A Research on Development of a Fixed Solar Dryer with a Practical Research

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Abstract— 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. This fixed solar dryer has the capacity of 15 kg which is used for the preservation, drying of grapes, potatoes, onions, mango pulp, chilies, green leafy vegetables, jack fruit pulp, green pepper, herbal medicines, ginger etc., more than 50 kinds have been dried using this solar dryer at various AKRUTI'S. Drying will generally refers to the removal of moisture content by evaporation rather than by pressure or other physical parameters. Our country is blessed with ample of solar energy round the year. The principle of this dryer is that, hot air is lighter than the cool air and its raises up the altitude. While raising this warm air comes in contact with food slices and draws the moisture from it. The repeated cycle of this process makes it a low cost, very healthy, long term investment. Generally the sun's power of heat is used to dry up the moisture content of the fruits or vegetables.

1. INTRODUCTION

Drying is one of the particular procedures used to preserve food products for longer durations. The fierce heat of the sun's energy coupled with the wind energy has been utilized to dry food for preservation for couple of years. Drying is the oldest action of preserving manner of agricultural substances and it is an energy intensive series of action. A great extent prices and shortfalls of fossil fuels has been increased the special importance for using the different another possibility of renewable energy resources. Drying of agricultural substances using non conventional sources of energies such as solar energy is the eco friendly and gives low environmental influence. Non identical models of solar energy dryers have been elaborated to a specified degree and had a practical analysis in the non related regions of the tropics, subtropics. The utmost two categoriesed solar energy dryers are natural convection solar potency dryers, forced convection solar energy dryers. In the case of natural convection solar dryers the airflow is created by the buoyancy induces the airflow while in the forced convection solar potency dryers the airflow is provided by use of a medium called fan operated either by electricity solar section or by fossil fuel. Solar thermal energy technology is rapidly gaining the fact of being received as adequate power saving measure in agriculture real time appeal. It is preferred to be supplementary alternate place of origins of energy such as the perceptible natural movement of the air and shale, because it is available in large quantities, unending, inexhaustible, and non-polluting. Solar energy air heaters are the elementary devices to heat the air by utilizing solar thermal energy and it is exert in many applications indispensable low to moderate temperature beneath 80°C, such as making moisture free crop's and space heating up.

2. MATERIALS CONSIDERED ESSENTIAL FOR MAKING THE SOLAR DRYER:

The essential materials that are used to make the solar thermal energy dryer are very much useful in our everyday life to which they are found easily near our localities also.

1) Aluminum Sheets
2) Hammer
3) M.S L angular
4) M . S Wired Mess
5) F i b e r Glass
6) Thermometer
7) Black Paint

FIGURE-2.1: Front view of Solar dryer

3. MATHEMATICAL FORMULA.

Efficiency = (output/input)*100

Here we calculate efficiency in terms of weight.

3.1 The fact of being active of the Dryer

This solar energy dryer is a passive inter connecting network means which has no moving section. It is energized by the solar energy radiation entering through the collector glossing of the dryer. The tricking of the sun's rays is further improve the quality by the inside surfaces of the solar energy collector that were painted in black in

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color to which the black color surfaces are having the capability to absorb heat and that trapped energy warms up the inside air of the collector. The greenhouse consequences successfully bring about within the solar energy collector drives the air current cross the drying chamber of the dryer. When the orifice are open, the hot air enters in to the chamber and rises the air temperature, through which it escapes from the upper passage in the drying chamber while cooler air at immediate surroundings temperature enters through the duct passage of the bottom vent in the collector.

3.2 Mechanism of drying

In this task of solar drying, heat energy is very much to remove the humidity content from the substance and a spill of air from the duct helps in fetching away the evaporated moisture from the chamber. Here we have two elementary mechanisms that involve in the drying a series of actions:

1) The moisture content is thoroughly migrated to remove the moisture content from the inner most of an individual material to the surfaces of the body.
2) Evaporating the moisture content from the surface to the circumambient air will leads to create the temperature difference also.

This moisture removal process is a complex heat and mass surrender process that depends upon external undependable like humidity, velocity and temperature of the air stream and internal variables that depends upon the variables like surface characteristics(rough or smooth surface), chemical formations(sugars, starches, etc.),physical structure(porosity, density, etc;) and size and shape of a substance that is manufactured.

