"DESIGN AND FABRICATION OF SOLAR DRYER"

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ABSTRACT

The solar dryer uses solar energy to heat the air and to dry the food product which is very useful in reducing unwanted product and helps in drying the food product. Considering the natural sun drying, for example:- exposing to direct sunlight, to protect the insects from the food product and increase the time of drying, and to save the cost of the mechanical dryer, a solar dryer is therefore developed to overcome for this limitation.

This project presents the design, construction and performance of solar dryer for food preservation. In the dryer the air from the copper tubes & ETC tubes was passed to the Drying cabinet, at the same time the air gets heated while flowing through the tubes. Inside the drying cabinet the heated dries the product placed on the drying trays. The results obtained during the test shows that the temperatures inside the drying cabinet and solar panel was higher than the atmospheric temperature during the day light. The temperature rise inside the drying cabinet was up to 91°C after 12.00hr (noon). The dryer helps to dry food products more rapidly to a required moisture level and it ensures a best quality of the dried product.

Keyword : - Sol*ar Dryer, ETC Tubes, Copper Tubes, Glass, Blower.*

1. INTRODUCTION:-

Drying is one of the best method used to protect food products for long time. The heat from the sun is used to dry food for preservation for several years. Drying is the oldest preservation technique of agricultural products and it is an energy intensive process. High prices and shortages of fossil fuels have increased the emphasis on using alternative renewable energy resources. Drying of agricultural products using renewable energy such as solar energy is environmental friendly and has less environmental impact.

The two main types of the dryers are indirect solar dryers and direct solar dryers. In the direct solar dryers the product is directly exposed to air and in indirect solar dryers the airflow is provided by using blower or fan operated by electricity or fossil fuel.

1.1 Indirect Type Solar Dryers:-

In this type the food products are not directly exposed to sun. The drying cabinet is used for keeping the food product in the drying trays. A solar panel is fixed below the drying cabinet at a sufficient distance from the

bottom of the drying cabinet. A coating of black colour is given to the panel from inside and the glass cover on its aperture to reduce heat losses from the panel. The inclination of the panel is taken as 45° from horizontal to receive maximum sun radiation. Solar radiation after passing through the glass cover incident on the tubes of which the copper tubes are also coated with black colour because of coated black colour the tubes get more heated. ETC tubes absorb more heat than the copper tubes and heat the inner copper tube which are inserted in the ETC tubes. The flowing air is thus heated inside the panel and passes through the placed in the drying cabinet. The exhaust air and moisture is removed through a exhaust fan provided at the top of drying cabinet.

2. COMPONENT:-

2.1 ETC Tubes:-

ETC tubes are used to increase the temperature if air passing through it. Their main purpose of these tubes is to trap as much as solar radiation possible and heat the copper tubes inside it.

Fig1- ETC Tubes

Glass-glass type of ETC tubes are made with a double layer of glass fused together at one end with a vacuum between the layers. There are two glass tubes in the ETC tubes which are vacuum sealed, but the two layers of glass reduces the heat that reaches the absorber. Copper coating inside the tubes allow more radiation to reach the absorber, because of ETC tubes more heat is generated and the efficiency of the dryer increases.

2.2 Drying Cabinet:-

The drying cabinet of the dryer is built from well-seasoned plywood which could withstand atmospheric changes. An outlet is provided toward the upper end of the cabinet to control the flow of heated air through the dryer. A door is given to the drying chamber at the back of the cabinet to give access inside the chamber for inserting and removal of drying trays. The roof or the upper end consist of a exhaust fan for removal of moisture from the dried product. The cabinet inside it consists of three removable wooden trays made of plywood, which overlapped each other. The product is dried inside the cabinet.

Fig2- Drying Cabinet

2.3 Blower:-

The blower is situated at the bottom of the dryer and it is used to blow the air through the ETC pipes and copper tube so that more heat can be supplied to the trays and we can be able to dry the product faster so that most of the time will be saved. By using the blower the efficiency of the dryer increases and more quantity of air is supplied to the trays so that the product will be dried faster.

Fig3- Blower

2.3 Exhaust Fan:-

The Exhaust fan is situated at the upper side of the dryer so that the air is removed from the product can be thrown out to the atmosphere. Other function of the exhaust fan is that it does not keep the moisture inside the cabinet.

Fig4- Exhaust Fan

2.4 Solar Panel:-

The solar panel is made up of plywood and it consist of ETC tubes and Copper tubes Connected to each other in parallel. The air is blown through blower inside the tubes and these tubes are connected to the cabinet. The air gets heated inside the tube and then it flows to the cabinet where the product is to be dried.

