Solar Green House Drying

Rohan L. Patre, Akash S. Mahajan, Aditya R. Bhavsar
[1]Department of Mechanical Engineering,
[1]Jawahar Institute Of Technology, Nashik, Maharashtra, India.

***Abstract*—In India, land is widely used for agricultural purpose hence the drying process is used over large scale for drying the product and preserve it or longer period of time. Green house drying is a method of removing moisture contain from the product. The medium of drying is solar energy which is easy available energy and low in cost for farmer. By this method the loss of product by spoilage will be cut off and will be beneficial to farmer in low cost.**

***Index Terms*— Drying, Solar, Efficiency, Moisture etc.**

I. INTRODUCTION (HEADING 1)

Solar drying is one of the application of solar energy. As a Drying is traditional process and used since a thousand years over globe. Drying is moisture removal process from product. It is helpful for preservation of food of long time and it prevent product from contamination. Direct, Indirect and Mix Mode solar Drying are different solar drying methods. Primarily open to sun or direct drying technique is used however it has some disadvantages. These disadvantage can be eliminated by indirect type of dryer which is used for drying product as application of solar energy Solar drying is the most common method for preserving food and extending the shelf life of agricultural produce. It is a simultaneous heat and mass transfer operation in which moisture is removed from food material and carried out using hot air. Solar dryers can be used for industrial and domestic drying processes. It is a useful device for energy conservation, saves drying time, minimizes drying area and enhances the quality of dried product, with reduced carbon emission co benefits. It is a key element in powering agriculture through reduction of postharvest losses and preparing agricultural products for secondary processing. . Conveniently there are 13 types of Indirect Sola drying. These are various modification in collector of Indirect Solar Drying over Simple flat collector solar dryer found out in last 50 years.

Parabolic Shape type collector is big improvement over flat plate collector but as manufacturing of parabolic collector is bit expensive. There was scope to make collector with features of parabolic collector but at reasonable cost. That's what exactly we are doing we are improving and optimizing design factors from both flat plate and parabolic collectors and integrating it with new type of collector which will be Cylindrical type collector. At this point we assume that this concept is has some unique features like its compact, easy to manufacture, quite cheap over flat plate collector, great heat transfer rate, etc.

II. PROBLEM FORMULATION

We are going to design and green house drying chamber so the problem farmers are facing of spoilage of food while farming will be reduced. It takes solar dryer to next step instead of normal drying the green house drying is used in usual method of farming. The purpose of this method is to develop a mixed-mode solar dryer in which the grains are dried simultaneously by both direct radiation through the transparent roof of the cabinet and by the heated air from the solar collector. The problems of low and medium scale processor could be alleviated, if the solar dryer is designed and constructed with the consideration of overcoming the limitations of direct and indirect type of solar dryer. Productivity of grains and crops will increase and hence farmers earns more profit.

Concept and Objective of the solar green house is explained below

a. Concept

By introducing a mix-mode solar drier to overcome the loss and spoilage that farmer face while drying the product using old ways of drying method. The concept of the work is,

(1) To overcome the old methods of drying and to identify the drawbacks.
(2) Easy to operate for farmer and easy drying.
(3) Observe all crops are dried and preserve from spoilage.
(4) Produce a specification for a low cost drying system.

b. Objective

The main objective of this project is to overcome the old method of drying

(1) To increase the efficiency.
(2) To reduce the drying time of farmer or worker.
(3) To preserve product for long period of time.

III. WORKING PRINCIPLE

The working principle of drying is mix-mode by means of open and indirect sun drying using only the solar energy. The crops are generally spread on the tray of drier where they receive short wavelength solar energy during a major part of the day and also natural air circulation. The solar plate is placed which contain aluminum meshing sheet which collects the heat from sun. The absorbed radiation is converted into thermal energy and the temperature of the material starts to increase. The long wavelength radiation from the surface of crop to ambient air through moist air and also convective heat due to the blowing wind through moist air over the crop surface. The exhaust fan helps the heated air to enter the cabinet by means of insulated pipe. The moisture is taken away by the air entering into the cabinet from below and escaping through at the top exit way in the cabinet dryer, of the total solar radiation impinging on the tray cover, a part is reflected back to atmosphere and the remaining is transmitted inside the cabinet. A part of the transmitted radiation is then absorbed by the surface of the crop which causes its temperature to increase and thereby emit long wavelength radiations which are not allowed to escape to atmosphere due to the green poly cover. The overall phenomena causes the temperature above the crop inside the cabinet to be higher. The green poly cover in the cabinet dryer thus serves in reducing direct convective losses to the ambient which plays an important role in increasing the crop and cabinet temperature.

