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Design and Fabrication of a Multi-spice dryer

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Abstract - *Spices are present in the daily diet and gain more attention as preservatives, flavor, aroma, and therapeutic agents in the foods. Solar drying gives fascinating product quality with tokenish environmental impact. It is an effective, cheap, and safe method of drying. India is the top spice producing, consuming, and exporting country in the world, accounting for 50% of the global trade. Despite the COVID-19 Pandemic, export of spices from India continued its upward trend during 2020-21 and crossed the 3.5 billion US $ mark. Export of spices attained an all-time record in terms of both volume and value in the year, registering an increase of 30% in volume, 23% in rupee terms compared to the previous year. India is the world's largest producer, consumer and exporter of chillies. The use of a dryer makes it facile and safe from unbalanced weather.*

Key Words: Spices, Solar drying, Chilli , Dryer, India

1. INTRODUCTION

The sun is the central energy producer of our solar system. It has the form of a ball and nuclear fusion takes place continuously in its center. A small fraction of the energy produced in the sun hits the earth and makes life possible on our planet. Solar radiation drives all natural cycles and processes such as rain, wind, photosynthesis, ocean currents and several others which are important for life. The whole world's energy needs have been based from the very beginning on solar energy. All fossil fuels (oil, gas, coal) are converted to solar energy.

The radiation intensity of the ca 6000°C solar surface corresponds to 70,000 to 80,000 kW/m2. Our planet receives only a very small portion of this energy. In spite of this, the incoming solar radiation energy in a year is some 200,000,000 billion kWh; this is more than 10,000 times the yearly energy needed of the whole world.The solar radiation intensity outside the atmosphere is on average 1,360 W/m2 (solar constant). When the solar radiation penetrates through the atmosphere , some radiation is lost so that on a clear sky sunny day in summer between 800 to 1000 W/m2 (global radiation) can be obtained on the ground.

1.1 AIM AND OBJECTIVES

The primary aim and objective of the project is to build a solar spice dryer primarily working on Solar Energy with the help of a solar panel. An AC switch over is also possible according to the light availability. Our focus is to build a dryer which is portable and economical for every livelihood for their personal and agricultural use.

The heat transfer occurs mainly due to 3 phenomena ; Conduction, Convection and Radiation.

Conduction **:** Heat conduction is a process in which heat is transferred from the hotter area to the colder area without involving any actual movement of the molecules of the body. Heat transfer takes place from one molecule to another molecule as a result of the vibration occurring between the molecules.

According to Fourier's law of heat conduction, the rate of flow of heat through a simple homogeneous solid is directly proportional to the area of the section right angle to the direction of heat flow and to the change of temp. with respect to the length of path of the heat flow.

$$Q \propto A dt/dx$$

$$Q = -kA dt/dx$$

where k is the thermal conductivity

A - Area of cross section and

dt /dx - Temperature Gradient

Convection : In this process, heat is transferred in the liquid and gases from the region of higher temperature to the region of lower temperature. Convection heat transfer occurs partly due to the movement of molecules or due to the mass transfer. There are mainly 2 types of convection- Free Convection and Forced convection.

Natural convection, also known as free convection, is a mechanism in which the fluid motion is generated only by density differences in the fluid occurring due to temperature gradients, not by any external source.

Forced convection is a process by which fluid motion is generated by the help of an external source.

Radiation : It is the process in which heat is transferred from one body to another body without involving any molecules in the medium.The heat transfer does not depend on the medium.

The radiation energy per unit time from a black body is proportional to the fourth power of absolute temperature and can be expressed with Stefan-Boltzmann Law as

$$q = \sigma T4 A$$

where

q = heat transfer per unit time (W)

σ = 5.6703 10-8 (W/m2K4) - The Stefan-Boltzmann Constant

T = absolute temperature in kelvins (K)

A = area of the emitting body (m2)

1.2 Components of dryer

The main components used for the working of dryer are

- Solar Panel
- Solar Charge Controller
- DC motor
- Two way switch
- Incandescent bulb
- Thermostat
- AC- DC Converter and a battery

2. DESIGN AND FABRICATION

The basic design includes a cylindrical mesh of 25 cm radius and 40 cm length. A motor is fixed in the bottom of the chamber . The box is 60 cm in length, 50 cm in breadth and 60 cm in height. All dimensions are in cm.

Table -1: Spices drying temperature

Spices	Temperature range of spices in which they dry (°C)
Cardamom	28°G30°C
Chilli	45°G50°C
Cinnamon	45°G55°C
Pepper	50°G65°C

The front view of the dryer shows the cylindrical mesh, sprocket , 2 bulbs, a chain and a motor. A bearing is provided at the ends. The material used for the cylindrical cage is wire mesh.