4. DRAFT PROCEDURE & IMPLEMENTATION

4.1 Design Procedure

In the real world task there is a huge growing awareness will be created, that non-conventional energies have playing an outstanding role in extending the solar energy technology in developing countries to enlarge their rate of productivity. Solar energy technology is a technology which is quickly gaining the approval as an energy saving amount in agriculture application for utilization of the energy. Hence the non conventional sources of energies are preferred as a alternative prominence of energy such as wind energy, tidal energy because it is available freely in infinite, non-polluting and inexhaustible in nature. Solar energy air warm-ups are the simple devices to warm-up the air by utilizing solar thermal energy and has employed in so many applications that requires the low moderate temperature below 80^0C. Hence these solar drying processes are playing a prominent role in the preservation of agricultural substances of the farmers like potatoes, chilies and grapes etc.

These are precisely marked as a process of moisture content of the action of taking away due to uninterrupted heat and mass transfer. So generally we know that we have two types of water molecules are present in the food items. They are the chemically bounded water and the physically held water. In the solar drying process, only the physically held water is removed. Due to the cause of the popularity of the dried products are longer shelf-life, product diversity as well as considerable volume will be made smaller. Thus this can be expanded for further improvements and considerations in the product quality and process applications. The major applications of the dryers are to develop the countries in this modernization which can reduces the post harvest losses and important way as to be worthy of attention for the contribution of the availability of the food substances in those nations. The rough calculations of those losses are predominantly had an evidence for justification to be in the order of 40% which are directly below very unfavorable conditions that is very close as high as 80%. As a sufficiently great percentage of these losses are highly inter connected due to improper and/or untimely drying of the food stuffs for example cereal grains, chilies etc; this fixed solar thermal energy dryer with a comfortable box-type soaks up collector is formed by bringing together various conceptual elements by using the useful substances which are easily obtainable from the nearby markets at a reasonable cost.

4.2 Design Implementation

The solar energy dryer's surroundings temperature was set down in writing during the direction followed by the physical experiments with the help of the calibrated thermometer, in which in this real time project, we presents the modern design, compact construction and a immense performance of a mixed-mode solar dryer for the preservation of the useful food products. Thus this solar dryer ultimately exhibits the sufficient ability in drying the clean food items reasonably rapidly to a safe moisture level and also evidently ensured a superior quality of the practical dried products.

4.2.1 Observations

The individual fact of the moisture eradicated during drying in the month of march-2019 both in outside and the inside assembly are as shown in the below. The room temperature during drying period is 31^0C and compared the percentage removal of the moisture from the solar energy dryer and the usual atmospheric air (useful substances present in the surroundings) the following practical table shows the observational based data.

We had also taken the different products for experimental calculation. The average dryer efficiency in one day which was satisfactorily found to be 15% in which the rate of removal of moisture content of various samples likes potatoes, grapes was found to be 64%, 58% respectively. All the practical perusals were on a day underlying support of the fully sunny day i.e. for one full period of a day.

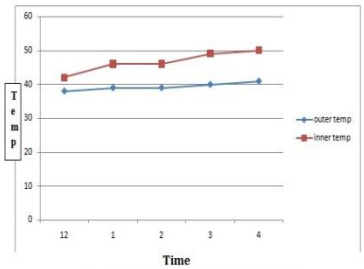
The coming after data is given below:

Table 4.2.1: Day wise temperature & weight of the potatoes in different conditions

S.NO	DATE	TIME	OUTER TEMP	INNER TEMP	WEIGHT AT MORNING	WEIGHT AT EVENING
1	27-03-2019	12:00PM	38°C	42°C	1KG	
		01:00PM	39°C	46°C		
		02:00PM	39°C	46°C		
		03:00PM	39°C	46°C		
		04:00PM	40°C	49°C		357gms
2	28-03-2019	12:30PM	38°C	45°C	357gms	
		01:30PM	40°C	54°C		
		02:30PM	41°C	56°C		
		03:30PM	41°C	55°C		
		04:30PM	40°C	53°C		159gms
3	30-03-2019	12:00PM	38°C	42°C	159gms	
		01:00PM	37°C	51°C		
		02:00PM	38°C	53°C		
		03:00PM	40°C	51°C		
		04:00PM	41°C	56°C		149gms

