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Fabrication of Multipurpose Solar Dryer

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Abstract : Grains vegetables and 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 vegetables 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 method uses solar radiation, which is both accessible and environmentally friendly and economically beneficial to the country.

IndexTerms **- Solar Radiation, Biological, Biochemical**

I. INTRODUCTION

The sun is the primary source of solar energy on the planet. The sun powers the entire world. As a result, we should put that energy to good use. The sun is 1.495 1011 (meter) away from the Earth's surface, its diameter is 1.39 109 (meter), and it emits 1353 w/m2 solar radiation on the Earth's surface perpendicular to the rays if there are no atmospheric disturbances such as cloud, dust, forest, and buildings. Approximately 165 trillion (kW) of solar energy is received by the Earth, with 30 percent of the total received energy reflecting space, and approximately 47 percent of energy is transformed to low-temperature heat energy, 23 percent of heat energy is used for evaporation, and 0.5 percent is consumed in kinetic energy of wind and waves [1].

This method uses solar radiation, which is both accessible and environmentally friendly and economically beneficial to the country. It is appropriate for drying at all levels, from minor to industrial. Solar radiation is one of the world's cheapest and most easily accessible energy sources. It is one of the most capable renewable energy sources due to its large quantity, nonpolluting nature, and infinite source as opposed to the costly and limited supply of fossil fuels—the concept of a solar dryer, in which solar radiation is used to dry. It reduces the use of fossil fuels, and the cost of solar dryers and equipment is meagre, and it produces no pollution, working on the greenhouse effect. Because there is no pollution, it is very environmentally friendly, providing a healthy environment with low-cost heating. Solar radiation air heating is a well-thought-out explanation of sun air heating, and it is a very efficient method of using solar dryers. When that radiation enters the atmosphere, some of it is lost or absorbed by the ozone and other gases present, so on clear sunny days in summer, and the global radiation is measured at 800–1250 w/m^2. [1]

In many developing countries large quantities of fruits and vegetables spoil due to inadequate infrastructure, insufficient processing capacities, and growing marketing difficulties caused by intensifying competition and protectionism in the worldwide agricultural markets. Up to 70 per cent of agricultural products spoil during the traditional process of open-air drying, especially in tropical and subtropical regions. Drying these products can help solve these problems, while also making an important contribution to improving the population's income and supply situation. Drying is an important form of food preservation that is often carried out at farm level right after harvest, or especially with highly perishable crops, at peak harvest time when local markets are saturated. Drying vegetables, fruits and meat with thermal energy enables longer storage times and easier transportation. Up to 70 per cent of agricultural products spoil during the traditional process of open-air drying, especially in tropical and subtropical regions (INNOTECH, 2012). [2]

Figure No. 01 Multipurpose Solar Dryer

II. LITERATURE REVIEW

1. **Ankit Kumar, Kamred Udham Singh, Mukesh Kumar Singh, Alok Kumar Singh Kushwaha, Abhishek Kumar, and Shambhu Mahato in their Design and Fabrication of Solar Dryer System for Food Preservation of Vegetables or Fruit:**
   Food preservation has been practiced in many parts of the world for thousands of years, and it applies to a wide range of foods, including fruits, vegetables, cereals, and meat. Food preservation techniques are canning, freezing, pickling, curing (smoking or salting), and drying.

2. **Parag Kishor Mahajan, Sandeep Patil in his Review Paper on Solar Dryer (IRJMETS)**
   The growing use of fossil fuels and the consequent economic growth in fuel prices has led to the need for alternative energy sources. Solar energy is one of the most renewable and sustainable sources and has attracted the attention of more and more researchers around the world.

3. **K.Nagendra Babu, P.Sudheer Kumar, D.Yamuna in A Research on Development of a Fixed Solar Dryer with a Practical Research.**
   Solar energy heating apparatus to dry food and other crops that can enhance the quality of the product while reducing the wasted product. Drying is an eminent way to preserve the food and solar energy food drying is an approximate food preservation mechanism for a sustainable real world.

4. **Amit Singh Rawat, Kuldeep Singh Rawat, Jitender Singh Uprari, Kamal Bhatt, Saurabh Aggarwal in the Review on Solar Dryer and its Types.**
   The unpredictable increase and frequent scarcity of fossil fuels has accelerated the ongoing search for an alternative source of energy. Solar energy is one of the renewable and sustainable energy sources that has attracted a large community of researchers from around the world.

III. PROBLEM DEFINITION

1. In such case the production of vegetables or fruits are more and the demand in market is less, due to this the vegetables or fruits have been wasted.
2. In summer season we can dry the grains using sunlight directly but, in another season, we have to use some auxiliary devices, such as solar dryers.
3. To store the vegetables, fruits and grains in cold storages there is Deficiency of cold storage and it is little costly.
4. To operate the solar dryer in the low Sun Radiations such as in the night and Cloudy conditions.