Fig 5- Solar Panel

2.5 Component Specification:-

Table No-1

Sr. No.	Name of Component	Specifications
1.	M S Square Pipe	Material: Mild steel Size: 25 mm x 25 mm x 20 ft Thickness: 2 mm
2.	Solar tubes	47mm * 600mm
3.	Copper tubes	Material: copper tube ID: 10 mm OD: 12 mm
4.	Glass	Material: glass Dimensions:630 mm x 882 mm
5.	Hinges	Material M S 50 mm
6.	Dc power supply	230 V
7.	Connecting wires	Type: current 2 amp
8.	Nut, bolt	Material C.I. 6 mm x 24 mm
9.	Switches	12 volt, 2 amp

Following table represents the specification of the components used in the project with proper dimensions and material used.

3. CALCULATIONS, OBSERVATIONS & RESULT:-

Observations were taken by using the green chilli as the drying product and the calculation data is mentioned below, also the observation table for green chilli is mentioned below,

3.1 Calculation of Efficiency and Heat gain:-

1. Heat gained

$$Q = m \times C_p \times \Delta T$$

Where,

m = Mass flow rate at inlet of cabin.
Cp= Specific heat of air.
T2= Cabinet inlet temperature.
T3=Exhaust temp of cabinet.
ΔT= Difference between T2 & T3

2. Efficiency

$$\eta = \frac{Q}{g \times A}$$

$$A = L \times B$$

Where,

η = Efficiency
Q = Heat gained.
L = Length of collector.
B = Breadth of collector
A = area of collector.
g = Radiation of sun.

3.2 Observation Table for green chilli:-

The moisture content present in green Chilli is more compared to potato slices and Apple slices so the drying time required for drying green Chilli is more than that of apple slices and potato slices. Time required to dry the green Chilli is 90mins for the same quantity.

Table No- 2

T1	T2	T3	Ta	TIME(t)	Radiation (W/m^2)	Q f.p	Efficiency (%)
52	69.8	42	39	9AM	1000	181.60	30.10
52	75	42.2	41	10AM	1020	214.27	34.82
54	84	45	42	11AM	1060	254.77	39.84
58	86	41	44	12PM	1080	293.96	45.12
61	88	40.3	45	1PM	1100	311.60	46.96
62	90	42.6	46	2PM	1090	309.64	47.09
52	87	46	42	3PM	1020	267.83	43.53
52	79	45	40	4PM	900	222.11	40.91
52	68	39	36	5PM	800	189.44	39.26

From above table we get to know that the efficiency of drier for green chilli which is 47.09 is achieved at the time period of 1pm-2pm.

3.3 Result:-

The graph below shows the Time vs Efficiency of the chill which was maximum at the time of 1pm-2pm.

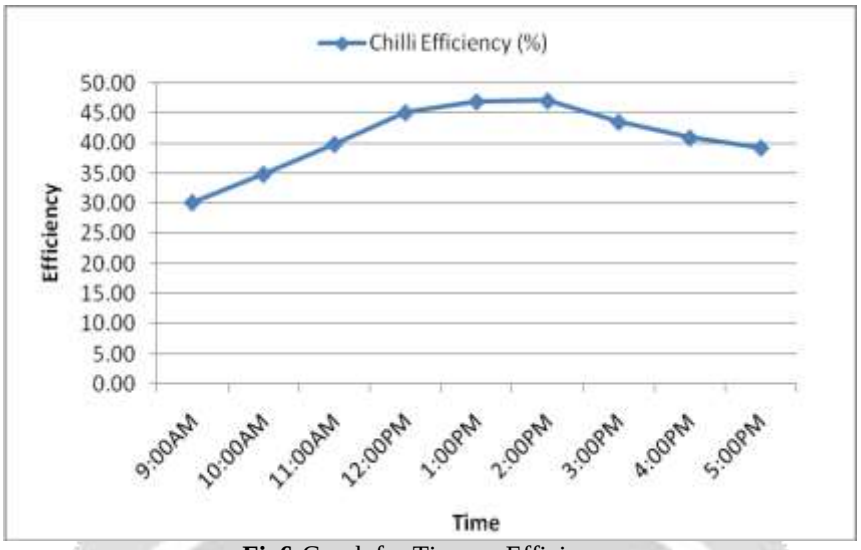

Fig6-Graph for Time vs Efficiency

Above graph represents that maximum efficiency is achieved at the duration of 1pm-2pm.

4. CONCLUSIONS:-

From the test carried out, the following conclusions were made,

1) The solar dryer can raise the ambient air temperature to a considerable high value for increasing the drying rate of agricultural crops.

2) The product inside the dryer is safe from rain or pest as compared with those in the direct type of drying. Although the dryer was used to dry green chilli, it can be used to dry other crops like yams, maize, Dates etc.

3) There is ease in monitoring when compared to the natural sun drying technique.

4) The capital cost involved in the construction of a solar dryer is much lower to that of a mechanical dryer. Also the simple and low costs solar dryer was designed and constructed using locally available material.

5) As per our experiment the maximum peak temperature inside the drying chamber is 91°C during mid-day (2pm) and in an average approximately 60°C to 62°C in a full sunny day (10:00AM to 02:00PM).

6) Such low-cost drying technologies can be readily introduced in rural areas to reduce spoilage, improve product quality and overall processing hygiene.

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