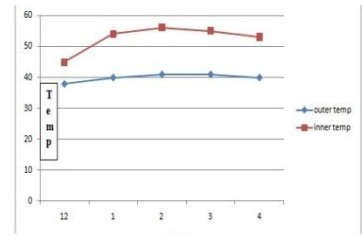
Graphical representation of temperature vs. time of drying potatoes:

DAY-1:



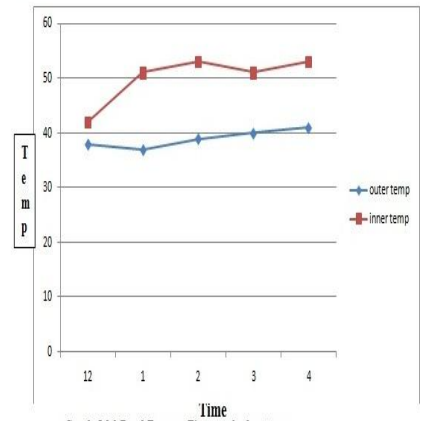
Graph 5.3.1-Day 1 Temp vs. Time graph of potatoes

DAY-2:



Graph 5.3.2-Day 2 Temp vs. Time graph of potatoes

DAY-3:



Graph 5.3.3-Day 3 Temp vs. Time graph of potatoes

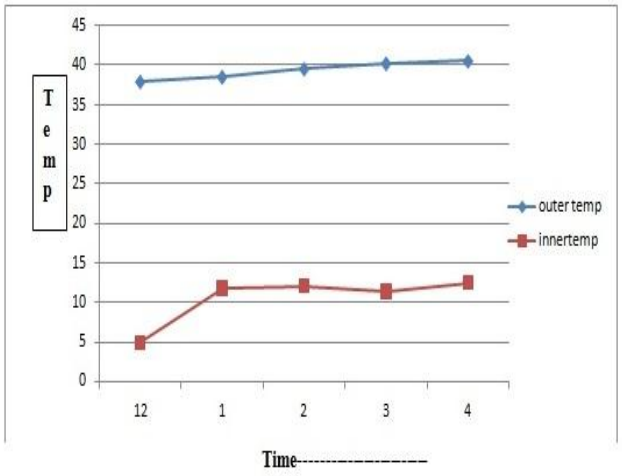
Original appearance of the potatoes before and after 5hours of drying in a full shiny day:

Figure 4.1: Potatoes before drying

Figure 4.2: Potatoes after drying

4.2.2 Drying rate of potatoes in graphical representation:

We see some of the following graphs that represent the temperature for every hour inside the drying chamber and the outside of the drying chamber of the solar dryer, to which the first and second graphical lines represent temperature at inside and outside the chamber. The second graphical line represents the temperature outside the drying chamber of the solar dryer. The following physical parameters represent the temperature within the reference of time at that particular point. In the intervening duration the solar drying does not give constant temperature due to the surrounding conditions that varies with time.

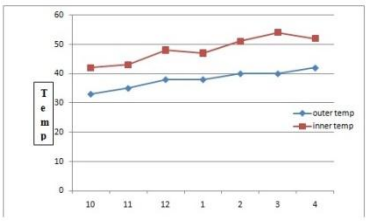


Graph 5.3.4-Avg. Temp vs. Time graph of potatoes

Table 4.2.2: Temperature & weight of grapes in different conditions

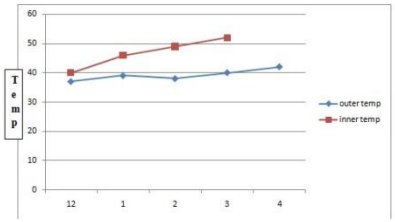
S.NO	DATE	TIME	OUTER TEMP	INNER TEMP	WEIGHT AT MORNING	WEIGHT AT EVENING
1	02-04-2019	10:00AM	33°C	42°C	1KG	
		11:00AM	35°C	43°C		
		12:00PM	38°C	48°C		
		01:00PM	38°C	47°C		
		02:00PM	40°C	51°C		
		03:00PM	40°C	54°C		
		04:00PM	42°C	52°C		828gms
2	03-04-2019	12:00PM	37°C	40°C	780gms	
		01:00PM	39°C	46°C		
		02:00PM	38°C	49°C		
		03:00PM	40°C	52°C		
		04:00PM	42°C	47°C		721gms
3	08-04-2019	10:00AM	33°C	38°C	681gms	
		11:00AM	35°C	44°C		
		12:00PM	36°C	47°C		
		01:00PM	38°C	50°C		
		02:00PM	38°C	51°C		
		03:00PM	39°C	54°C		
		04:00PM	37°C	50°C		317gms