IV. OBJECTIVES

1. Solar dryers aim to harness solar energy efficiently to reduce reliance on fossil fuels or electricity for the drying process. By using renewable energy, they contribute to sustainability and reduce greenhouse gas emissions.
2. Properly dried products have longer shelf lives as the drying process removes moisture, reducing the risk of spoilage due to microbial growth or enzymatic reactions. Solar drying can extend the shelf life of fruits, vegetables, herbs, grains, and other perishable items.
3. Properly dried products have longer shelf lives as the drying process removes moisture, reducing the risk of spoilage due to microbial growth or enzymatic reactions. Solar drying can extend the shelf life of fruits, vegetables, herbs, grains, and other perishable items.
4. This is work will be based on the importance of a solar dryer which is reliable and economically, design and construct a solar dryer using locally available materials and to evaluate the performance of this solar dryer.
5. To provide a low-cost solution for drying agricultural produce, which can be affordable for small-scale farmers.
6. To utilize solar energy effectively for drying various agricultural products, thus reducing dependence on conventional energy sources.

V. DESIGN

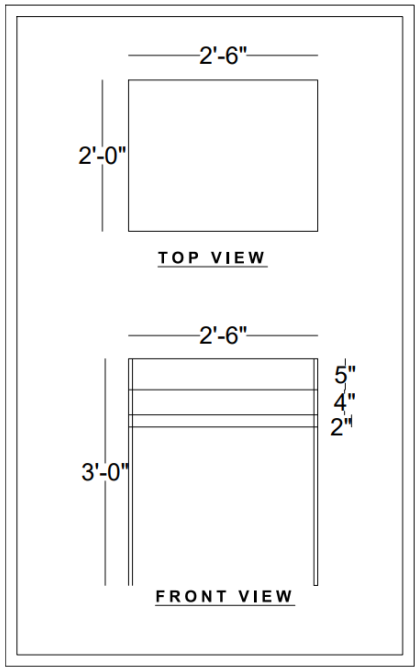

Figure No. 02: 2D Design of Multipurpose Solar dryer

5.1. Dimensions:

1. Length – 2 feet 6 inches
2. Breadth – 2 feet
3. Height of chamber – 11 inches

4. In Chamber, drying trays –
   - From top to 1st tray – 5 inches
   - From 1st tray to 2nd tray – 4 inches
   - From 2nd tray to bottom – 2 inches

5. Total Height of Dryer – 3 feet

VI. CONSTRUCTION AND WORKING

6.1 Construction:

1. The 1-inch M.S. angle is used to build the structure. The size of the chamber, 2.5 feet long, 2 feet wide and the height is 11 inches. The total height of the Solar dryer is 3 feet. There are Two trays are placed in the drying chamber 1st tray is at 5 inches from top, 2nd tray is at 4 inches from 1st tray.
2. The Mild Steel perforated sheet is used to make the trays. They are coated with black color for better heat absorption. The Poly Carbonate sheet is placed on top of drying chamber. The advantage of sheet is that the heat rejection is less. The whole structure is covered by the Aluminum composite panel which gives the insulation to the Drying chamber. There are two fans placed in the drying chamber to control the Humidity in the chamber to maintain quality of product.
3. The Auxiliary heaters is also used to control the temperature of chamber in winters season.
4. The charge controller is used to control the energy come from the solar panel. The Automatic controller is used to set the Temperature and Humidity according to the requirement for product.

6.2 Components:

1. Charge Controller,
2. Temperature and Humidity Controller,
3. Temperature and Humidity Sensor,
4. Solar Panel,
5. Battery,
6. DC Fan,
7. Heating Element,
8. 3 – Way switch.

6.3 Working:

A Multipurpose Solar Dryer works by utilizing the Solar energy to heat air, which is then circulated around the items being dried. Here is a basic overview of how it typically operates:

The dryer has a solar collector panel, usually it converts the solar energy into the Electric energy. Then it is used to charge the battery, when the battery is charging simultaneously the power is also transmitted to the components which are fitted to the solar dryer. The items are placed in the drying trays (such as Vegetables, Fruits, grains etc.) to do a drying process on it. The Fans are fitted in a one direction of drying chamber i.e. it can circulate the air flow and maintain the humidity or moisture in the chamber. The heating element is also fitted in the drying chamber, when the Temperature is getting low then the heating element is starts heating and get the desired temperature for product.

Depending on the design, a Multipurpose Solar dryer may have different attachment or configuration to accommodate various types of items for drying, such as adjustable trays. The Automatic and Manual Mode are given to ease the control of dryer. The Manual mode works manual like start and stop the fan and heater manually. The Automatic mode is working such that only once we have to set the desired low and High Temperature and Humidity and then after the Fans and Heater is automatically ON and OFF according to the set temperature and humidity. Hence the automatic mode is very reliable to the user.

VII. RESULT AND DISCUSSION

1. The result for this product is taken in the form of one-by-one product is being tested in the Multipurpose solar dryer.
2. Firstly, the Onion is been tested the onion slices are spread in the both trays. The Time required in drying Onion Slices at a Temperature range of; 50^0 C in 250 Minutes and 65^0 C in 200 Minutes.
3. Then the Tomato slices get spread on the trays, The temperature is up to 60^0 to 70^0 C Having the initial moisture of approx. 90 % we had reduced 14 % to 20 % final moisture content in 10 hours.
4. The Potato slices are then placed in the drying chamber, potatoes are get easily dried. It dries at 60^0 C to 65^0 C over an 5-8 hours.
5. The apple slices sample is also been tested, it takes 360 minutes at 50^0 C and 280 minutes at 60^0 C.
6. Then the wheat grains are tested the maximum drying temperature for wheat is 65^0 C for 16% moisture and 60^0 C for 20 % moisture content.

