medium temperature applications like food processing industries, cooking, steam generation, crematorium. The performance analysis of scheffler reflector was done by correlating experimental results and the mathematical modelling. It can be understood that there is big potential to work on scheffler technology like material indigenization, improving geometric concentration ratio, radiation enhancement etc.

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