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Review Article

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Review on Heat Convection Solar Drying in Dryer

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ABSTRACT

Solar is a renewable resources, sun give energy in the form of heat in food processing this solar energy is used to preserved the food product. Food drying is essential part of with the help of solar dryer preservation in agricultural applications. Early year we used open sun drying for different crop or food product but in modern age we use solar dryer. Using a solar dryer is comparatively cheaper; process is very easy, time consumable and more efficient. These review paper present different kinds of solar dryer that are more used in food processing sector in present era. This review paper also presents the related technologies that can help improve existing solar dryers. Weather conditions are not same in every place. Solar dryer is mostly dependent on the weather condition. When Sun shine is not greater than working efficiency of drying that we can say it is not work well. Solar dryer is mostly use for drying its means moisture remove from the food product.

Key word: *Renewable resources, Solar dryer, Food drying, Moisture remove.*

INTRODUCTION

India is the 2nd largest produce raw food fruit and vegetables, however said the country looses the annual 15-20% if these valuable food commodity due to in proper perform post harvest handling, storage and transportation. The annual economical loss on this account has been estimated at 40000 crore rupees farmer are through the produce marketing. is there why able appropriate and adoptable solution of this avoidable food and economy losses yes, one of the why able appropriate and adoptable solution at the village and farmable is solar dryer.

Solar dryer offers a lasting solution of farmer in preserving and adding value to produce, reduce the post harvest losses and enable higher revenue generation for their produce. Since the technology is based on solar energy. it further help the farmer with zero energy cost and help the society through batter protection of the environment besides making the process hygienic and safe. it reduce about 36288Kg CO2 emission gas per ton of fruit bar produced and safe about 1000MW of power. The conventional drying system to preserve fruits, vegetables, grains, fish, meat, wood and other agricultural products is sun drying which is a free and renewable source of energy.

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But, for large-scale production, there are various known limitations of sun drying as damage to the crops by animals, birds and rodents, degradation in quality due to direct exposure to solar radiation, dew or rain, contamination by dirt, dust or debris. Also this system is labour- and time intensive, as crops have to be covered at night and during bad weather, and have to be protected from attack by domestic animals. There is also a chance of insect infestation and growth of microorganism due to non-uniform drying. The advancement of sun drying is solar drying systems in which products are dried in a closed system in which inside temperature is higher [1]. Open air and uncontrolled sun drying is still the most common method used to preserve and process Agricultural product. But uncontrolled drying suffers from serious problem of wind born dust, infestation by insect, product may be seriously degraded to the extent that sometimes become market valueless and resultant loss of and have to the food quality may have adverse economic effects on domestic and international market. Dryers have been developed and used to dry agricultural products in order to improve s helf life[2]. Most of these either use an expensive source of energy such as electricity[3] or a combination of solar energy and some other form of energy[4]. Most projects of these nature have not been adopted by the small farmers, either because the final design and data collection procedures are frequently inappropriate or the cost has remained inaccessible and the subsequent transfer of technology from researcher to the end user has been anything but effective[5].

The solar dryer are versatile and fixable in handling brought very of fruit, vegetable, non timber forest produce and medicinal plants. The process enhances the value addiction of the product by retention of nutritional value and also increase.

Not all drying tasks are the same, not all material behaves in the same manner. When being dried different types of dryer are design are required for different tasks. Dryer can be divided into two groups based on the material being. There are also ways of removing moisture without the application heat.

With direct application of heat the material is usually dried directly over the heat source. with indirect application of heat the material is dried using air that has been previously heated by contact with heat.the indirect application of heat offers batter control over the drying process than can be achieved with direct heating.

- temperature of the control
- volumetric of the air
- direction of the air
- humidity

Solar dryer

solar dryer popular in light of rising energy costs, use heat from sun to warm air which then flow across surface of food being direct, highly depended on weather condition, may take excessively long time to dry the food product. Solar dryer are remove moisture from surface early in the drying process which is more rapid than moisture remove later.use caution in solar drying product. The sun is the primal energy producer of our solar system. Because of continuous nuclear fusion taking place in its core, a tremendous amount of energy is generated; a small fraction of the energy produced in the sun hits the earth and makes life possible on our planet. Solar radiation causes all natural cycles and activities such as rain, wind, ocean currents, photosynthesis and several other phenomena which are crucial for life. The entire world energy need has been based from the very beginning on solar energy[6,8].

Advantages of Solar Drying System

1) Better Quality of Products are obtained

2) It Reduces Losses and Better market price to the products.

3) Products are protected against flies, rain and dust; product can be left in the dryer overnight during rain, since dryers are waterproof.

