Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 6, Issue 5; April-June, 2019, pp. 332-336

http://www.krishisanskriti.org/Publication.html

Experimental Investigation of Small Size of Scheffler Reflector for Baking Application

Arun Kumar[1a] and Dr.Avadhesh Yadav[2]

[1]M.Tech Research Scholar, Department of Mechanical Engineering, NIT Kurukshetra
[2]Assistant Professor, Department of Mechanical Engineering, NIT Kurukshetra
E-mail: aarun895623@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.*
In this research a scheffler reflector of area 1m^2 has been used for backing purpose. A rectangular backing unit of size 29×32 cm was made of mild steel. An aluminum (K=235 W/mk) plate having strip to hold the biscuit was fixed inside the backing unit. The backing unit was insulated from all side excepted front face which is exposed to solar radiation. The front surface has a glass cover to reduce the convection and surface radiation heat losses. The experiment was performed on 10 June 2019 at Nit kurukshetra at 10am, 12pm and 2pm. The quantity of biscuit was .5kg. The temperature require for backing of biscuits is 142°C -146°C. The maximum temperature achieved by 1m^2 scheffler reflector was 150°C. From the experiment it has been found that the minimum time required for backing was 40 minute at 12am while at 10am and 2pm it takes 85 minute and 65 minute respectively.

Keywords-*Solar energy, scheffler reflector, baking unit.*

Introduction

Energy consumption is one of the main criteria to determine the development of a country. Now a day in most of the countries, whether it is developed or developing non-renewable sources are being used primarily for energy generation. The situation is scarier for the countries like India, which depends on other countries for the fulfilment of its energy need. To transit from developing to developed nation, it is important to become an energy independent nation. Waste from household and forest is the main source of energy for the people in rural area especially in India. Rural area mainly requires energy for cooking purposes as food is one of the basic need for humans. Use of solar energy for cooking is very efficient because Solar Energy is the most abundant source of renewable energy. India blessed with solar energy as it gets more than 300 sunny days in a calendar year with average solar irradiance of 200MW/km². The food cooking especially baking process is an energy intensive unit operation and it becomes more challenging for the developing countries facing severe energy crises. It is important to mention here that a large quantity of heat energy is consumed for low to medium scale heating applications. The firewood and fossil fuels are used for the generation of heat which causes deforestation and environmental pollution. Cooking is one of the main energy application processes and its share of energy consumption is more in developing countries. A considerable share of heat utilization is taken by baking industry. There is need to develop environment-friendly new cooking, baking, and heating technologies to overcome the rising environmental issues, Ramachandran et al (2005). W.Scheffler et al (2006) described Scheffler fixed focus concentrator technology is successfully employed for moderate to high-temperature applications in different parts of the world for heating, cooking, baking, and power generation. The development of the Scheffler Reflector was done in rural mechanical workshops in Kenya and in India, to ensure the resulting technology would be within the reach of everybody who would need it in future. Munir et al (2009) described that these concentrators are the lateral sections of paraboloid focusing all the incident beam radiation on a fixed receiver throughout the year and would be quite effective to perform the baking process. Solar thermal application for cooking is quite common and easy to manage but the baking process requires a considerably higher temperature and need to be optimized.Muller et al (2009) developed a solar bakery oven of volume about 200 l. It gained a temperature of about 350 _C by means of 3 kW input power obtained from concentrated light gave 40% efficiency at 300 _C. They also estimated that solar bakery unit could save about 150 tons of firewood per annum. The drawback of this system was nonuniform circulation of hot air through a perforated plate of the baking chamber. Hassen et al (2016) developed an innovative baking system powered by solar concentrated parabolic trough. Surface temperatures of 191 _C were attained on top of the glass baking pan and Injera baking experiments were conducted efficiently. Ayub et al (2018) presented a detailed thermal analysis of solar bakery unit. Thermal analysis of solar bakery unit presented variations in rate of energy utilization, energy utilization ratio,

exergy losses, and exergy efficiency in range of 0.01–0.07 kW, 25–75%, 0.19–1.08 kW, and 6.62–56.46%, respectively. The overall exergy efficiency of solar bakery unit was found to be 59.26%. This research provides a comprehensive method to conduct the thermal analysis of a solar bakery unit.

