EXPERIMENTAL ANALYSIS OF IOT BASED SOLAR DRYER

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ABSTRACT

Solar dryer[1] are widely used for drying fruits, vegetable, fish, coffee and agriculture product for both domestic as well as industrial purpose. In this research, performance of evacuated solar collector using adjustable reflection sheet with fully covered so that heat loss through convection are minimize has been examine. It has been found that temperature of water increases by 5 degree when the whole setup is covered with transparentcover and the peak temperature achieved with the single evacuated solar collector is 47 ^{o} C. for the above study the setup is constructed in LNCT BHOPAL campus to take multiple readings to find desired result. With the help of this data a arduino app[2] programing in matlab[3] is created with the help of this the whole mechanical work is converted into software work and the water temperature is observed at each point of time there is no need to take further reading with arduino app approach and finally this data is needs to validatedwith the original data.

KEYWORD Solar dryer, Arduino app, MATLAB, Moisture content, Efficiency of solar drying, defect of product.

1)INTRODUCTION

Solar dryers are used to remove the moisture content [4] from vegetables, crops, and fruits. The solar dryer consists of a box made up of easily available and cheap material like galvanized iron, brick, and plywood. The main use of drying is to lower the moisture content of the grain for safe storage and further processing. Many applications of solar dryer are paint drying, drying glass and plastics, ink, adhesives, and removing excess water from filter material.

The following some considerations are very important in the solar dryer design:

A. Temperature - The minimum temperature for drying food is 30°C and the maximum temperature is 65°C, therefore 45°C and above is considered normal for drying vegetables, fruits, leaves and other crops.
B. Efficiency of solar dryer[5] - A defined as the ratio of the useful output of a device to the input of the device.
C. Air gap - It is suggested that for hot climate passive solar dryers, a gap of 7 cm should be created as air vent (inlet) and air passage.
D. Dryer Trays – Metal mesh can use as dryer trays to pass air circulation within the drying chamber. The design of the dryer chamber use of wooden wall sides.
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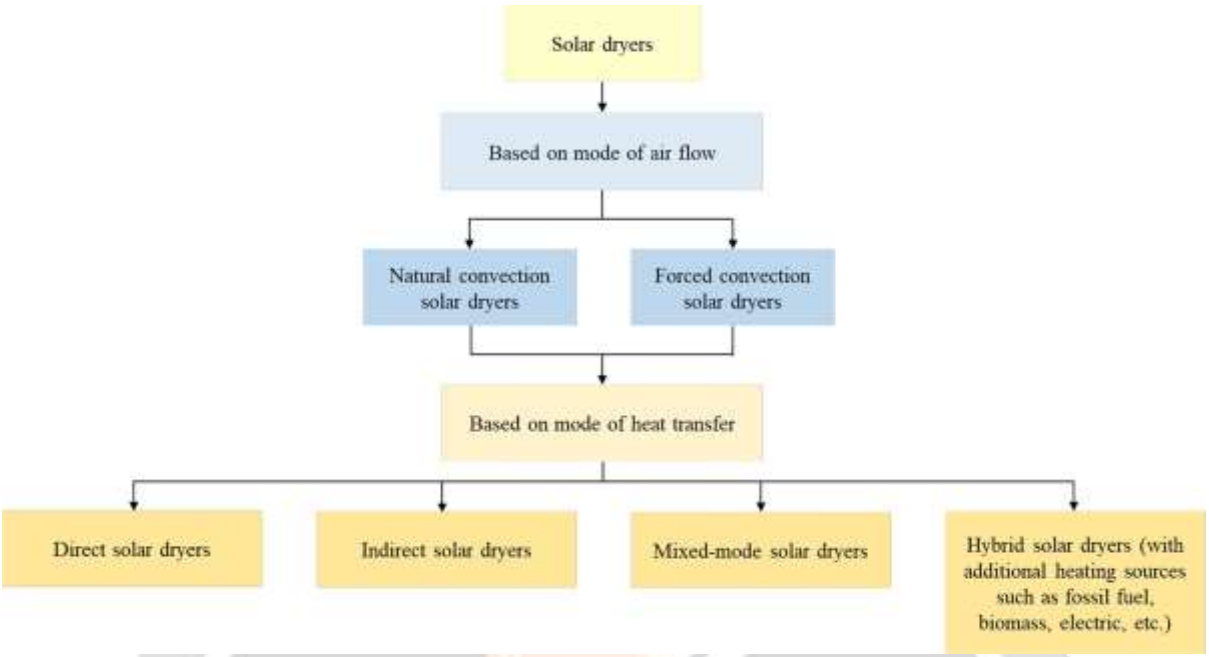
Categorization of solar dryers-



