



Performance investigation of enhanced solar dryer using parabolic dish collector

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Abstract — The basic idea of our project is concerned with the Performance investigation of enhanced solar dryer using parabolic dish collector. In our project we will use Dryer cabinet, parabolic collector, Pipe, Blower, Thermometer, Weighing instrument, Stand, Foods etc. Our main goal is to maximum drying rate with use of minimum energy. Drying means removing moisture from the product. Drying is useful for preserving food products for long time. Conventional sun dryer has several disadvantages like slow drying rate, dust accumulation, insect and rodent attack etc. To overcome these problems, we can use solar dryer. There are so many research has been already done with flat plate collector. The objective of this project is to investigate the performance of solar dryer using parabolic dish collector to evaluate the enhanced drying rate quality, flavor of food product.

Keywords-; solar dryer, Parabolic dish collector, Cabinet dryer, Forced convection

1. INTRODUCTION

1.1 Introduction of solar dryer

Preservation of fruits, vegetables, and food are essential for keeping them for a long time without further deterioration in the quality of the product. Several process technologies have been employed on an industrial scale to preserve food product; the major ones are canning, freezing, and dehydration. Among these, drying is especially suited for developing countries with poorly established low-temperature and thermal processing facilities. It offers a highly effective and practical means of preservation to reduce postharvest losses and offset the shortages in supply. Drying is a simple process of moisture content and is an energy intensive operation. Drying involves the application of heat to vaporize moisture and some means of removing water vapor after its separation from the food products. It is thus a combined and simultaneous heat and mass transfer operation for which energy must be supplied. Solar radiation in the form of solar thermal energy, is an alternative source of energy for drying especially to dry fruits, Vegetables, agricultural grains and other kind of material, such as wood etc. Contributing thus significantly to the economy of small agricultural communities and farms. The world population is more than 6 billion and about 800-900 million people do not have enough food to eat. There are three methods to solve hunger problem (1) Increase food production (2) Reduce population growth (3) Reduce loss of food during and after harvesting. It has been estimated that world as a whole more than 20-30 percent food grain and 30-50 percent vegetables, fruits / fish etc. are lost before it reaches to the consumers. Drying is a traditional method for preserving food. Solar drying is an effective method to preserve food. Solar energy is diffuse in nature and thus suitable for crop drying, locally available and thus saves transportation, solar dryers can be made locally of any size and capacity and solar dryer are economical if cash crops are dried.

1.2 Drying Principles

Drying is basically a phenomenon of removal of liquid by evaporation from a solid. Mechanical method for separating a liquid from a solid are not generally considered drying. In the following section an attempt is made to provide a concise overview of the fundamental principles of drying process for agricultural products. These principle are applied in general, to mechanical conventional drying and here concerned mainly with solar drying. However in general, must be noted that conventional drying principles and phenomena are independent of the type of energy used. A major part of energy consumption during drying is for the evaporation of liquid water in to its vapor. The

water may be contained in the solid in various forms like free moisture or bound form which directly effects the drying rate.

1.3 Parameter for solar Drying

The drying of product depends on external variables like temperature, humidity and velocity of air stream and internal variables which is a function of drying material and depends on parameters like surface characteristics and size and shape of the product. The rate of moisture movement from the product inside to the air weather the material is hygroscopic or non-hygroscopic. Non-hygroscopic materials can be dried to zero moisture level while the hygroscopic material like most of the food product will always have residual moisture content. The design of a solar dryer depends on: Solar radiation, temperature of air, relative humidity of air, moisture content of the product, amount of product to be dried, time required for drying, availability of auxiliary energy, material of construction of dryer and the resource availability.

1.4 Introduction of Parabolic collector

Collector: Receiver and the concentrator. Receiver: Radiation is absorbed and converted to some other energy form (e.g. heat). With a parabolic dish collector, one or more parabolic dishes concentrated solar energy at a single focal point, similar to the way reflecting telescoping focuses starlight, or a dish antenna focuses radio waves. The shape of a parabola means that incoming light rays which are parallel to the dish's axis will be reflected toward the focus, no matter where on the dish they arrive. Light from the sun arrives at Earth's surface

