International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

A Solar Dryer Technology

Rahul Girase[1], Vishwas Mahajan[2], Ankita Kotwal[3], Akash Ugale[4]

[1,2,3,4]*Students of Mechanical Engineering Department, Sandip University, Nashik- Maharashtra 422012*

Abstract - Solar Drying or solar dehydration is one of the important process required for preservation of food and agriculture products. Bacterial growth and moisture is being removed in this process. It helps for preserving the food products for more long time. Solar drying is the oldest & effective method used for drying food products.

The device used for preservation of food products using solar energy is called as solar dryer or solar dehydrator. The solar dryer is classified on the basis of mode of drying, circulation of air, type and arrangement of solar air collector.

1. INTRODUCTION

Now a days most of the food processing and food preservation activities in the industries are depends upon non-renewable energy sources. In which the requirement of energy is not full filled by the supply. It is required to check for alternatives for non-renewable and polluting fossil fuels. Use of renewable energy source like solar energy is one of the best solution for reducing the usage of non-renewable sources.

The sun produce its energy by many thermonuclear reactions which creates large amount of heat and electromagnetic radiations which is easily available throughout the earth. This solar energy is trapped by the heat exchanger devices called as solar collectors.

Solar dryer it is oldest method of food preservation. Generally most of the agricultural and food products contains 70-80%. So far the preservation of the food is controlled, these values of moisture are very high which results into reduction in the life of products. Most of the times the crops get subjected to the bacterial and fungal growth due to this moisture. These problems can be resolved by implementing the usage of solar dryer which is absolutely pollution free and free from emission & carbon particles.

The solar dryers are classified on the basis of type of circulation (natural circulation and forced circulation.).The objective of this study is to present some basic types of solar dryer systems with a construction of providing a better indication on their drying effectiveness for agricultural and food products.

By implementation of solar dryer for preservation of agro products, we get

1) Better Quality of food products

2) Reduction inwastage of food products

3) Better market price can be achieved to the products.

4) Products can be protected against flies, rain and dust

5) Product can be left in the dryer overnight during rain, since dryers are waterproof.

6) Prevent fuel dependence and Reduces the environmental impact

7) It is more efficient and cheap.

But in some of the cases we has limitations like

1) Quality of products are not obtained in some cases.

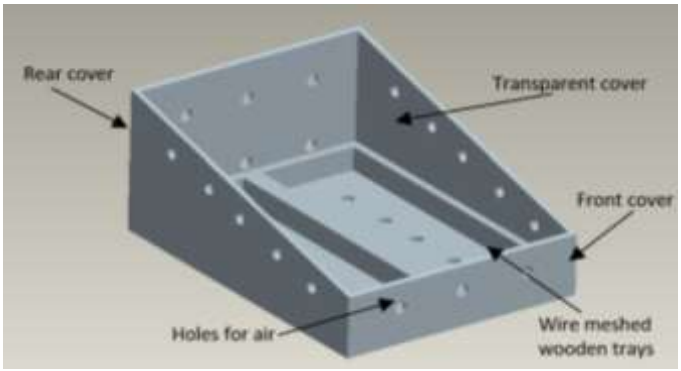
2) Adequate solar radiation is required.

3) It require more time for drying.

2. METHODS OF SOLAR DRYING TECHNOLOGIES

1) Direct Solar Dryer

In direct type solar dryer the solar radiation is directly absorbed by the agro products kept inside the dryer cabinet. This cabinet is also called as natural convection cabinet. The direct type solar dryer comprises of a solar drying chamber having compartments for storing products which is further covered by the transparent cover made of glass, plastic or acrylic sheet. Generally the structure of drying chamber is shallow insulated box with multiple air holes in it which allows circulation of air from atmosphere to the drying chamber. Fig shows the schematic construction of a simple direct type solar dryer.



