

Development of Solar Dryer System

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Abstract -

In this presentation a review of the solar dryer is presented. The world population is more than 6 billion and about 20-25 percent people does not have enough food to eat. It has been estimated that world as a whole more than 25-30 percent food grains and 30-50 percent vegetables, fruits etc. are lost before it reaches to the consumers. To overcoming spoiling problems of vegetables, food grains and fruit; various preserving methods are used and renewable sources are best for this purpose by which we can save energy for preservation and keeping the product in their natural flavor. A solar dryer is an enclosed unit, which is used to dry agricultural products. It is also required to keep the food safe from damage, birds, insects and unexpected rainfall. Solar dryers, also known as dehydrators, have been used throughout the ages to preserve grains, vegetables and fruits by removing moisture. Solar dryers can be made locally of any size and capacity and solar dryers are economical if cash crops are dried. The various design of the solar dryer is reported in the literature thus far is presented.

Keywords: *Solar energy, Air dryer, Battery, Temperature sensor etc.*

INTRODUCTION

Open sun drying is simple and economical but suffer from many drawbacks such as no control over drying rate, over drying of crop, discoloration by UV, attack of insects and fungi, unfavorable weather etc. In general, open sun drying does not fulfill the international quality standards and therefore it cannot be sold in the national and international market. Other method direct drying is also having disadvantages such as,

- a) Small capacity
- b) Discoloration of food inside the dryer
- c) Moisture condensation inside glass covers
- d) Insufficient rise in food temperature.

In an indirect drying system problem due to direct exposure of sun is avoided by the used solar energy into electrical energy. Which will be further utilized to operate air expose unit and heating unit, closed chamber, problem of discoloration and cracking of the product is also very low in indirect dryers.

Separate air expose unit with heating function feed the high temperature humid free air to drying chamber. Hence moisture evaporation is faster in indirect drying system. In an indirect type solar dryer heat losses can be minimize by insulating the drying chamber.

Citrus fruits are agricultural products that are known for their rich vitamins, high concentration of moisture and low fats. These are seasonal crops and are mostly available during the production season. The demand for citrus fruits by the growing population has not been met despite the increase.

This is as a result of wastes that result from biological and biochemical activities taking place in the fresh product and unfavorable storage conditions, inefficient handling, transportation, inadequate post harvest infrastructure and poor market outlets. Sun drying is still the most common method used to preserve agricultural products like grains and vegetables in most tropical and subtropical countries.

This project presents the design and construction of a solar dryer for drying such food, which is very important for all social women's who work on such products, The dryer is composed of solar panel , the high speed air allowed in

through air inlet inside the insulated box. In the solar collector chamber and channeled through the drying chamber where it is utilized in drying (removing of the moisture content from the food substances or fruits and vegetables product which is loaded in it). In this way of concept portable solar based machine is used to remove the moisture contain form fruits and vegetables easily within less time.

PROBLEM IDENTIFICATION

Drying is one of the oldest methods using solar energy where the products such as vegetables, fruits, fish, and meat, etc to be dried exposed directly to the sun. This method has many disadvantages such as spoilt products due to rain, wind, dust, insect infestation, animal attack and fungi. The speed of drying especially in open sun drying which is solar radiation exposed directly to the products will cause the product's surface becomes hard before the moisture inside has a chance to evaporate and it will affect the quality of dried product due to over drying. Open sun drying also suffers from a high labor requirement and excessive food specially vegetables & fruits handling particularly in periods of inclement weather which can result in high costs, crop damage and a loss in quality. In this study, the renewable solar energy based portable dryer was designed to solve this problem and will adapt the ergonomics criteria and produce a better quality product.

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OBJECTIVE

The objective of this work is to design, develop and evaluate performance of an indirect solar dryer fruits and vegetables prototype model in a passive and active mode using solar energy and battery unit.

The design of a functional solar dryer system would minimize all disadvantages. This design of both modes was employed and has compared with the performance testing through parameters such as temperature, air velocity, collector efficiency and weight loss.

It was shown that the use of this type of solar dryer reduced the drying time significantly and essentially provide better product quality compared with conventional drying method. The effect of temperature to moisture contents against time and rate of drying are studied in this research.

There are two main objectives to achieve in this research which are:

- i. To study a characteristics and performance of the solar dryer system.
 - ii. To develop a solar dryer system for fruits and vegetables drying.
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LITERATURE REVIEW

- In many parts of the world there is a growing awareness that renewable energy has an important role to play in extending technology to the farmer in developing countries to increase their productivity (Waewsak, et al., 2006).
- Solar thermal technology is a technology that is rapidly gaining acceptance as an energy saving measure in agriculture application. It is preferred to other alternative sources of energy such as wind and shale, because it is abundant, inexhaustible, and non-polluting (Akinola 1999; Akinola and Fapetu 2006; Akinola et al., 2006).