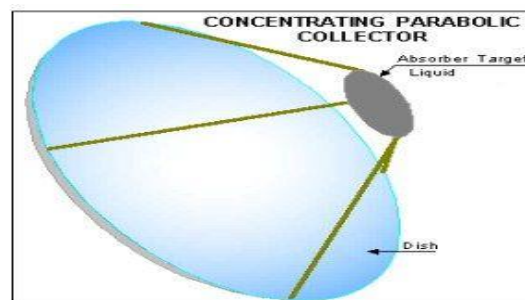
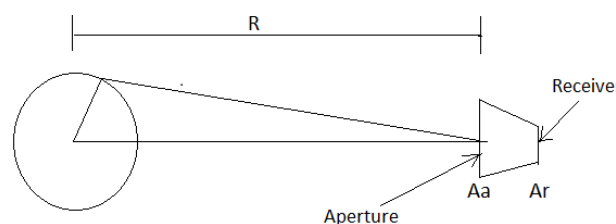


Fig. 1 Parabolic solar collector

almost completely parallel. So the dish is aligned with its axis pointing at the sun, allowing almost radiation to be reflected towards the focal point of the dish. Collectors are oriented to track the sun so the beam radiation will be directed onto the absorbing surface. Parabolic Collector main goal is to increasing the radiation flux on receivers. Fresnel lens: An optical device for concentrating light that is made of concentric rings that are faced at different angles so that light falling on any ring is focused to the same point.

Concentration Ratio - The area of the collector aperture A_a divided by the surface area of the receiver A_r is called Area concentration ration (geometric)



$$C = A_a / A_r$$

The averaged irradiance (radiant flux) (I_r) integrated over the receiver area (A_r), divided by the insulation incident on the collector aperture.

$$CO = \frac{1 \int I_r dA_r}{\frac{A_r}{I_a}}$$

Optical concentration ratio:

I_r is the averaged irradiance

I_a is the insulation indent on the collector aperture



Fig. 2 solar dryer actual model

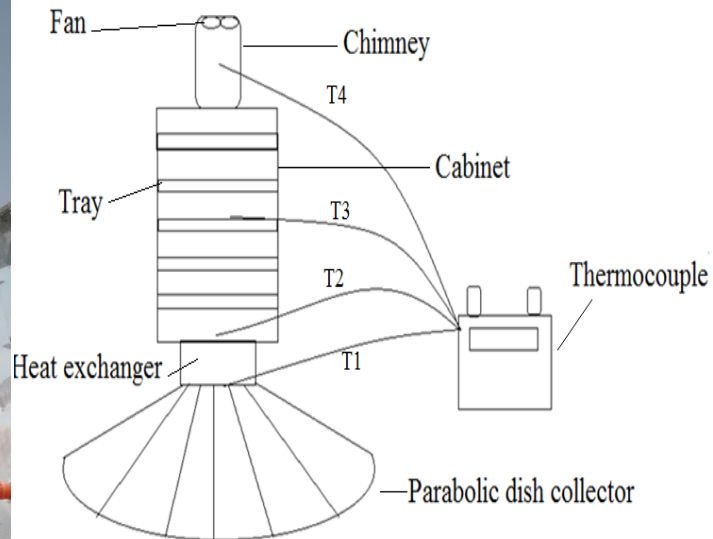


Fig.3 Line diagram of solar dryer

2. LITERATURE SURVEY

1. Subarna Maiti^[1] et al had try to increase the efficiency of solar collector and also increase the efficiency and drying rate of solar dryer. Although the high efficiency of collector was achieved, the average drying efficiency was low on account of under-loading of the dryer. They got an improvement was brought about in the design of the natural convection indirect type solar dryer by adding the collector with N-S reflectors in a V-trough alignment
2. M. Manoj^[2] et al had Developed a MATLAB-based modeling and simulation system to predict the air flow properties, equilibrium moisture content of the solar dryer technology. The Crank-Nicholson equation has been applied to heat and finite difference method has been used to develop for drying cocoa bean. This results show a time of drying reduces the moisture contains for 50% to 7% and 60% to 8% of moisture removal of dried bean.
3. F K Forson^[3] et al had revealed that, minimum of 42.4 m² of solar collector area, according to the design, is required for an expected drying efficiency of 12.5% with solar irradiance of 340.4 W/m², a drying time of 35.5 hour was realized and the drying efficiency was evaluated as 12.3% when tested under full designed load signifying that the design procedure proposed is sufficiently.
4. Blake Ringeisen^[4] et al had add the trough type concentrator to one dryer reduced drying times by 21% on average as compared to the control dryer. This was done by an increase in the internal dryer temperature and a lowering of the relative humidity, allowing for more favorable drying conditions. It was also shown that the use of a concentrator did not negatively affect tomato quality.

5. James Stiling^[5] et al had revealed that, the Drying time of tomatoes was reduced when using the concentrating solar panels as compared to not using the concentrating solar panels. The use of mobile concentrating solar panels with mixed-mode dryers ensures a faster drying rate and it therefore reduces the chance of spoilage.

