SOLAR CROP DRYER

PROJECT REPORT 2022-2023

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BONAFIDE CERTIFICATE

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SOLAR CROP DRYER

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In the near future the present energy conversion system will change drastically due to lack of conventional fuels. Hence solar energy will play a prominent role. Food is a basic need of human beings after water and air. Food holds a key position in the development of a country. In India, almost all crops have to be dried except fruits and vegetables which are mostly consumed fruits. Usually the crops are dried by traditional methods of open sun drying which cause adverse effects due to dust, rain, wind and insects which result in the quality of dried crops being low.This project deals with design, fabrication & testing of low cost solar dryers incorporated with heat pipe technology. Heat pipes are the most effective heat transfer device that transfers heat with minimum heat loss. The trapping of solar energy effectively & transferring to the crop with minimal losses is done by heat pipes. The crop dryer is designed in such a way to fit for various crops where the operating temperature differs from one another. It is a low cost solar dryer which enhances the effectiveness of solar drying. It also reduces dry matter losses & the qualities of dried products are improved The project consists of glass plate, and blower

CHAPTER-1

INTRODUCTION

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In the near future the present energy conversion system will change drastically due to lack of conventional fuels. Hence solar energy will play a prominent role. Food is a basic need of human being after water and air. Food holds a key position in the development of a country. In India, almost all crops have to be dried except fruits and vegetables which are mostly consumed fruits. Usually the crops are dried by traditional methods of open sun drying which cause adverse effects due to dust, rain, wind and insects which result in the quality of dried crops being low. The losses range from 10% to 25%. This can be prevented by introducing a low cost solar dryer. The drying of food material is primarily a low temperature operation as higher temperatures are likely to result in destruction of nutrients and flavor of the food. The recommended values of drying temperatures for various food materials are shown in the below table.

CHAPTER-2

LITERATURE REVIEW

CHAPTER-2

LITERATURE REVIEW

Crop drying is the most energy consuming process in all processes on the farm. The purpose of drying is to remove moisture from the agricultural produce so that it can be processed safely and stored for increased periods of time. Crops are also dried before storage or, during storage, by forced circulation of air, to prevent spontaneous combustion by inhibiting fermentation. It is estimated that 20% of the world‘s grain production is lost after harvest because of inefficient handling and poor implementation of post- harvest technology, says Hartman‘s (1991). Grains and seeds are normally harvested at a moisture level between 18% and 40% depending on the nature of the crop. These must be dried to a level of 7% to 11%

II. Design of Solar Crop Dryer

The design involves the following step

1. Design of glass collector.

The glass plate collector consists of 1 heat glass plate collector heat carrying capacity

The following are the specifications of a glass collector

Total length of glass plate	1500 mm
Length of heat pipe	26.5 mm
Thickness of heat pipe	1 mm

2. Estimation of air flow rate.

The blower with the following specifications is required

speeds	4000 RPM
Voltage required	12V
Current required	2 A
Frequency range	50 -60Hz
Wattage amount	500 W

3. Design of drying bed & outer MS box

The dryer box will be made of mild steel with dimensions of 26.5cm x 31cm x 30cm.The box contains an exhaust chimney at the left top corner for exhausting the air. The front part of the box will contain the heat glass condenser section. Another small box of dimensions 26.5cm x 31cm is provided inside the main box for the purpose of heating the stagnant volume of air.

The drying bed contains two trays. One tray with coarse size mesh holes and another tray with fine mesh holes. The drying bed is used to support the crops by hot air. The trays will be made of mild steel.