4) Prevent fuel dependence and reduces the environmental impact

5) It is more efficient and cheap.

Disadvantages of Solar Drying System

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

2) Adequate solar radiation is required.
3) It is more expensive require more time for drying.

Limiting issues with solar dryer

• Can be only used during day time when adequate amount of solar energy is present.

• Lack of skilled personnel for operation and maintenance.

• Less efficiency as compared with modern type of dryers.

• A backup heating system is necessary for products require continuous drying.

Classification of solar dryers

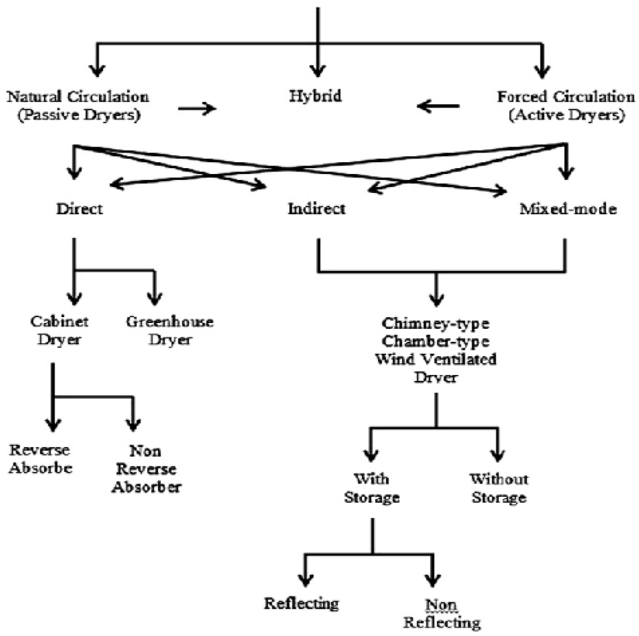

Fig. 1: Schematic diagram of solar dryer classification[9]

To classify the various types of solar dryers, it is necessary to simplify the complex constructions and various modes of operation to the basic principles. Solar dryers can be classified based on the following criteria:

- Mode of air movement
- Direction of air flow
- Arrangement of the dryer
- Status of solar contribution
- Insulation exposure
- Type of fruit to be dried

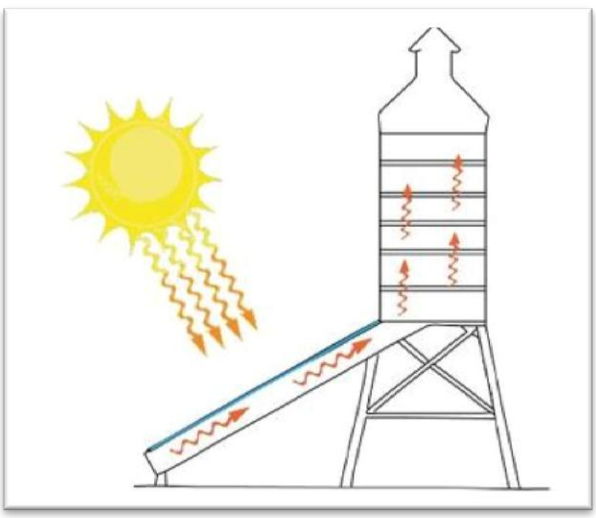

Fig. 2: solar dryer

These solar food dryers are basically wooden boxes with vents at the top and bottom. Food is placed on screened frames which slide into the boxes. A properly sized solar air heater with south-facing plastic glazing and a black metal absorber is connected to the bottom of the boxes. Air enters the bottom of the solar air heater and is heated by the black metal absorber. The warm airs rises up past the food and out through the vents at the top (see Figure 3). While operating, these dryers produce temperatures of 130–180° F (54–82° C), which is a desirable range for most food drying and for pasteurization. With these dryers, it's possible to dry food in one day, even when it is partly cloudy, hazy, and very humid. Inside, there are thirteen shelves that will hold 35 to 40 medium sized apples or peaches cut into thin slices.