Keeping in view the above discussion, the current study has been carried for Experimental investigation of small size of scheffler reflector for baking application.

Experimental Setup

The experiment has been performed for the baked biscuits by Scheffler reflector. The experiment has been conducted at NIT Kurukshetra, India (29°58′ North and 76°53′ East). The schematic diagram of the experimental setup has been shown in the Figure.

The experimental setup consists of the following four parts:

scheffler reflector, baking unitand measuring device.

Scheffler Reflector

The Scheffler reflector as shown in Figure4.2 refers to a point focusing device which concentrates the solar radiations to the baking unit. The Scheffler reflector of 1 m^2 is used for baking of biscuits. The tracking of the Scheffler reflector is done manually after every 5 minutes. Instead of mirror, flexible mirror sheets are used as a reflecting material.

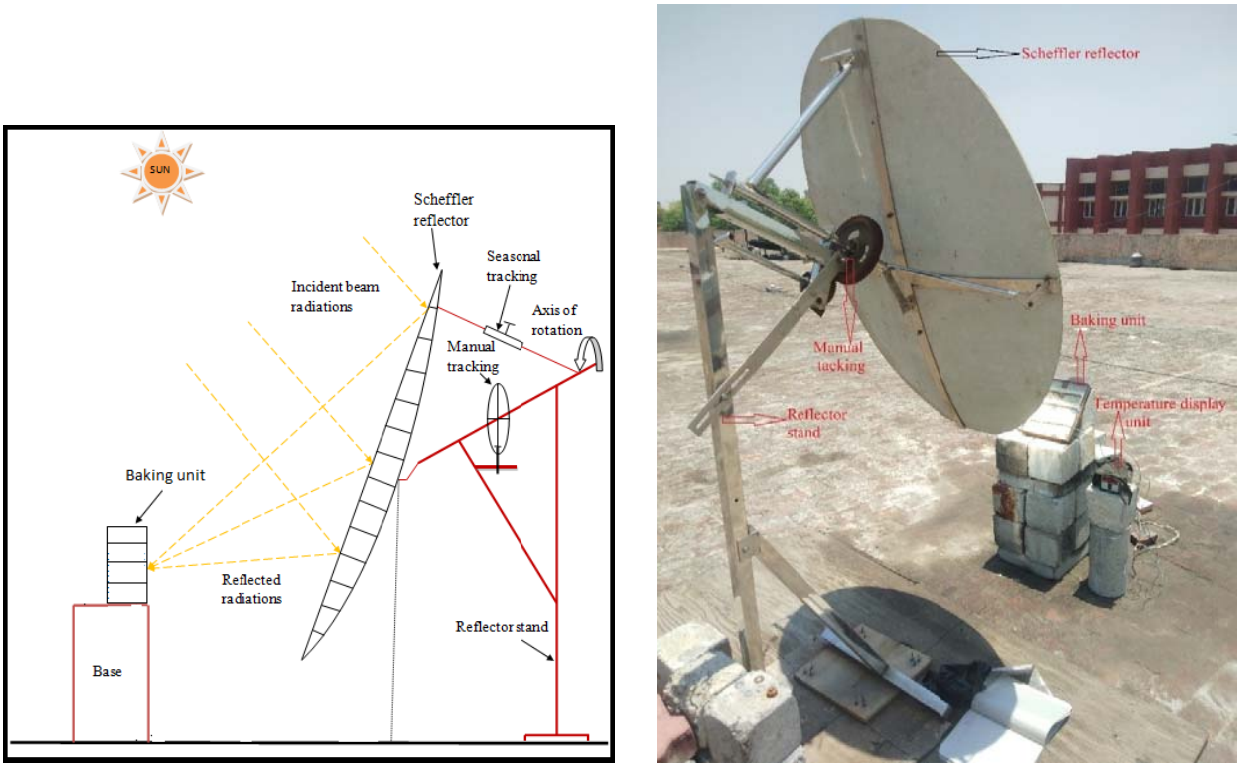

Figure 1: Schematic and experimental diagram of scheffler reflector

Baking unit

A rectangular backing unit of size 29×32 cm was made of mild steel. An aluminum (K=235 W/mk) plate having strip to hold the biscuit was fixed inside the backing unit. The backing unit was insulated from all side excepted front face which is exposed tosolar radiation. The front surface has a glass cover to reduce the convection and surface radiation heat losses.