IV. FORMULAS USED FOR CALCULATE HUMIDITY

(1) Absolute humidity (A.H.)

It is the total mass of water vapour present in a given volume of air. It does not take temperature into consideration. Absolute humidity is the mass of the water vapour (m_v), divided by the volume of the air and water vapours mixture (V_{net}) which can be expressed as

$$\text{A. H.} = \frac{m_V}{V_{net}}$$

(2) Relative Humidity (R.H. or Φ)

It is the ratio of actual partial pressure exerted by the water vapour in any volume of air (p_v) to the partial pressure that would be exerted by the water vapour if water vapour in the air is saturated (p_s) at the temperature of the air

$$\text{R. H. or } \Phi = \frac{\text{actual partial pressure } (p_V)}{\text{partial pressure at saturation}(p_S)} * 100\%$$

(3) Specific Humidity (w)

Specific humidity (or moisture content) is the ratio of the mass of water vapour (m_v) to the total mass of the moist air parcel (m_a). Specific humidity is approximately equal to the "mixing ratio", which is defined as the ratio of the mass of water vapour in an air parcel to the mass of *dry* air for the same parcel. As temperature decreases, the amount of water vapour needed to reach saturation also decreases. As the temperature of a parcel of air becomes lower it will eventually reach the point of saturation without adding or losing water mass.

$$w = \frac{m_V}{m_{net}} = 0.6229 \frac{p_V}{p_{net} - p_V}$$

V. MODELLING AND ASSEMBLY

After completion of design the development is done by observing the parameters needed to increase the efficiency of drying. Parameters are selected according to objectives. Main mottos of this project were to develop the first prototype of any easy use, low priced and test its performance. Design must be easy to maintain and should not require highly skilled worker or operator, which is hard to be found in rural and urban areas. Assembly process should be simple and based on locally available techniques in rural areas. Important components of the Solar Green House Drying is :-

(1) Drying space, where the material is to be dried is placed.
(2) Collector to convert solar radiations into heat.
(3) Digital display to set the temperature and to observe the temperature of cabinet.
(4) Auxiliary energy sources. (optional)
(5) Insulated pipe.
(6) Exhaust fan to pass the heated air.
(7) 12V battery
(8) Measuring and control equipment. (optional)

The assembly of various component of "Solar Green House Drying" is done as follows:

(1) The solar collector contains aluminum meshing sheet to collect solar radiation and exhaust to pass the heated air.
(2) The insulated pipe is attached to the solar collector and drying cabinet.
(3) The digital display is displayed on the drying cabinet and sensor is placed inside the cabinet.
(4) The drying tray is placed inside the drying cabinet.
(5) The ducts and air exit is given on the top of the drying cabinet.
(6) The power is given by 12V battery to the digital display and he sensor.

Fig.1 Final Assembly of Solar Green House Drying

VI. TESTING AND ANALYSIS

The test we conduct on day time was the time taken for drying was less and the efficiency of drying was more. The carrot and chilly was demonstrated by drying them and the drying time was noted and they were stored for long period of time.

VII. RESULTS

1. Drying rate is faster under forced convection than natural convection mode.
2. Convective heat transfer coefficient is more than open sun drying mode.
3. Values of convective heat transfer coefficient diverse with the size and primary moisture content of a product.
4. Use of inclined reflection north wall in greenhouse solar drying can increased the total solar radiation.
5. PV- ventilated solar greenhouse dryer gives a very high quality dried product and reduces drying time than open air sun drying.
6. Greenhouse drying reduces moisture content in a very less time.
7. Solar greenhouse tunnel drier can be used in rural areas.
8. Relative humidity under forced convection is inferior to natural convection mode.
9. Greenhouse type agricultural dryers are of much higher quality and more effective than open sun dry