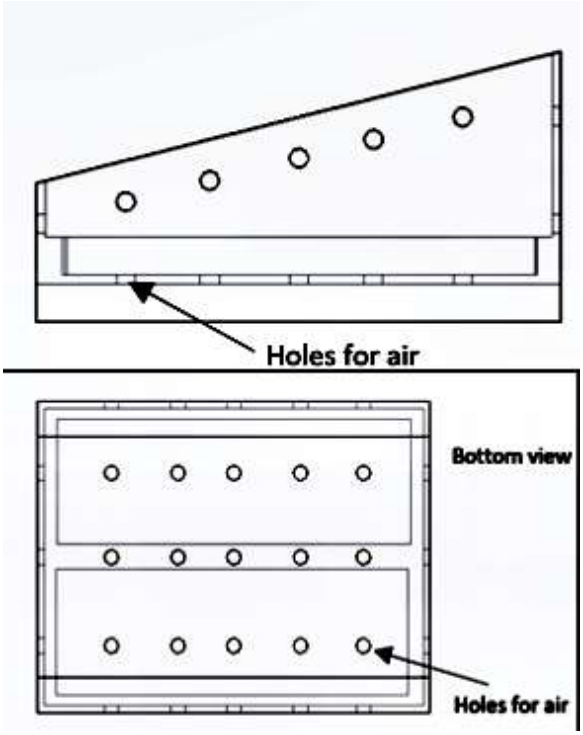


Fig.1 direct solar drying

(Natural convection type cabinet drier)

2) Indirect Solar Dryer

In Indirect type solar dryer, the air circulating inside dryer cabin is heated by solar radiation. Due to air heated in solar collector drying quality of agro products is improved with improvement in drying rate. The heated air is forcefully blown to the dryer chamber and the moisture in the cabin is escaped out using vents located at the top of the drying chamber.in this indirect type solar dryer a better control over drying is achieved. Below figure shows indirect solar dryer construction.

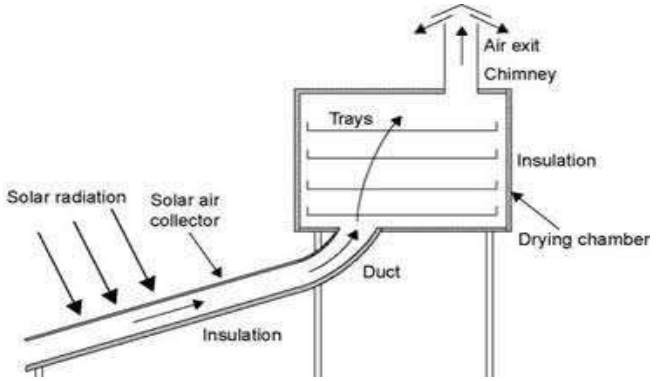


Fig.2 İndirect solar drier (Forced convection solar drier)[2]

3) Forced Convection and Natural Convection Solar Dryer-

Forced convection-In this type of solar dryer air is forced through a solar collector and the product is exposed by a fan or a blower, normally referred to as active dryer.

Natural convection– In natural convection type or passive dryers the circulation of air is takes place in natural way. The flow of heated air is transfer by temperature gradient.

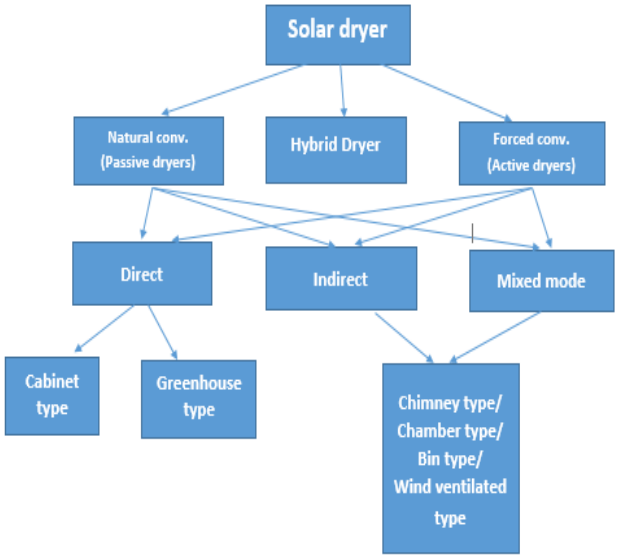


Fig.3 Classification of solar dryers and their drying modes.