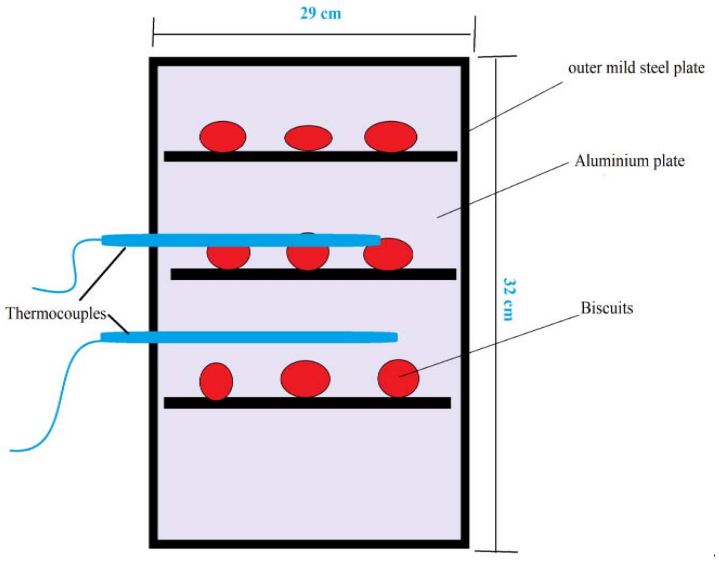

Fig. 2: Schematic diagram of baking unit

Fig. 3: Experimental diagram of baking unit

Measuring device Different devices are used to measure different parameters like food/water temperature, ambient temperature and solar intensity. Mainly, two measuring devices are used one for measuring temperature and other is to measure solar intensity. For temperature measurement RTD PT100 thermocouple is used and for solar intensity pyranometer is used.

RTD PT100 thermocouple

RTD PT100 thermocouple is used to measure temperature of surface of aluminium plate and biscuits. It can measure temperature with a resolution of 0.1^{o}c. RTD PT100 is a temperature sensitive resistor with a positive temperature coefficient which means when temperature increases its resistance also increases. It is used with digital temperature indicator.

Pyranometer

Pyranometer is a device that is used to measure global solar radiation. Global solar radiation is sum of beam and diffuse radiation. Due to difference betweentemperature of hot and cold junction of pyranometer an emf is generated which is proportional to solar radiation. EMF ranges between 0 to 10mV with a calibration of 2%. Solar intensity is measured in W/m^2 by using Pyranometer.

Results and conclusions

Experiments were carried out at NIT Kurukshetra and the following readings were observed at different time starting from morning to afternoon.

Table 1: Temperature variation with time during biscuit baking arrangement

Time	Solar intensity	Ambient temperature	Wind speed	Relative humidity	Biscuit temperature	Plate surface temperature
10:00 AM	733.6	34.9	0.9	47.8	23.4	41.7
10:05 AM	749.7	34.5	2.5	47.5	31.3	48.9
10:10 AM	768.2	35	2.5	47.1	36	59.6
10:15 AM	757.6	34.7	2.1	47.3	49	71.2
10:20 AM	727.3	35.4	0.7	47.7	65.3	92.8
10:25 AM	793.5	35.7	2.4	44.2	81.5	115
10:30 AM	763.7	35.5	1.4	44.7	90.2	120.7
10:35 AM	786.8	36.3	1.8	41.8	110.9	126.4
10:40 AM	803.5	37	1.1	41.1	120.4	131.3
10:45 AM	819.9	36	1.8	41.5	125.3	136
10:50 AM	823.2	35.9	1.6	40.5	128.9	141.3
10:55 AM	824.6	36.4	1.7	37.3	130.9	143.9
11:00 AM	855.3	36.8	1.6	37.4	132.3	145.3
11:05 AM	856.4	36.7	1.5	37.3	136	147.2
11:10 AM	868.9	36.5	1.5	37.2	139.5	147.5
11:15 AM	894	37.1	1.6	36.9	145.3	148.1
11:20 AM	894.9	38.9	1.9	36.3	146.2	148.9