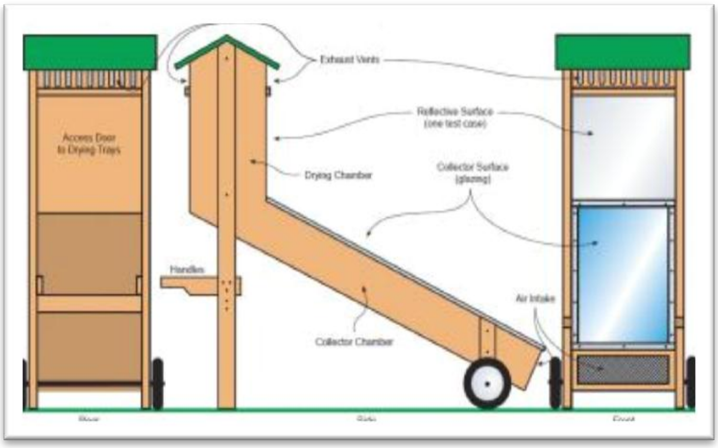

Fig. 3: Small natural convection solar dryer design[10]

The inside of the dryer is lined up with a black absorbing material or painted black. Cold air flows in at the bottom but the sun rays will heat up the drying chamber and the air in it. Warm air rises up and leaves the chamber. This natural air flow depends on the difference in height (pressure) between fresh air intake and hot air exhaust. The bigger the difference the faster the air flow.

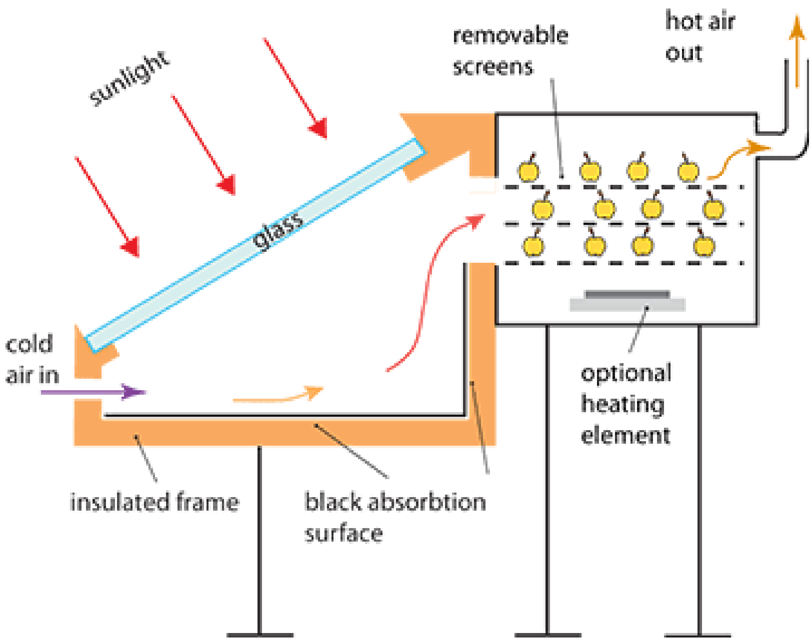

Fig. 4: step up design of the previous arrangement of dryer[11]

A typical distributed-type active solar dryer is shown in Figure 5. It comprises four components: a drying chamber, a solar energy air heater, a fan, and ducting to transfer the hot air from the collector to the dryer.

Large-scale, commercial, forced-convection, greenhouse-type dryers are like transparent roof solar barns and are used for solar timber drying kilns (see Figure 6). Small-scale forced dryers are often equipped with auxiliary heating.

Another variation of this type of dryer is the solar collector-roof/wall, in which the solar heat collector forms an integral part of the roof and/or wall of

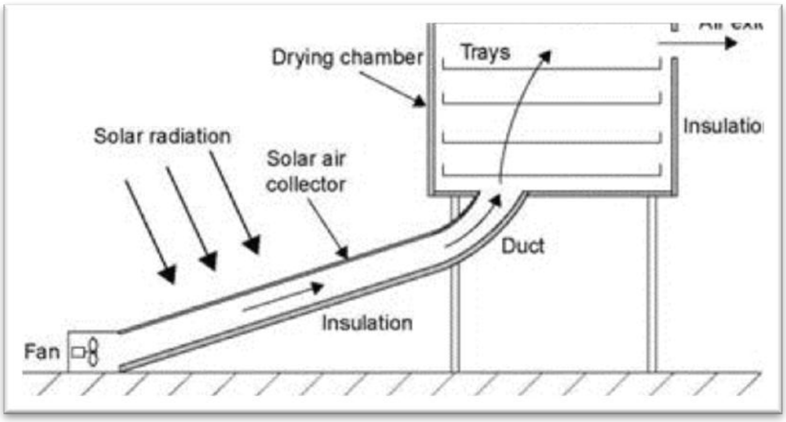

Fig. 5: Schematic diagram of a distributed-type active solar dryer[12]