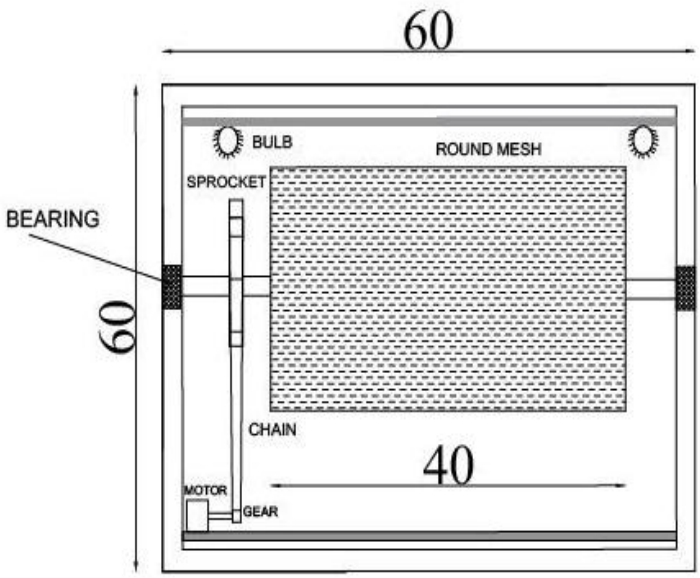

Fig -1: Front view of dryer

A frame of 60cm×60cm×50 cm is made using 0.5 inch square pipe. A cylindrical cage of 40 cm length and 25 cm diameter is made using a wire mesh and a door is attached to it. It is supported at the frame using a ball bearing for free rotation. A sprocket is fixed in the cylindrical cage through a shaft. The motor is fixed on the bottom of the cabinet such that it is in proper alignment with the sprocket. A chain is used to connect the motor and sprocket inorder to transfer the motion.

The box is covered completely using a tin sheet by the application of welding. A Door is provided for the access to the dryer and also a lock is attached. An insulating material is placed between the tin sheet and box inorder to trap heat inside.We are using a 75 watt solar panel as the source along with a 10 amps solar charge controller. A 12 v dc motor of 30 rpm is used for better performance, where 4500 rpm is reduced to a rated speed of 27 rpm.

Fig -2: Multi-spice dryer isometric view

The dryer is connected to a solar panel which is the initial power source, through a charge controller. Temperature controller and motor are connected to the solar charge controller. Solar charge controller regulates the voltage and battery inorder to avoid voltage fluctuations. Solar charge controller charges the battery and provides energy for the working of the dryer. A suitable range of temperature is set on the temperature controller for the proper drying of spices. The thermostat senses the temperature inside the cabinet.

According to the temperature inside the cabinet, the temperature controller switches the bulb ON or OFF. If the temperature falls below the required level the bulbs turn ON thereby increasing the temperature inside. When the temperature reaches the maximum level, the bulb turns OFF. The cylindrical cabin inside the dryer is continuously driven by a dc motor with the help of a chain drive.

3. CONCLUSIONS

The dryer in the present study is easy to build and requires only semi-skilled labor and limited manufacturing facilities to fabricate. The dryer can be easily operated and less maintenance is required. The use of solar energy makes it renewable and energy efficient. The application of electricity as an alternate source is also provided which makes it easy to work during rainy and cloudy weather. The portability of the dryer is such that it can be easily moved due its less weight.

Advancement in the dryer can be made according to the scale of drying and production availability. Use of high capacity batteries can increase the battery backup. Adjustments in panels make a huge change in the dryer. Use of Automation and programming can be done in future to reduce material handling and easy operation. Several other mechanisms such as grinding and packaging makes it more promisable and engaging in the market.

REFERENCES

[1] Abuelnuor Abuelnuor A. A, Adil A. M. Omara, Israa k. Salih, Eman K. M. Ahmed (2020) " Experimental Study on Tomato Drying Using a Solar Dryer Integrated with Reflectors and Phase Change Material" , 2020 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE) , 978, 728-736

[2] Charles Berville, Cristiana-Verona Croitoru and Ilinca Nastase (2019) "Recent Advances in Solar Drying Technologies- A Short Review" , 2019 International Conference on Energy and Environment (CIEM), 19228476, 294-297.

[3] C P Kothandaraman , Fundamentals of heat and mass transfer, New Age International Publishers, 2006

[4] C P Kothandaraman and S Subramanyan, Heat and Mass Transfer Data Book, New Age International Publishers , 9th Ed. 2018.