4. **Design of glass plate collector**
    - Estimation of moisture content of the crop
    - Amount of water to be evaporated
    - Heat required for evaporation of water
    - Heat transfer capacity of heat pipe
5. **Design of Heating System**

Ambient air temperature	: 30°C
Relative humidity	: 70%
Initial moisture content of chilly	: 60%
Final moisture content of chilly	: 30%
Inlet grain temperature	: 30°C
Outlet grain temperature	: 45°C
Latent heat of vaporization of water	: 2500 kJ/kg
Specific heat of chilly	: 1.25 kJ/kg
Specific heat of water	: 4.184 kJ/kg

6. **Moisture Balance**

Weight of chilly to be dried	1 kg
Moisture content of chilly	60% dry basis Weight of moisture present (1 x 30)/100 0.3 kg
Bone weight of dry chilly	(1-0.3) = 0.7 kg
Amount of water to be evaporated	0.7 x (60 – 30) /100 = 0.21 kg
7. Heat Balance	

Sensible heat gained by chilly	bone dry weight x specific heat x temperature difference 0.7 x 1.25 x (45 -30) 13.12 kJ
Sensible heat gained by moisture present in the grain	12.5 kJ
Heat utilized for evaporation of water	weight of water evaporated x latent heat of vaporization 0.21 x 12.5 = 2.62 kJ
Total amount of heat to be removed	13.12+12.5+2.62 = 28.24 kJ
Assuming a loss of 20%	
Final heat to be removed	28.24/0.8 = 35.3 kJ
Total heating capacity required for removing the moisture from 1 kg of chilly	35.3/(30*60) = **0.0196 kW**

III. Solar Drier Specifications

Components	**Specifications**
Heatglassplate	1 glass plate
Blower	220V, 50Hz ,600W ,0-13000 RPM, 2.3 m3/min
Mild Steel box	Size = 820 * 400 * 450 mm box with exhaust chimney, 170 * 170 cm outer frame,
Drying Bed	2 trays of 24x29 mm size with fine coarse mesh

IV. Experimentation

The blower is initially adjusted to the required speed. The gate valve 1 is closed to attain the required speed. After attaining the required speed the gate valve 2 is opened. The samples to be measured are arranged in a tray. The entire set up is kept in a place where the solar exposure is more.

OBJECTIVE OF SOLAR CROP DRYER

The objectives of this project are:

- To create 2D and 3D models of solar crop dryers.
- To design and construct a solar dryer.
- To evaluate the solar dryer's performance
- To protect the product against flies, pests, rain and dust.
- The product can be left in the dryer overnight or during rain.
- To achieve better quality of product in terms of nutrients, hygiene and color.
- To improve family nutrition because fruit and vegetables contain high quantities of vitamins, minerals and fiber.
- To improve the bargaining position of farmers. To encourage people to establish their own gardens.

Problem Statement

Food scientists have found that by reducing the moisture content of food to between 10 and 20%, bacteria, yeast, mold and enzymes are prevented from spoiling it. The flavor and most of the nutritional value is preserved and concentrated. Drying and preservation of agricultural products have been one of the oldest uses of solar energy. The traditional method, still widely used throughout the world, is open sun drying where diverse crops, such as fruits, vegetables, cereals, grains, tobacco, etc. are spread on the ground and turned regularly until sufficiently dried so that they can be stored safely. However, there exist many problems associated with open sun drying. It has been seen that open sun drying has the following disadvantages. It requires both a large amount of space and a long drying time. The disadvantages of open sun drying need an appropriate technology that can help in improving the quality of the dried products and in reducing the wastage. This led to the application of various types of drying devices like solar dryer, electric dryers, wood fuel driers and oil-burned driers. However, the high cost of oil and electricity and their scarcity in the rural areas of most third world countries have made some of these drivers very unattractive. Therefore interest has been focused mainly on the development of solar dryers. Solar dryers are usually classified according to the mode of air flow into natural convection and forced convection dryers. Natural convection dryers do not require a fan to pump the air through the dryer. The low air flow rate and the long drying time, however, result in low drying capacity. One basic disadvantage of forced convection dryers lies in their requirement of electrical power to run the fan. Since the rural or remote areas of many developing countries are not connected, the use of these dryers is limited to electrified urban areas.