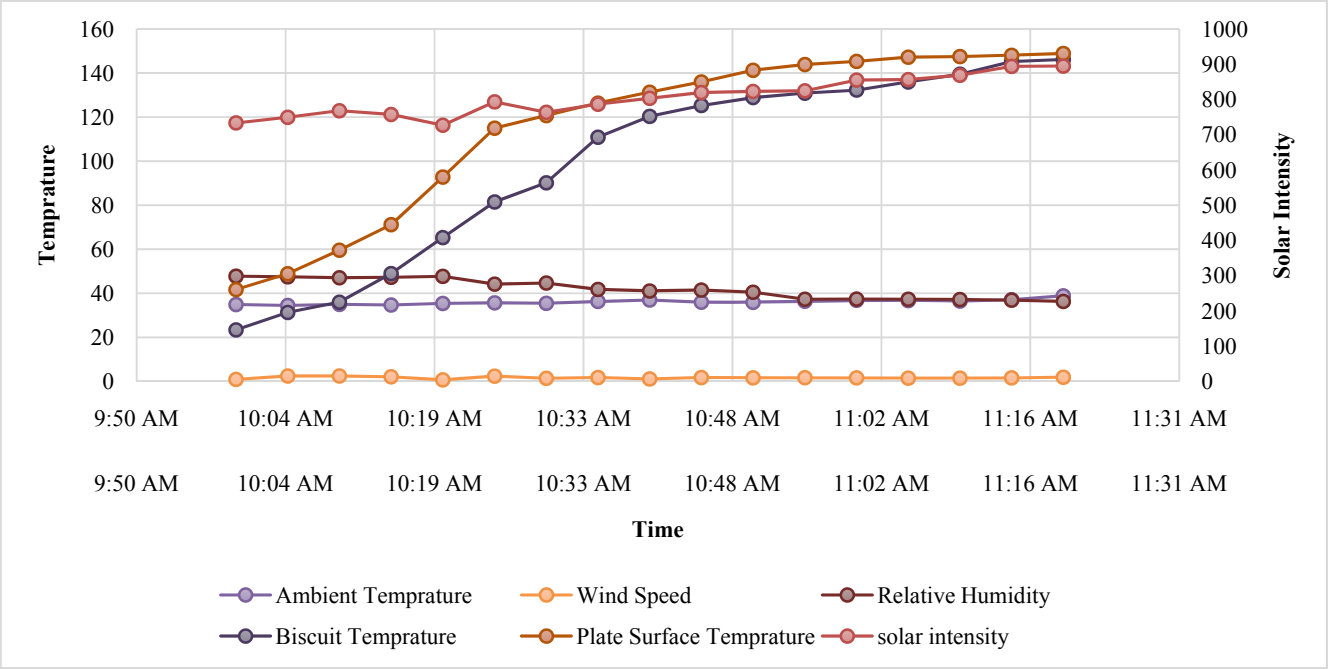

Fig. 4: Graphical variation of temperature vs time

Conclusion

There are various methods of backing of biscuits but scheffler reflctor is more superior method due to use of renewable solar energy and there is no pollution involved. From the above experiments we can say that if this method is adopted for industrial works it can save enormous amount of energy and can help in reducing the pollution.

References

[1] Scheffler, W., Bruecke, S., and von Werdenbergstr, G., 2006, "Introduction to the Revolutionary Design of Scheffler Reflectors," International Solar Cooker Conference, Granada, Spain, July 12–16, pp. 12–6.
[2] Munir, A., and Hensel, O., 2009, "Solar Distillation for Essential Oils Extraction—A Decentralized Approach for Rural Development," InternationalSolar Food Processing Conference, Witzenhausen, Germany, Jan 14–16, pp. 1–5.
[3] Muller, C., Ecoandia, F., and Arias, C., 2009, "Solar Community Bakeries on the Argentinean Altiplano," International Solar Food Conference, Indore, India, Jan. 14–16, pp. 1–6.
[4] Hassen, A., Kebedy, S. B., and Wihib, N. M., 2016, "Design and Manufacturing of Thermal Energy Based Injeria Baking Glass Pan," Energy Procedia, 93, pp. 154–159.
[5] Ayub, I., Munir, A., Amjad, W., Ghafoor, A., and Nasir, M. S., 2018, "Energyand Exergy-Based Thermal Analyses of a Solar Bakery Unit," J. Therm. Anal.Calorim. (in press).