These testing is done in the summer season. The results are shown above is taken in the summer season the heat content in the air is high so the products get easily dried. For the winter season the Heating element and the Fans are given to maintain the temperature and humidity of the product. We can evaluate the quality of dried products in terms of moisture content, color retention and flavor preservation comparing them with product dried using other methods.

7.1 Temperature, Time and Humidity Chart:

Table No. 01 Temperature, Time and Humidity chart

Onion	The Time required in drying Onion Slices at a Temperature range of ; **50^0 C in 240 Min,** **60^0 C in 210 Min,** **70^0 C in 160 Min**
Tomato	The temperature to dry Tomato at **60^0 C to 70^0 C** Having Initial moisture content **of 90% to 95 %** Were reduced to **14% to 15% Final moisture content over 8 to 10 Hour**
Apple	The Time required in drying Apple Slices at a Temperature range of ; **50^0 C in 366 Min,** **60^0 C in 292 Min,** **70^0 C in 221 Min**
Potato	The Arranged Potato Slices Dry **at 60^0 C to 65^0C Over an 5 to 8 Hours**
Wheat	The Maximum Drying Temperature required for Wheat in dryer is up to; **65^0 C for 16% moisture &** **60^0 C for 20% moisture content in wheat**

VIII. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

8.1 Advantages

1. Better product quality is obtained.
2. The higher the temperature, movement of air, and lower humidity, increases the rate of drying.
3. It reduces losses and offers a better market price to products.
4. Prevent fuel dependence and reduce the impact on the environment
5. It is more efficient and less expensive.
6. These automatic solar dryers are designed to be user friendly, requiring minimal manual intervention once set up.
7. With proper design and insulation, the solar dryer can operate effectively even in varying weather condition throughout the year.

8.2 Disadvantages

1. Adequate solar radiation is required.
2. Like any equipment solar dryer require regular maintenance to ensure optimal performance and longevity, which may involve repairs and component replacement.
3. The upfront cost of purchasing and installing a multipurpose solar dryer can be relatively high compared to traditional dryers.
4. Meeting the diverse needs of different crops or products in a Multipurpose solar dryer might require customizations and adjustment which could add complexity.

8.3 Applications

1. The Domestic Solar dryer offers a cost effective and sustainable solution for preserving food products.
2. **Agriculture:** Farmers can utilize solar dryer to crops such as grains, pulses, nuts and seeds, thereby preventing mold growth and ensuring better marketability of their produce.
3. **Medicinal Herbs and Plants:** Solar dryers are valuable for drying medicinal herbs and plants, maintaining their potency for herbal medicines.
4. **Food Preservation:** Solar dryer can be used to dry fruits, vegetables, herbs and spices, preserving them for longer period without the need for electricity. This helps in reducing post – harvest losses and maintaining food quality. |
5. **Industrial applications:** Multipurpose solar dryer can also find application in various industrial processes that require drying of material or products, such as ceramics, clay, paper pulp and more.

IX. CONCLUSION AND FUTURE SCOPE

9.1 Conclusion:

1. From the Above information and the results are taken by us is concluded that we get the approximate result from all the available resources.
2. Energy saving achieved by using solar power compared to traditional drying methods, such as fossil fuel-based dryer.
3. The cost effectiveness of the solar dryer in terms of initial investment, operation and maintenance cost and compare it to alternative drying methods.
4. Emphasize the versatility of the multipurpose solar dryer in accommodating different types of produce and varying weather conditions.
5. Summaries the main findings and significance of the study, the maintenance of solar drying as sustainable and environmentally friendly solution.

9.2 Future Scope:

1. The Automatic Opening and Closing of the Glass cover with insulation for Cutt off the whole system (To stop unnecessary heat and power consumption).
2. To make the system IR based i.e. it can be controlled by remote (Easy to use and to give simplicity).
3. IOT based system is being install in the Solar dryer i.e. it can be operated by Smartphone from anywhere and any place.

REFERENCES

[1] Ankit Kumar, Kamred Udham Singh, Mukesh Kumar Singh, Alok Kumar Singh Kushwaha, Abhishek Kumar, and Shambhu Mahato in their Design and Fabrication of Solar Dryer System for Food Preservation of Vegetables or Fruit

[2] Parag Kishor Mahajan, Sandeep Patil in his Review Paper on Solar Dryer (IRJMETS)

[3] K.Nagendra Babu, P.Sudheer Kumar, D.Yamuna in A Research on Development of a Fixed Solar Dryer with a Practical Research.

[4] Amit Singh Rawat, Kuldeep Singh Rawat, Jitender Singh Uprari, Kamal Bhatt, Saurabh Aggarwal in the Review on Solar Dryer and its Types.