Design Methodology

Types of solar driers Solar-energy drying systems are classified primarily according to their heating modes and the manner in which the solar heat is utilized. In broad terms; they can be classified into two major groups, namely • Direct (integral) type solar dryers. • Indirect (distributed) type solar dryers. • Direct solar dryers have the material to be dried placed in an enclosure, with a transparent cover on it. Heat is generated by absorption of solar radiation on the product itself as well as on the internal surfaces of the drying chamber. In indirect solar dryers, solar radiation is not directly incident on the material to be dried. Air is heated in a solar collector and then ducted to the drying chamber to dry the product. Specialized dryers are normally designed with a specific product in mind and may include hybrid systems where other forms of energy are also used. Although indirect dryers are less compact when compared to direct solar dryers, they are generally more efficient. Hybrid solar systems allow for faster rate of drying by using other sources of heat energy to supplement solar heat. • The three modes of drying are: (i) open sun, (ii) direct and (iii) indirect in the presence of solar energy. The working principle of these modes mainly depends upon the method of solar-energy collection and its conversion to useful thermal energy.

(i)Open sun drying

Open Sun Drying solar energy falls on the uneven product surface. A part of this energy is reflected back and the remaining part is absorbed by the surface. The absorbed radiation is converted into thermal energy and the temperature of product stars increases. This results in long wavelength radiation loss from the surface of the product to ambient air through moist air. In addition to long wavelength radiation loss there is convective heat loss too due to the blowing wind through moist air over the material surface. Evaporation of moisture takes place in the form of evaporative losses and so the material is dried. Further a part of absorbed thermal energy is conducted into the interior of the product. This causes a rise in temperature and formation of water vapor inside the material and then diffuses towards the surface of the and finally loses thermal energy in the end then diffuses towards the surface of the and finally losses the thermal energy in the form of evaporation. In the initial stages, the moisture removal is rapid since the excess moisture on the surface of the product presents a wet surface to the drying air. Subsequently, drying depends upon the rate at which the moisture within the product moves to the surface by a diffusion process depending upon the type of the product.

(ii)Direct type solar drying (DSD) Direct solar drying is also called natural convection cabinet dryer. Direct solar dryers use only the natural movement of heated air. A part of incidence solar radiation on the glass cover is reflected back to the atmosphere and remaining is transmitted inside the cabin dryer. . A direct solar dryer is one in which the material is directly exposed to the sun‘s rays. This dryer comprises a drying chamber that is covered by a transparent cover made of glass or plastic. The drying chamber is usually a shallow, insulated box with air-holes in it to allow air to enter and exit the box. The product samples are placed on a perforated tray that allows the air to flow through it and the material. Fig. 2.6 shows a schematic of a simple direct dryer [15]. Solar radiation passes through the transparent cover and is converted to low-grade heat when it strikes an opaque wall. This low-grade heat is then trapped inside the box by what is known as the ‗greenhouse effect.‗ Simply stated, the short wavelength solar radiation can penetrate the transparent cover. Once converted to low-grade heat, the energy radiates. Figure 2.6: Direct Type Solar Drying (iii)Indirect type solar drying (ISD) This type is not directly exposed to solar radiation to minimize discolorations and cracking. The drying chamber is used for keeping the in wire mesh tray. A downward facing absorber is fixed below the drying chamber at a sufficient distance from the bottom of the drying chamber. A cylindrical reflector is placed under the absorber fitted with the glass cover on its aperture to minimize convective heat losses from the absorber. The absorber can be selectively coated. The inclination of the glass cover is taken as 45o from horizontal to receive maximum radiation. The area of absorber and glass cover are equal to the area of the bottom of the drying chamber. Solar radiation after passing through the glass cover is reflected by a cylindrical reflector toward an absorber. After absorber, a part of this is lost to ambient through a glass cover and remaining is transferred to the flowing air above it by convection. The flowing air is thus heated and passes through the placed in the drying chamber. The exhaust air and moisture is removed through a vent provided at the top of the drying chamber. Indirect Type Solar Drying

CHAPTER-4

DESIGN AND DRAWING

CHAPTER-IV

DESIGN AND DRAWING

4.1 COMPONENTS

The solar crop dryer consists of the following components to fulfill the requirements of complete operation of the machine.