- Solar air heaters are simple devices that heat air by utilizing solar energy and are employed in many applications requiring low to moderate temperature below 80o C, such as crop drying and space heating (Kurtbas and Turgut, 2006).
 - Drying processes play an important role in the preservation of agricultural products, they are defined as a process of moisture removal due to simultaneous heat and mass transfer (Ertekin and Yaldiz, 2004).
 - (Bassey, 1989; Togrul and Pehlivan, 2004) Traditional drying, which is frequently done on the ground in the open air, is the most widespread method used in developing countries because it is the simplest and cheapest method of conserving foodstuffs. Some disadvantages of open air drying are: exposure of the foodstuff to rain and dust; uncontrolled drying; exposure to direct sunlight which is undesirable for some foodstuffs; infestation by insects; attack by animals; etc (Madhlopa, et al., 2002).
 - In order to improve traditional drying, solar dryers which have the potential of substantially reducing the above-mentioned disadvantages of open air drying, have received considerable attention over the past 20 years (Bassey, 1989).
 - Soponronnarit (1995) reviewed the research and development work in solar drying conducted in Thailand during the past 15 years (since 1980s). He found that, in terms of techniques and economy, solar drying for some crops such as paddy, multiple crops and fruit is feasible. However, the method has not been widely accepted by farmers. Most of the solar air heaters developed in Thailand has used modifications to the building roofs. Both bare and glass-covered solar air heaters were reported to be technically and economically feasible when compared to electricity but have not been able to compete with fuel oil.
 - Bahnasawy and Shenana (2004) developed a mathematical model of direct sun and solar drying of some fermented dairy products (kishk). The main components of the equations describing the drying system were solar radiation, heat convection, heat gained or lost from the dryer bin wall and the latent heat of moisture evaporation. The model was able to predict the drying temperatures at a wide range of relative humidity values. It also has the capability to predict the moisture loss from the product at wide ranges of relative humidity values, temperatures and air velocities.
 - Enein (2000) reported a parametric study of a solar air heater with and without thermal storage for solar drying applications. An optimization process for a flat-plate solar air heater with and without thermal storage was carried out. Three kinds of material for thermal storage were used, i.e. water, stones and sand.
 - Pangavhen, et al. (2002) proposed a design, development and performance testing of a new convection solar dryer, the solar dryer is capable of producing average temperature between 50 and 55°C, which was optimal for dehydration of grapes as well as for most of the fruits and vegetables.
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EXPERIMENTAL BLOCK DIAGRAM



Fig. 1. System Diagram of system

WORKING PRINCIPLE

- The designed and constructed solar dryer consists of two major compartments or chambers being integrated together, the solar power generation unit and Air dryer heating compartment unit, which can also be referred to as the air heater, and the drying chamber, designed to accommodate single layers of drying trays on which the produces (fruits and vegetables) are placed for drying.
- Solar panel converts the solar energy into electrical energy. This energy is transferred through charge controller (use for indication of charging) to battery unit.
- The stored energy is utilised and operate all function in this machine. To operate various function we attached the control board. Function like, High speed exhaust fan, solar panel, battery, glass, container etc. Can be control from this control board.
- When any product is placed on tray, the slider is pulled down to place the product over it. And push it back. After it switch ON the all function inside the insulated box.
- There is small glass window, to see all operation inside it. The moisture contain in fruits and vegetables is soak out rapidly with the help of exhaust fan. And in few time fruits and vegetables is in dry state.
- In this way, solar powered portable fruits and vegetables drying system work effacingly with use of renewable energy source.

APPLICATION

1. Agricultural Sector: Solar air dryers are extensively used in the agricultural sector for drying crops, fruits, vegetables, grains, and herbs.
2. Food Processing Industry: They are employed in food processing industries for drying various food products like spices, herbs, and grains.
3. Timber Industry: Solar air dryers find application in the timber industry for drying wood and timber products.
4. Textile Industry: They are utilized in the textile industry for drying fabrics, yarns, and garments.
5. Pharmaceutical Industry: Solar air dryers are used in the pharmaceutical industry for drying medicinal herbs and plants.
6. Industrial Applications: They are also employed in various industrial processes for drying chemicals, minerals, and other materials.

SCOPE

1. **Energy Efficiency:** Solar air dryers offer a sustainable and energy-efficient solution for drying applications by utilizing solar energy, which is abundant and renewable.
 2. **Cost-Effectiveness:** They help in reducing operational costs associated with drying processes by utilizing free solar energy, thereby minimizing reliance on conventional energy sources.
 3. **Environmental Sustainability:** Solar air dryers contribute to environmental sustainability by reducing greenhouse gas emissions and dependence on fossil fuels.
 4. **Scalability:** These systems can be scaled up or down based on the drying requirements of different industries and applications.
 5. **Versatility:** Solar air dryers can be adapted to different climates and geographic locations, making them suitable for use in various regions across the globe.
 6. **Innovation:** Ongoing research and development in solar air drying technology continue to expand the scope of applications and improve the efficiency and effectiveness of these systems.
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ADVANTAGES

1. **Renewable Energy Source:** Solar air dryers utilize solar energy, which is a clean and renewable energy source, reducing reliance on fossil fuels.
 2. **Low Operating Costs:** They have low operating costs as they harness free solar energy for drying, resulting in cost savings over time.
 3. **Reduced Environmental Impact:** Solar air dryers help in reducing carbon emissions and environmental pollution associated with conventional drying methods.
 4. **Improved Product Quality:** Drying with solar air dryers can help maintain the quality, nutritional value, and flavor of dried products compared to other drying methods.
 5. **Minimal Maintenance:** These systems require minimal maintenance and have long lifespans, making them cost-effective and reliable solutions for drying applications.
 6. **Independence from Grid Power:** Solar air dryers offer independence from grid power, making them suitable for remote and off-grid locations where electricity supply may be unreliable or unavailable.
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CONCLUSION

The solar dryer can raise the ambient air temperature to a considerable high value for increasing the drying rate of agricultural crops. 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 various products, it can be used to dry other food products also. 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. Also from the test carried out, the simple and inexpensive solar dryer was designed and constructed using locally sourced materials.

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