3. SOLAR DRYER

Classification of Solar Dryer

Solar dryers are available in vivid categories of design and sizes for drying of vivid agro products. These dryers are mostly used by farmers thus these are easily available in agro markets. Solar dryer systems are classified on the basis of their operating temperature ranges that is High Temperature solar dryer and Low Temperature Solar dryer.Below criteria is required for the classification of solar dryer:-

1) Air circulation mode

2) Insulation exposure

3) Air flow direction& venting

4) Dryer compartment arrangement

5) Solar contribution

6) Type of product to be dried

3.1. Natural Circulation Solar Dryer

In case of natural circulation solar dryers the agro product are kept inside the cabin or hot box units. Where heating method is either direct or indirect type depend on the desired product quality. Generally heating is takes place by natural convection, solar radiation through the transparent glass or in a solar air heater. The natural circulation type solar dryers are less expensive in constructions, easy to install and operate.

3.1.1 Cabinet Type Natural Circulation Solar Dryer

Akash Ugale and Vishwas Mahajan remarked that the simple cabinet type solar dryer is a small box generally made from easily available wooden material. Front, Side and rear panel are provided Solar Dryer with holes for circulation of air and venting. The lower base of box is made from the wire mesh wooden trays and wooden flat plates.

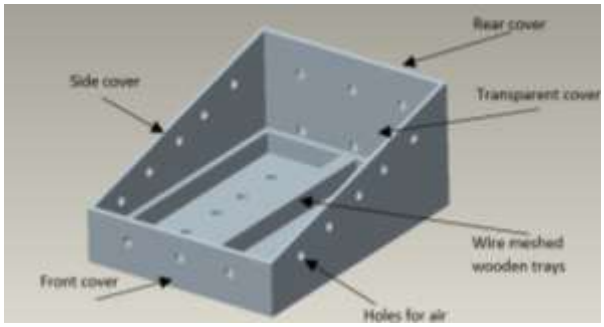
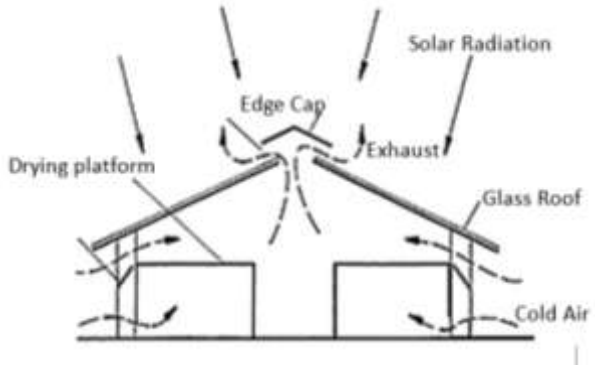


Fig. 4 Simple design of Cabinet Solar Dryer

3.1.2 Green House Type Natural Circulation Solar Dryer



Green house type solar dryers are used for large quantity products drying. As shown in above fig. the construction of glass roof green house type solar dryer. Here cold atmospheric air passes from two side walls and circulate throughout the product. chamber consist of length wise two parallel rows of drying sub chambers made up of galvanized iron wire mesh surface. It was laid over wooden beams. Glass roofs allow passing solar radiation over the product. Side walls are black painted which improves solar radiation absorption. Exit vents are provided on top most position.

Literature Review

Syed Mohammed Shamiq, P Sudhakar and M Cheralath

The two methods of solar drying by circulated air in the drying chamber. Due to these, the efficiency may vary. Experimental setup consist of solar dryring chamber and solar air collector. Different material are used like Aluminum, foam, glass, plywood, glass wool and UPVC pipe.For measuring the velocity of air they used anemometer and for measuring the solar radiation they use pyranometer. Two types of air circulation method are used. Air distributed through bottom of chamber -They got efficiency upto 19.2%.Air distributed from each tray separately – they got efficiency upto 22.6%.The second condition of air flowing chamber is better and more effective as compare to first condition.

Aditrana ,Ranchan Chauhan, MuneeshSethi, Amit Kumar

The tubular solar dryer is better than simple solar dryer. To built the experimental setup material used like plywood, Aluminum chip and aluminum tubes and for insulation thermocol and glass wool. Solar dryer is mixed mode forced convection type and collector is placed at an inclination angle of 32 degree.The product which are selected for drying products are Himalayan fig with pre treated 0.5% of ascorbic acid. Is found by using aluminum chips temperature rise from 15-25 degree as compare to simple absorber. Relative humidity reduced from RH66% to RH16% of product.