1.drying chamber

2.glass plate

3. Solar panel

4. Battery

5. blower

GENERAL MACHINE SPECIFICATIONS

SOLAR CROP DRYER COMPONENTS

DRYING CHAMBER

The drying chamber was made up mild steel consist of two drying trays also made of steel the material has been chosen since wood is a poor conductor of heat and its smooth surface finish and also heat loss by radiation is minimized. Heating chamber It consists of following components: glass plate, absorber plate, blower.

GLASS PLATE

Materials used for cover plates are glass, but the material used for this Project is glass. This is a metal painted black and painted over the cover to absorb the incident solar radiation transmitted by the cover thereby heating the air between it and the cover, to keep the absorbed solar radiation.

SOLAR PANEL

Material =silicon semiconductor

Type =dark blue

Voltage = 0.5v (each silicon cell)

Quantity =1

2. BATTERY

Voltage =12v dc

Material =plastic

Type =lead acid battery

Quantity 1

3.BLOWER

12v dc

battery to solar panel

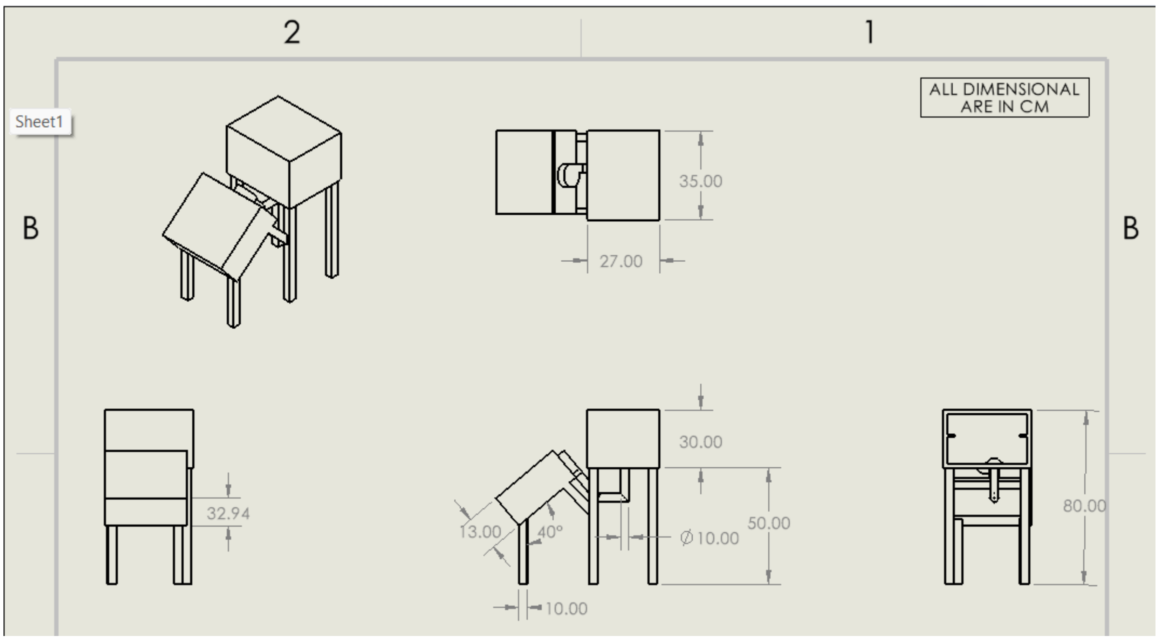
Quantity 1

THE ORIENTATION OF THE SOLAR COLLECTOR

The Glass-plate solar collector was always tilted and oriented in such a way that it receives maximum solar radiation during the desired season of used. The best stationary orientation is due south in the northern hemisphere and due north in southern hemisphere. Therefore, solar collector in this work is oriented facing south to the horizontal. This is approximately 10 º more than the local geographical latitude which is the best recommended orientation for stationary absorber. This inclination is also to allow easy run off of water and enhance air circulation.

