



A Review on Solar Dryers and their Applications

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ABSTRACT

The paper details a solar drying system for agricultural products. This system reduces waste and supports community health. These solar dryers are used to preservation of agricultural crops, dehydration of fruits and vegetables and etc...Local materials were used for construction. The development of this cost-effective solar dryer with thermal energy storage offers a sustainable alternative to fossil fuels, addressing energy needs in both rural and urban areas these rural and urban people depend mainly on non-commercial fuels to meet their energy needs. These solar energy storages can reduce the time between energy supply and energy demand. The review also covers research on thermal energy storage in solar dryers. And plays a vital role in energy conservation. So that, solar dryers with storage unit is very useful for the humans and as well as the environment. Therefore, solar dryers are essential for preserving the crops and various industries such as food, vegetables, meat, milk and textile drying.

Introduction

In many rural areas in Africa and other developing countries, electricity and supplies of other non-renewable sources of energy are unavailable for many farmers, too expensive. And the initial cost of the fossil fuels also large in cost Thus, in such areas, crop-drying systems are insufficient.

The Earth has plenty of solar energy. The use of solar energy has become popular. Solar energy can be used in various processes like drying, heating, and cooking. It is classified into electrical and thermal applications. And these solar thermal systems are used to conserve grains, fruits, and vegetables in an economical and ideal for farmers in some developing countries.

The solar drying technology is used in agricultural field to preserve crops, food, fruits, seeds and vegetables, and has been proved economic as well as eco-friendly. In many countries, solar drying is used extremely for drying the crops. The energy can be used in the various processes such as to generate electric power, heating, drying, etc.

The major barrier in adoption of solar dryers is their cost. Tara Chandra Kandpal, Atal Kumar and Pallav Purohit analysed how solar dryers fare economically compared to open sun drying and found that solar drying of agricultural products appears to be financially crops and it may even be possible to justify the use of high cost solar drying systems. And it is possible to develop low cost solar dryers from local materials.

Food is the basic need of every humankind. It is difficult to keep balance between the food production and usage due to increasing population of world. Solar drying is the option for drying of food. Industrial drying is another solution for drying but it costs more. Large amount of fossil fuel is required, which may cause pollution. In India, food or crop is cultivated in large amount by farmer but they do not get appropriate price due to large production.

LITERATURE REVIEW:-

Drying is an important post handling process of agricultural produce, drying under controlled conditions of temperature and humidity helps the agricultural products to dry rapidly to safe moisture content and quality of the product. Controlled drying is practiced mostly in industrial drying processes, which uses large quantities of fossil fuels.

Rapidly increasing population in world has created food problems for the entire population. Because there is a shortage of storage facilities and poor processing techniques, the quality and quantity of food grains are continuously decreasing. Therefore, it become mandatory to reduce food losses and maintain balance between food supply and population growth. And in rural areas it is difficult to maximizing the food production capabilities of small farmers.

The basic need of drying is to reduce the moisture content of the product to a certain level that controls degradation within a certain period of time, normally regarded as the safe storage period. Solar drying is mainly involving in the extraction of moisture from the product. It is a dual process of heat transfer to the product and mass transfer of moisture to the surrounding atmospheric air.[1]

1. Solar dryers

Solar dryers are mainly categorized as indirect or direct and open sun drying. This gives precision outcomes such as good product quality and dust-free results. These solar dryers can operate through natural or forced convection methods each impacts the overall efficiency. Natural convection dryers with an efficiency range of 20 to 40%. Forced convection dryers with an efficiency range of 60% to 80%. Further solar dryers integrate Thermal Energy Storage systems such as sensible heat or latent heat storage units. These thermal energy storages are good and gives precision product quality and much harmful for environmental conditions. [8]

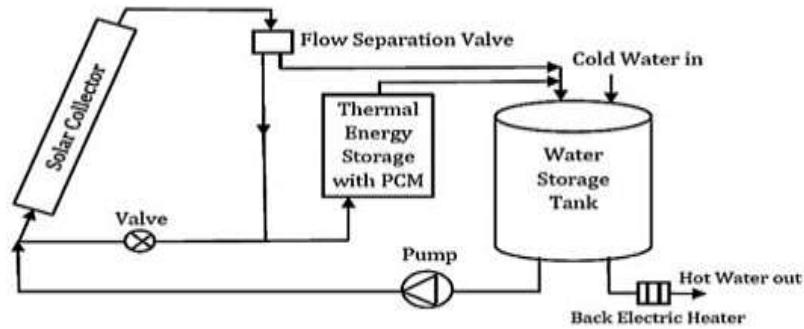


Fig 1 Thermal energy storage system[11]