WIND VELOCITY	T1	CHILLY DRYING TIME	CARROT DRYING TIME	SET TEMPERATURE
(m/s)	°C	/hr	/hr	°C
1.94	36	2 hr	2 hr 30 min	50
5.55	35	2 hr 15 min	2 hr 40 min	50
3.167	36	2 hr	2 hr 30 min	50
4.55	38	1 hr 50 min	2 hr 10 min	50
2.5	34	2 hr 50 min	2 hr 50 min	50
2.5	37	2 hrs 10 min	2 hr 20 min	50

Table1 Testing table

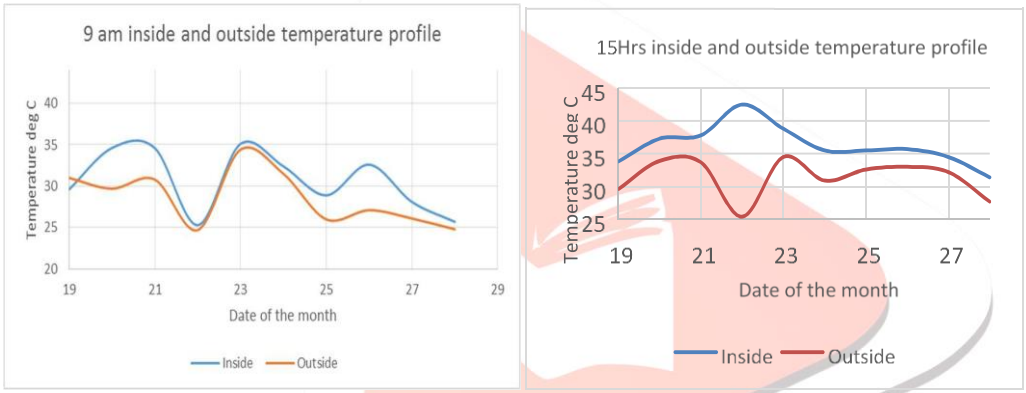

Fig.2 Temperature Gradient between inside and outside of drying

VIII. CONCLUSION

The solar dryer can raise the ambient air temperature to a considerable high value for increasing the drying rate of agricultural crops. The storage of crops for long period of time and easy to operate. The product inside the dryer requires less attentions, like attack of the product by rain or pest (both human and animals), compared with those in the open sun drying. Although the dryer was used to dry Potato, it can be used to dry other crops like yams, cassava, maize and plantain etc. There is ease in monitoring when compared to the natural sun drying technique. The capital cost involved in the construction of a solar dryer is much lower to that of a mechanical dryer.

IX. ACKNOWLEDGMENT

A guide acknowledges the help rendered by Dr.D.R. Patil, HOD of Mechanical Engineering Department, Jawahar Institute of Technology, Nashik for the help rendered in design and asasembly of the drying unit.

REFERENCES

(1). Pravin M. Gupta, Amit S. Das, Ranjit C. Barai, Sagar C. Pusadkar, Vishal G. Pawar, "Design and Construction of Solar Dryer for Drying Agricultural," *International Research Journal of Engineering and Technology (IRJET),* vol. 04, no. 03, March 2017.

(2). S. VijayaVenkataRaman, S. Iniyan,, Ranko Goic, "A review of solar drying technologies," *Renewable and Sustainable Energy Reviews*, p. 20, 2012.

(3). V. Belessiotis, E. Delyannis, "Solar Drying," *Solar Energy*, vol. 80, 2011.

(4). Zdzisław Pakowski and Arun S. Mujumdar, Basic Process Calculations and Simulations in Drying, : Taylor & Francis Group, LLC., 2007.

(5). Bena, B., Fuller, R.J., 2002. Natural convection solar dryer with biomass back-up heater. Solar Energy, Vol.72, pp. 75–83.

(6). Condori, M., Echazu, R., Saravia, L., 2001. Solar drying of sweet pepper and garlic using the tunnel greenhouse drier. Renewable Energy, Vol.22, pp. 447–460.

(7). Condori, M., Saravia, L., 2003. Analytical model for the performance of the tunneltype greenhouse drier. Renewable Energy, Vol.28, pp. 467–485.

(8). Ekechukwu, O.V., Norton, B., 1999. Review of solar-energy drying systems II an overview of solar drying technology. Energy Conversion & Management, Vol.40 (6), pp. 615-655.