DRAWING

4.2 SOLAR CROP DRYER


2
1
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27.00
30.00
32.94
13.00
40°
Ø 10.00
50.00
80.00
10.00

CHAPTER -5

WORKING PRINCIPLE

CHAPTER -5

WORKING PRINCIPLE

To construct the solar Crop dryer we need space for normal air to flow into the air dryer. The arrangements are made as shown in the figure. The Mirror in the upper surface of the setup absorbs the heat from the sun directly. The heat flows where there is an outlet, according to the arrangement the air flows to the other end of the arrangement where there is a fan. Due to the heat absorbed in the copper sheet the air gets heated and comes to the drying cabinet. In the cabinet two trays are kept to keep the products. The door is attached to the cabinet. The hot air flows in an upward direction so that the products in the tray are heated gradually.

CHAPTER -6

MERITS AND DEMERIT

CHAPTER -6

MERITS AND DEMERIT

MERITS

- Easy way to produce hot air
- Most Economical
- Less maintenance
- Easy to construct

DEMERIT

Initial investment is high.

CHAPTER -7

APPLICATIONS

CHAPTER -7

APPLICATIONS

- Agricultural crop drying.
- Food processing industries for dehydration of fruits and vegetables.
- Fish and meat drying.
- Dairy industries for production of milk powder.
- Seasoning of wood and timber.
- Textile industries for drying of textile materials, etc,

CHAPTER-8

LIST OF MATERIALS

LIST OF MATERIALS

FACTORS DETERMINING THE CHOICE OF MATERIALS

The various factors which determine the choice of material are discussed below.

1. **Properties**

   The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied Can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.

   The following four types of principle properties of materials decisively affect their selection

   a. Physical
   b. Mechanical
   c. From manufacturing point of view

The various physical properties concerned are melting point, thermal

Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc.

The various Mechanical properties Concerned are strength in tensile, Compressive shear, bending, torsional and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties.

The various properties concerned from the manufacturing point of view are,

- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

2. Manufacturing case:

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

3. Quality Required:

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a smaller number of components which can be fabricated much more economically by welding or hand forging the steel.

4. Availability of Material:

Some materials may be scarce or in short supply. It then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. the delivery of materials and the delivery date of the product should also be kept in mind.

5. Space consideration:

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

6. Cost:

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored.

Sometimes factors like scrap utilization, appearance, and non-maintenance of the designed part are involved in the selection of proper materials.

CHAPTER-9

COST ESTIMATION

CHAPTER-9

COST ESTIMATION

1.MATERIAL COST

2. LABOR COST

Lathe, drilling, welding, grinding, power hacksaw, gas cutting cost

3. OVERHEAD CHARGES

The overhead charges are arrived by "manufacturing cost"

Manufacturing Cost =Material Cost +Labour Cost

=5000+3000

=8000

Overhead Charges =20%of the manufacturing cost

=1000

4. TOTAL COST

Total cost = Material Cost +Labour Cost +Overhead Charges

=5000+3000+2000

=10000

Total cost for this project =10000

CHAPTER-10

CONCLUSION

CHAPTER-X

CONCLUSION

The following conclusions were arrived at the from the investigation

1. Solar crop dryer incorporated with heat pipes offer a potentially attractive means for crop drying with great reliability and low maintenance as compared with traditional crop drying technique.
2. The entire process is pollution free and friendly to the environment and consumes minimum power.
3. The use of heat pipe technology provides maximum utilization of solar energy and transfer of this energy to crops without any losses is possible.
4. This new technology will meet the growing demand of crop drying at lower cost than by traditional methods of drying.
5. The cost of running the dryer is Rs 25/hr which is 56% lower than the normal drying operation.

PHOTOGRAPHY


WORKS