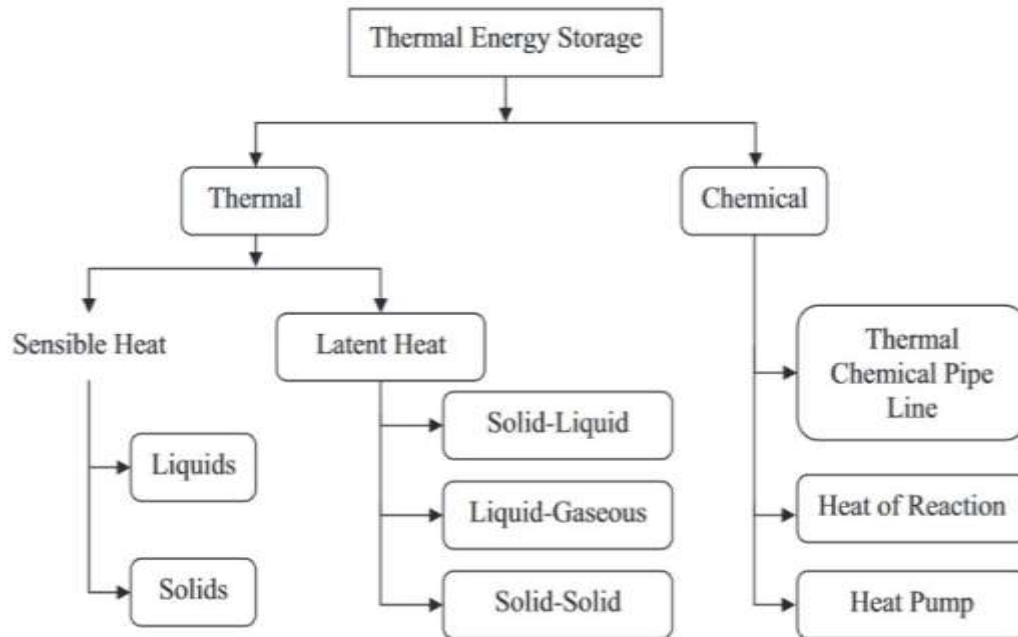


Fig 2 Different types of thermal energy of solar energy[9]

2. Types of solar dryers

1. Open sun drying

It is the most common drying method used in equatorial region countries involving in spreading the crop into thin layers, and exposing the product to air and sun. The open sun drying process is not suitable for large amounts of products. Open sun drying depends on environmental conditions, such as solar radiation, wind, and other atmospheric conditions. As the open sun drying process is very slow and few losses will occur such as, growth of micro-organisms and insect's infection which leads to reduction in product quality. To overcome those losses these are replaced by the mechanical dryers and etc...

2. Direct solar drying

Solar drying is comparatively better than the open sun drying. In this type of drying small amount of fruits, crops, and vegetables have been developed, by using available materials by the farmers in the rural areas themselves. In this solar drying process, a transparent cover is used to reduce heat losses and protect from rain and dust. In many countries, 20% of farmers are able to produce 80% of crops during production time.

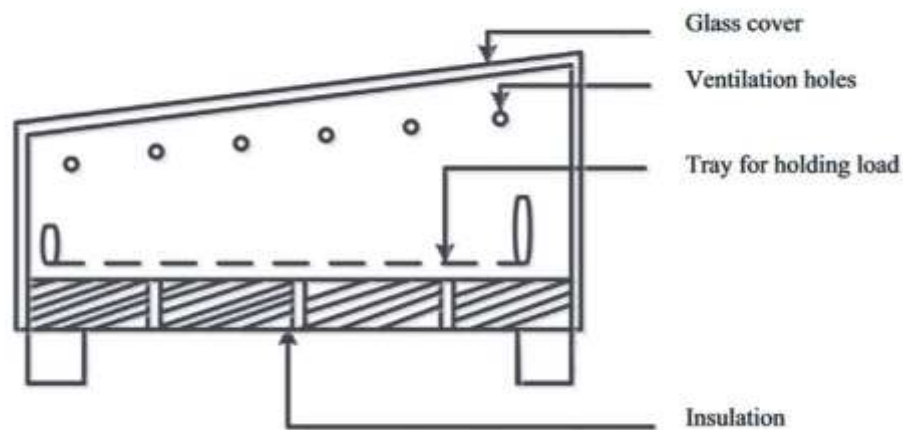


Fig 3 Direct solar dryer[2]

3. Indirect solar drying

In this indirect solar drying system heat source from the sun is first collected by the solar collectors and is then passed to the dryer cabinet, the place where the drying occurs. The solar air that enters the chamber is heated and is then made to pass through over the wet crops. The basic concept of collector is used to dry food products. Here, a solar air heater is used to heat the air which enters the chamber. The heated air then turns into warm air, which passes through an outlet. This kind of dryer is better than other dryers in terms to overcome the various limitations.[2]