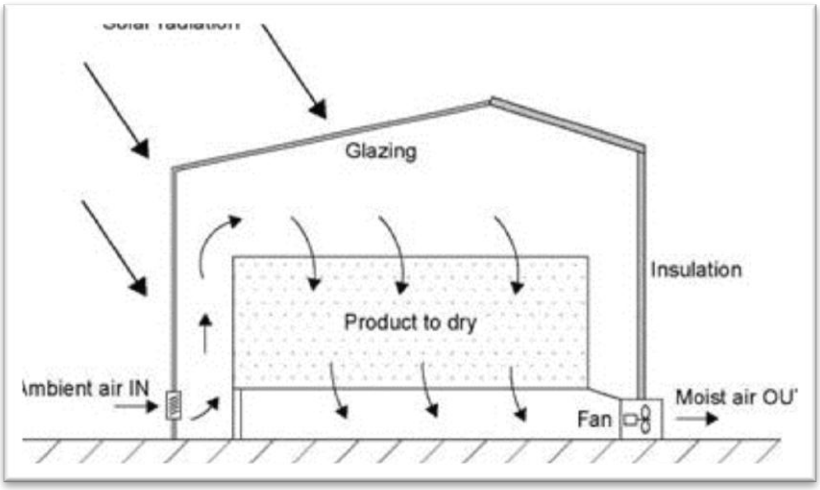

Fig. 6: Schematic diagram of a forced-convection, transparent-roof solar barn[12]

A.A. El-Sebaii[13] designed an indirect type natural convection solar dryer (Figure-7). The system consists of a flat plate solar air heater connected to a cabinet acting as a drying chamber. The air heater is designed to be able to insert various storage materials under the absorber plate in order to improve the drying process. Sand is used as the storage material. They conducted drying experiments with and without storage materials for drying various fruits. They found that the equilibrium moisture content for seedless grapes was reached after 60 and 72 h when the system is used with and without storage material, respectively. Therefore, the storage material reduced the drying process by 12 h. In order to accelerate the drying process, they divided products into pieces and then chemically treated them by dipping the samples into boiling water containing 0.4% olive oil and 0.3% NaOH for 60 s. However, the required time to achieve required moisture for the chemically treated seedless grapes, when the system is used with sand as a storage material, is drastically reduced to 8 h. They finally concluded that system is capable of drying 10 kg of chemically treated grapes or green peas during 20h of sunshine.

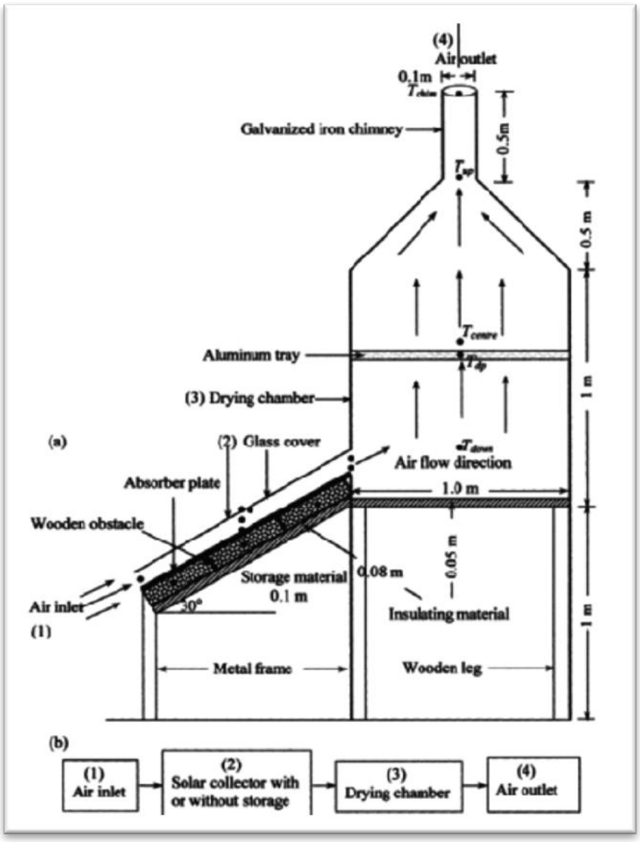

Fig. 7: (a) Cross-sectional view of the indirect type natural convection solar dryer; (b) Air flow diagram

R. K. Aggarwal[14] developed an indirect solar dryer for drying of hill products (Figure-8). The solar dryer of 25kg capacity was attached with a solar cell for running the fan. Bulbs were also provided in the solar collector for heating air during cloudy days, evenings and mornings for faster drying, thereby reducing the drying time. He also compared the market value of the dried products. Figure-18. Actual setup of indirect type solar dryer developed by R. K. Aggarwal[14].