3. BASIC FORMULA FOR CALCULATING EFFICIENCY

Some important formulas used are given as follows:-

1. *Collector efficiency (η_c):*- It is the ratio of heat receiver by the drying air to the insulation on the absorber surface.

$$\eta_c = \frac{(10^{-6} M_a (T_1 - T_5) C_p)}{A_c I_c} * 100$$

Where,

M_a = mass flow rate of air required for drying (Kg / h)

T_1 = the collector outlet temperature (°C)

T_5 = the ambient temperature (°C)

C_p = Specific heat of air (J / Kg °K)

A_c = the area of collector (m²)

I_c = the avg. solar radiation incident on the collector (W / m²)

2. *Dryer efficiency (η_d):*- It is the ratio of the energy utilized to evaporator the moisture to the energy supplied to the collector.

$$\eta_d = \frac{10^{-3} D h_{fg}}{A_c I_c} * 100$$

Where,

D = drying rate (Kg / h)

h_{fg} = latent heat of vaporization of air (KJ / Kg)

3. *Amount of moisture (M_w):*-

$$M_w = \frac{M_p(M_i - M_f)}{(100 - M_f)}$$

Where,

M_p = the initial mass of product to be dried in (Kg)

M_i = the initial moisture content (% w.b.)

M_f = the final moisture content (% w.b.)

4. *Quality of heat (Q):*-

$$Q = \frac{M_w h_{fg} \eta_d}{\eta_c}$$

5. *Moisture ratio:*-

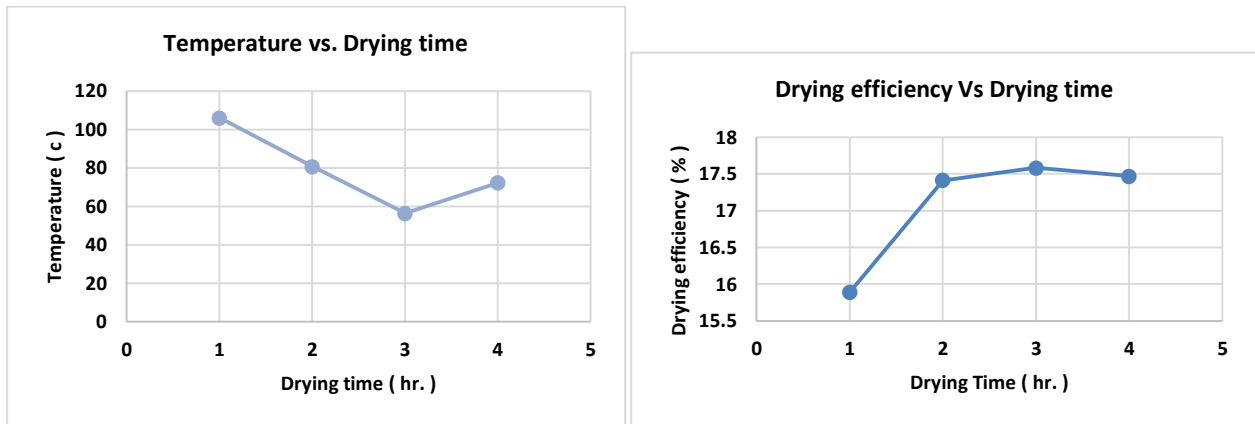
$$M_r = \frac{M - M_e}{M_i - M_e}$$

Where,

M = moisture content (dry basis)

M_i = initial moisture content (dry basis)

M_e = the equilibrium moisture content (dry basis)



Forced Convection = inlet moisture content = 1000 gm
 = Final moisture content = 270 gm

Natural Convection = inlet moisture content = 1000 gm
 = Final moisture content = 324 gm

ASSUMPTION

1. Take solar radiation on collector = 750 w/m^2
2. Drying Period = 11:00am to 4:00 pm
3. Ambient Temperature = 37°C
4. Load = 1 kg

4. CONCLUSION

This paper presents a study to investigate the performance of solar dryer using parabolic dish collector to evaluate the enhance drying rate and quality of product. By the use of various types of solar dryers available today. The types examined are the direct, indirect, mixed-mode, active, and passive solar dryers. This paper focuses on solar dryer models that are suitable for producing high-quality dried products. The best solutions to solve the issues associated with traditional drying (i.e., open sun drying) are discussed, along with the ways by which to create simple, inexpensive, and low-cost solar dryers. We also discuss some environmental impacts and how these can be mitigated.

Sample	Flat Plate drying efficiency	Parabolic dish collector drying efficiency
Ginger	14.19 %	17.89 %
Chilly	13.78 %	16.78%

5. REFERENCES

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