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Study and experimental investigation Of solar dryer by using concentric Collector

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ABSTRACT

Solar drying is one of the application of solar energy. Drying means moisture removal from the product. Drying is helpful in preserving food product for long time; it prevent product from contamination. Direct solar drying, indirect solar drying, and mixed mode solar drying these are different solar drying methods. Primarily open to the sun or direct sun drying technique is used. However, it has some disadvantages. These disadvantages can be eliminated by indirect type of dryer which is used for drying products as application of solar energy. In this paper, we studied the indirect type of solar dryer by using concentric collector.

Keywords— Concentric dish collector, Direct type solar dryer, Drying chamber, Indirect type solar dryer.

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I. INTRODUCTION

Drying means preservation of food, fruits and vegetables for long time with good quality. It is a process of moisture removal due to simultaneous heat and mass transfer. Agricultural products, especially fruits and vegetables require hot air in the temperature range of 45–60˚C for safe drying. When any agricultural product is drying under controlled condition at specific humidity as well as temperature it gives rapid superior quality of dry product [1]. 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. The removal of moisture prevents the growth and reproduction of microorganisms like bacteria, yeasts and molds causing decay and minimizes many of the moisture-mediated deteriorative reactions. It observed that reduction in weight and volume, minimizing packing, storage, and transportation costs and enables storability of the product under ambient temperatures. These features are especially important for developing countries [2].

Drying process takes place in two stages first one happens at the surface of the drying material at constant drying rate and is similar to the vaporization of water into the ambient and second stage is according to properties of drying product with decreasing drying rate [3]. Previously open sun drying is used for drying product. In this method, the crop is placed on the ground or concrete floors, which can reach higher temperatures in open sun, and left there for a number of days to dry. Capacity wise, and despite the very rudimentary nature of the process, natural drying remains the most common method of solar drying. This is because the energy requirements, which come from solar radiation and the air enthalpy, are readily available in the ambient environment and no capital investment in equipment is required. The process, however, has some serious limitations. The most obvious ones are that the crops suffer the undesirable effects of dust, dirt, atmospheric pollution, and insect and rodent attacks. Because of these limitations, the quality of the resulting product can be degraded, sometimes beyond edibility. All these disadvantages can be eliminated by using a solar dryer [4].

II. METHODOLOGY

The objective of this work is to investigate the performance of solar dryer with point focus collector. Dish type concentric collector used. It is possible to adjust this concentric collector on an average level house. It is pollution free, require almost no maintenance and fuel free which makes it sustainable, reliable and affordable with less capital cost. Parabolic collector concentrates solar energy at a single focal point. It focuses all the sunlight which strikes on it to a single focal point and receiver captures this light and changes into other form.

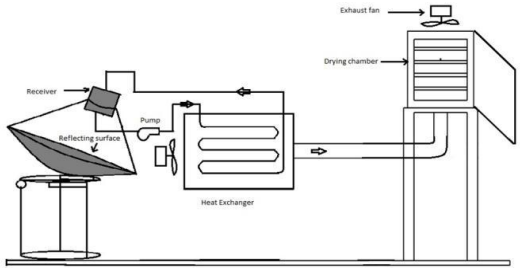

Fig 1: Schematic diagram of experimental setup

The drying is essential process in day to day life as well as in most of the industries such as food processing, food preservation, waste management, wood drying etc.

Temperature require for drying cloths is 100˚- 120˚C. Solar concentrating parabolic dish collector is used to get this temperature. The temperature at receiver is up to 200˚C, receiver is having thermic fluid which is passed through heat exchanger with the help of pump. Heat from hot fluid is extracted by supplying cold air through heat exchanger. This saturated air is then passed with the help of pump in the close cabinet where cloths are placed.

III. MECHANISM OF DRYING AGRICULTURAL PRODUCTS AND CLOTHS.

Drying is most cost effective application of solar energy. There are various products which are dried by solar dryer like various fruits, grains, meat, timber, fish, cloths. Food products are preserved by drying. In developing nations, open to the sun drying technique is used for drying agricultural products. Open to the sun drying means products are exposed directly to sun, allowed to absorbed solar radiation. It was reported that this method has many disadvantages like poor quality, contamination of product [5]

The dryer is container which is powered by electricity or fuel as source of heat, design for house product like cloths or agricultural product and used air for drying the products is called as mechanized form of dryer. This is faster dryer but it needs large initial cost for various equipment's as well as for fuel. Following gives advantages and disadvantages between Solar dryer with other means of drying [6].