Fig. 8: a) Schematic view b) Pictorial view of forced circulation solar dryer for hill products

The use of solar energy in recent years had reached a remarkable edge. It had become even more popular as the cost of fossil fuel continues to rise. A study was undertaken to develop a natural circulating solar dryer and evaluate its performance with Open sun drying. The drying experiments were carried out at lab VSAET, SHIATS Allahabad. The performance of the dryer was evaluated by drying samples of potato. This solar drying system consisting of two parts, solar collector and solar drying cabinet. In this experiment two solar collector were joined in series. Solar collector with area of 0.97 m2 (1.06 m x 0.91 m x 0.19 m) had placed black marble, area of marble 0.64 m2 (0.76 m x 0.84 m), angle of frame was 370 and float glass of rectangular shape had thickness 0.008 m to absorb solar radiation and there are 4 hole in each collector it size was 0.075 m. A cabinet that was divided into two divisions separated by two removable shelves. Each shelf was 0.36 m width and 0.53 m length and made of wire mesh framed. Three sides of the drying chamber walls were covered by tin sheet (0.0011 m) and a door in the back. The highest temperature inside the cabinet significantly elevated compared to environmental air with temperature increases of up to 55°C and 66°C depending on air flow and loading. Loading tests conducted with an average of 100g of potato slices resulted in effective drying within one days from a moisture content of 86.8% (wb) down to approximately 1.02% (wb) for modified natural circulating solar dryer of operation respectively. These results indicated sufficient drying and preservation of potato slices within one day of sunlight. It was found that the dryer was suitable for drying of potato slice[15].

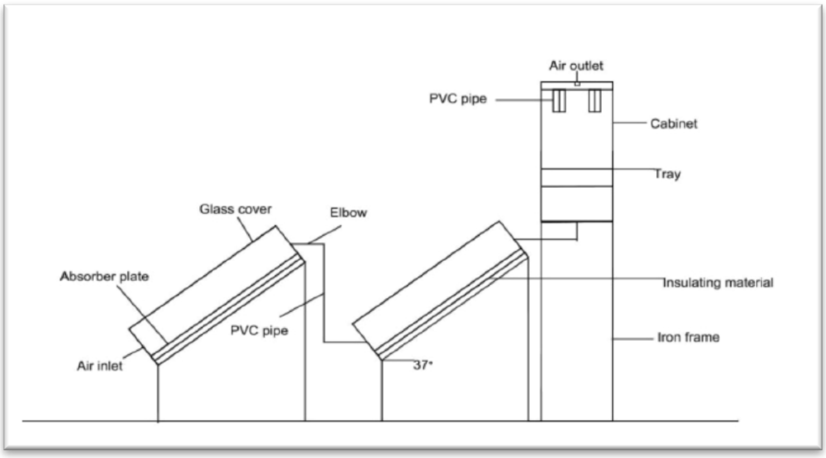

Fig. 9: Cross-sectional view of the modified natural circulating solar dryer

Government Initiatives to Promote Solar Dryers in India

In Tamil Nadu, Farmers who buy solar driers are eligible for a 50 per cent subsidy under the National Agricultural Development Programme. Farmers can set up solar driers either individually or as a group. The minimum area required for setting up the solar drier is 400 sq ft. The cost of a drier is about 3.68 lakh. The subsidy shall not exceed Rs. 1.84 lakh.

Farmers of Krishnagiri, Pochampalli, and Uthangarai shall apply to the Assistant Executive Engineer, Agricultural engineering department, 311, Phase I, Tamil Nadu Housing Board, near Krishangiri All Women's Police Station, Krishnagiri.

Farmers of Denkanikottai, and Hosur, may apply to the Assistant Executive Engineer, Agricultural Engineering department, Rayakottai road, Sanachathiram, Hosur[16].

Jawaharlal Nehru National Solar Mission (JNSSM) was launchedon the 11th January, 2010 by the Prime Minister to encourage ecologically sustainable growth while dealing with India's energy security challenges. The objective of the JNNSM is to establish India as a global leader in solar energy, by creating the policy conditions for its promotion[17].

CONCLUSIONS

This review paper is focused on some direct and in direct solar dryers. In this study we know how indirect and direct solar dryers different in design, manufacturing , uses, modification on the basis of food product and collector design modifications applied to them has been performed. Paper also shown that some low cost for manufacturing, assemble the fabricate part is very easy and easy to operate, that can be suitably for employed in small yield industries. Some advantage and disadvantage of dryer are dependent on such as weather, temperature and time, product thickness.

However, to further improve the effectiveness of these dryers and to keep them continuously operational.

Combination of such different techniques must be developed in one single unit while keeping the overall cost minimal.

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