DAY-1:



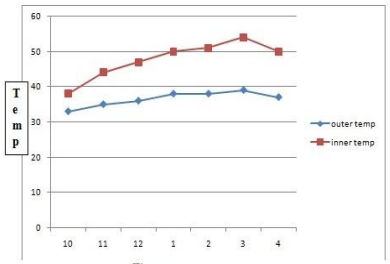
Graph 5.3.5-Day 1 Temp vs. Time graph of Grapes

DAY-2:



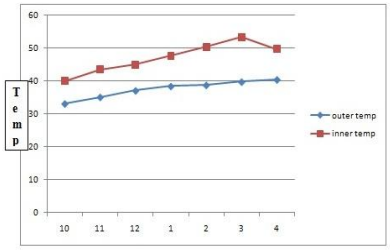
Graph 5.3.6-Day 2 Temp vs. Time graph of Grapes

DAY-3:



Graph 5.3.7-Day 3 Temp vs. Time graph of Grapes

GRAPHICAL REPRESENTATION OF AVERAGE DRYING OF GRAPES:



Graph 5.3.8 -Avg.Temp vs. Time graph of Grapes

Physical appearance of (grapes) before and after 5hours of drying in a full sunny day:

Figure 5.5: Grapes before dry

Figure 5.6: Grapes after dry

5. CALCULATION OF FIXED SOLAR DRYER'S PRACTICAL EFFICIENCY:

1. Dryer productivity

i) One day Dryer productivity (η_d) for potatoes = 14.9 %

ii) One day Dryer productivity (η_d) for grapes = 31.7%

The average dryer productivity is discovered out to be 15% for one day

6. RESULTS & DISCUSSION

After this case examination we have practically found that the developed solar thermal energy dryer gives more than three-four times heat inside the chamber than that of the outside atmospheric temperature during a time a fully sunny day. In 6 hours of without interruption drying direct bellow the same climatic order and same time 643grams of weight has removed. Our experimental setup gives an average dryer productivity for one complete sunny day was unexpectedly to be 15%.

7. CONCLUSION & RECOMMENDATIONS

7.1 Conclusion

This solar food dryer will be operated by using the help of the solar energy. In a nation like India 300 days out of 365 days are sunny have a huge valuable thing of solar energy. The government is also actively encouraging the use of renewable sources of energy like solar energy by the condition subsidies on solar panels, solar pumps, solar water heaters, solar gadgets and solar lights etc... So it's a good opportunity to take the advantage of these schemes. The solar energy costs us nothing just only needs a solar panel, sunlight is which is a free of cost and also it is a non finishing source of energy.

SAMPLES	DRYER EFFICIENCY
Potatoes	14.9%
Grapes	31.7%

The concluded data while performing the experimental analysis is shown in the coming after table for unlike samples:
Table-7.1

7.2 Recommendations

The practical implementation of this developed solar food dryer can still be made better upon especially in the feature of reducing the drying time, and also the probable energy storage system of heat energy within the complex mechanism by compact vary in degree in the physical size of the solar energy collector. We also take the pre calibrated meteorological data which is readily able to be used to the users of solar substances to ensure empowered efficiency for effectiveness working of the network. Such facts provided will doubtless guide the associated farmers on when to dry their agricultural substances and when not to dry those useful substances in the solar dryer's.

8. FORTH COMING SCOPE

This work is carried out in order to get good capability by involving the use of theory and experimental applications beyond in our day to day conceptual studies under the module of "Advanced free energy topics in mechanical engineering". The implementation of the solar dryer diminishing short comings associated with low efficiency, high cost, and importable solar dryers. Estimating the size of food in the solar dryer to which the original design of our solar food dryer is for day time only. In future we will are trying to make it that, it can be for night time also by adding air heater and also for the reason of solar panel fabrication the dryer size becomes heavier.

Further study on other modeling software's it is needed to uphold confidence in mathematical simulation of drying process. Solar energy is a measure of non polluted quality of solar energy which can be taken can clearly into the account of the loss of availability of heat in the solar drying systems. Hence the energy analysis should be used to design and fabricating the solar drying systems with the highest possible thermodynamic efficiency in the real time applications.

9. REFFERENCES

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