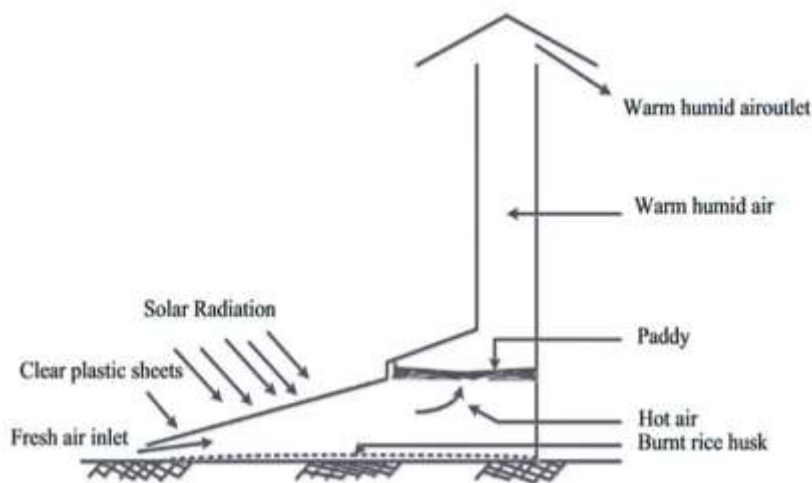


Fig 4 Indirect solar dryer[2]

Classification, advantages and disadvantages of the types of solar dryers.

Classification: -

- Passive dryers
- Active dryers
- Hybrid solar dryers

Advantages: -

- Simplest
- Low capital
- Independent of the ambient climatic conditions
- Better control of drying

- Faster than passive and active dryers

Disadvantages: -

- Low capacity
- More complex
- Expensive than passive dryers
- May cause fuel and gas dependence.[3]

Construction

These solar drying machines are generally constructed by wood because it is light in weight and easily available and low in cost. The major construction works of solar food dryers is carpentry works. The following tools were used in the carpentry works are

- Carpenter's pencil.
- Steel meter rule.
- Vernier calipers
- Angle plate
- Steel square
- Scriber.
- Hand saws
- Wood chisel
- Jack plane
- Mallet
- Hammer
- Pinch bar and pincers.

The construction was sequenced as the following.

- Marking out the sheets to cut into the desired shapes and sizes.
- Cutting out the marked parts neatly.
- Planning of cutting out parts to smooth the surfaces.
- Fastening and combining of the cutting out parts with nails and glues.
- The metal sheet which is used was Aluminium of required thickness.
- It was cut to the desired size of to minimize the heat loss.
- It was painted black colour for maximum absorption of heat energy and radiation.[6]

Materials used for solar dryers

Different authors and many other researchers have designed and developed the solar dryer with different materials. Materials used for the solar dryers are wood, cast iron ,aluminium sheet and hybrid composite. The insulating materials which are used in solar dryers plays an important role in the solar drying system. Cast iron is mostly used as a storage in the dryer for the storage of the hot fluid.[7]

Types of Solar Greenhouse Dryer

Greenhouse dryers are classified based on the mode of heat transfer 1. greenhouse dryer under natural convection and 2. greenhouse dryer under forced convection. The greenhouse dryer under natural convection works on the principle of thermosyphic effect. Air gets out through the chimney. In greenhouse dryer under forced convection the humid air is gets out by the help of an exhaust fan which is at the ventilator.[10]

Applications of different solar dryers

- It is more efficient in drying small amounts of crops, fruits, and vegetables.
- A locally made indirect-type natural convection dryer is useful for drying fruits and vegetables in rural areas.
- A solar dryer can be used for drying jackfruit bulbs and leather.
- The mixed-mode dryer is cheap, readily available, and can be easily made by local farmers.
- The forced convection solar dryer is used in small firms with limited sources.

Conclusion:-

This paper tells about the design and application of different types of solar dryers available in nowadays. And focuses on solar dryer models which are sufficient to produce better quality dried products. This review focuses on industries where drying is involved during their production processes. The essential drying factors for all the industries were moisture content of the product, humidity of drying air, temperature and location. The solar dryers assisted with thermal energy storage systems helps to reduce the total time required for drying. Solar drying techniques are a sustainable method for preserving food and agricultural products. This is eco-friendly and beneficial in regions with abundant sunlight and limited access to electricity. Solar drying helps us to retain the nutritional value and making it a valuable practice for communities to improve food security and reduce waste.

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