3.1 Comparison between Solar dryer with Mechanized form of dryer:

Advantages:

a. It reduces environmental impact.

b. Easily managed.

c. Prevent fuel dependence.

d. Often less expensive.

Disadvantages:

a. Requires adequate solar radiation.

b. Hot and dry climate preferred (relative humidity below 60% needed).

c. Requires more time.

3.2 Comparison between Solar dryer with open air drying.

Advantages:

a. It gives better quality of drying product.

b. It reduces losses and bacterial contamination.

c. Requires less area for drying.

d. May reduce labor required.

e. Drying time reduces.

Disadvantages:

a. More expensive.

b. It may require some parts material to be import.

IV. DESIGN OF STUDIED SYSTEM

A. Objective

Researchers have done lots of research on solar dryer by using flat plate collector. Objective of this study is to analyse the performance of solar dryer by using concentric collector.

B. Concentric dish collector

Solar concentric dish collector is the collector which concentrates solar radiation which is falling on the collector surface and concentrates at one point, hence it is called as point focus concentric collector. Thermal and optical efficiency of parabolic dish concentrator is highest than all other current concentrator option [7].

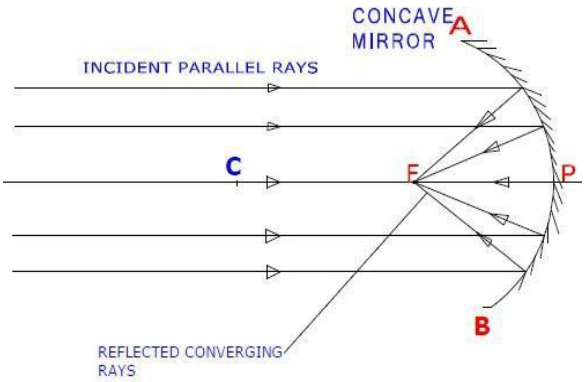

Fig 2: Parabolic dish collector [8]

Figure (2) shows when rays of light from the sun travels parallel to the principal axis are incident on a concave or parabolic shaped mirror, they converge or come together after reflection to a point F on the principal axis called the principal focus. Where, F is principle focus, P is pole, C is Centre curvature, AB is aperture (width of the mirror).

Collector efficiency is given by,

$$\eta = \frac{Q}{A_c I_t}$$

Where, Q = The rate of useful gain. A_c= Area of collector.
I_t = The amount of solar radiation falling on the collector.

$$Q = mC_p \Delta T.$$

Concentration ratio (CR) for concentric dish collector is given by,

$$CR = \frac{A_a}{A_r}$$

Where, A_a = aperture area. A_r = receiver area.

C. Drying chamber

Solar drying used in this set up is Force convection or Hybrid Solar dryer. Optimum air flow can be provided in the dryer throughout the drying process to control temperature and moisture in wide ranges independent of the weather condition. Hence the capacity and the reliability of the dryers are increased considerably compared to natural convection dryer. The use of forced convection can reduce drying time by three times.

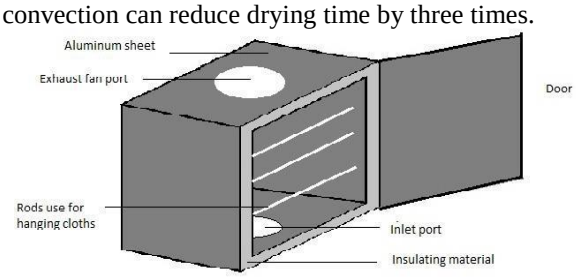

Fig 3: Schematic diagram of drying chamber.

The general equation of mass conservation of drying air can be expressed as,

$$\dot{m}_{dai} = \dot{m}_{dao}$$

Where, m_{dai} = inlet mass flow of drying air. m_{dao} = outlet mass flow of drying air.

The useful energy gain by the drying air, Q_{uda}, was determined from

$$Q_{uda} = m_{da} C_{pda} (T_{ho} - T_{hi}).$$

Where, T_{ho}= drying air temperature at inlet. T_{hi}= Drying air temperature at outlet.

V. CONCLUSIONS

As the temperature obtained through this collector is more than the flat plate collector so time required for drying is less as compared to other collector

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