Ashish D. Chaudhari ,Prof. Sanjay P. Salve

Solar dryer is the different method to eliminate disadvantage of conventional drying method. Solar dryer is important process an applied on agricultural and industrial products. The method of solar dryer technologies areDirect solar drying, Indirect solar drying, Mixed made solar drying, Thin layer drying, Deep bed drying. It also classified solar dryer are Natural circulation dryer and Forced circulation dryer.A mixed made drying process is better than direct and Indirect drying process. It required less time for drying process. Natural and Forced circulation solar dryer used for limited quantity of production and greenhouse solar dryer used large quantity of product .

Jarineejongpluempiti, NattadonPannucharoenwong

Using of different angle he get different efficiency and temperature. The best inclination angle is 15 degree. By this angle get maximum temperature of 83.92 degree by using blower also increasing temperature and reducing time.

Majedulislam,Meheditusar

Basically drying is used for vegetables and fruits .There are three types of solar drying, Thin tube chimney tube chamber, Attic space type, Natural draft chamber. The best moisture removal rate is obtain in natural draft chamber i.e58.9% . It also observed that moisture removal rate after 1pm is higher

than before 1pm as solar irradiation was higher after 1pm in best performance days. The natural draft chamber was made of wooden. Therefore it is cheap to make and performance is better than other three chambers.

Hajaressalhi, Rachidtadilis

Solar air collector for indirect solar drying. they setup made of the absorber consist of two aluminum plates and also the two plates are air circulated the collector by using these solar dryer they get efficiency of drying chamber is 11.11% for drying purpose the product are pear which reduces the mass from 997.3 gm to 135.13gm.

Umeshtoshniwal, S.R. karate

Different types of solar dryer and classification of solar dryer by air movement mode, Insulation exposure, Air flow direction, Dryer arrangement, Solar contribution, Type of fruit to be dried and different types of method for dryer, Direct solar dryer, Indirect solar dryer, forced convection and Natural convection. Solar dryer is more efficient , safe and quick than conventional sun drying methods.

4. CONCLUSION

Solar dryer is one of the best alternative technology to avoid disadvantages of conventional drying methods. Generally solar dryer is designed for a particular crop and atmospheric conditions depend on location. Various types like mixed mode, natural circulation, forced circulation, green house type of solar dryer are reviewed with design parameters and performance. In mixed mode of drying the product may dry in less time compared to direct and indirect mode drying.

REFERENCES

[1] Syed MonammedShamiq, P Sudhakar, M cheralathan, "Experimental Study of a solar dryer with different flow patterns of air in the drying chamber", ICAME 2018.

[2] AditRana, Ranchan Chauhan, MuneeshSethi, "Experimental Investigation of the performance of tubular solar dryer", International advanced research journal in science, Engineering and technology CETCME-2017.

[3] Ashish D. Chaudhari , Prof. Sanjay P. Salve, " A review of solar dryer technologies", international journal of research in advent technology, vou.2, No.2, February 2014.

[4]JarineeJongpluempiti, Nattadon Pannuchar oenwong,"Design and construction of the flat plate solar air heater for spray dryer", International conference on Alternative energy in developing countries and emerging economies, may 2017.

[5] Majedul Islam, MdImrulLslam, MehediTusar, "Effect of cover design on moisture removal rate of a cabinet type solar dryer for food drying application", International conference on energy and power, ICEP2018,13-15 December 2018.

[6] HajarEssalhi, RachidTadili, M.N Bargach, "Conception of a solar air collector for an Indirect solar dryer. Pear drying Test.", International conference on power and energy systems Engineering, September 2017.

[7] UmeshToshiwal, S.R Karale, " A review paper on solar dyer" , International journal of engineering research and applications, vol.3, Issue2, March- April 2013.

[8] Isaac NyambeSimate, Sam Cherotich, " Desigh and testing of a natural convection solar tunnel dryer for mango", Hindawi journal of solar energy, volume 2017, Article ID 4525141.

[9] Jyoti Singh, "Review paper of study on solar dryer", Journal of Mechanical and Mechanics Engineering, Vol.1, Issue 1.

[10] SreedeviMadhavan, Dr. P N Ramachandran, "Design, Fabrication and testing of a solar paper dryer", International research journal of engineering and technology, Vol.2, Issue 4, July 2015.