2)Materials and Methods

MECHANISM OF DRYING AGRICULTURAL PRODUCTS AND CLOTHS

Drying is most cost effective appling of solar energy. There are many products which are dried by solar dryer like various fruits, grains, timber, fish, cloths. Food products are conserve by drying. In succeed nations, open to the sun drying technique is used for drying food products. Open to the sun drying means products are manifest directly to sun, permit to absorbed solar radiation. It was describe that this method has many disadvantages like poor quality, defect of product [6]

The following materials were used for the construction of the solar dryer:

A. Wood: **-** The casing (housing) of the whole system; wood is selected being a good insulator and relatively cheaper than metals. Wood having low thermal conductivity than other materials, so heat transfer is less.
B. Glass: - The solar collector cover permits the solar radiation into the system but resists flow of heat energy out of system. It is having a higher transmissivity than other materials.
C. Galvanize for maximum absorption of solar radiation.
D. Net cloth (metal mesh) and wooden frames for constructing the trays.
E. Nails and glue as fasteners and adhesives.
F. Insect net at air inlet and outlet - to prevent insects from entering into the dryer.
G. Hinges and handle for the dryer's door.
H. Paint:-black for the solar dryer outlook

Difference between Solar dryer with open air drying.

Advantages:

a. It set out better quality of drying product.
b. It reduces losses and bacterial contamination.
c. Requires less area for drying.
d. May reduce labor required.
e. Drying time reduces.

Disadvantages:

a. More expensive.

Differnce between Solar dryer with Mechanized form of dryer:

Advantages:

a. It decrease environmental impact.
b. Easily managed.
c. Prevent fuel dependence.
d. Often less expensive.

Disadvantages:

a. Requires adequate solar radiation.
b. Hot and dry climate preferred (relative humidity below 60% needed).
c. Requires more time.

2.2 difference between Solar dryer with open air drying.

Advantages:

a. It set out better quality of drying product.
b. It reduces losses and bacterial contamination.
c. Requires less area for drying.
d. May reduce labor required.
e. Drying time reduces.

Disadvantages:

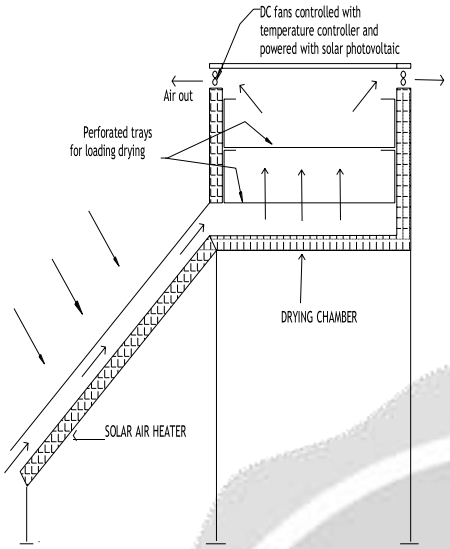
a. More expensive.
b. It may need some parts material to be implication.

Solar air heater

The solar air heater works by natural circulation of air. The aperture area of solar air heater is 2.25 m^2 (1.87 m x 1.20 m). The duct spacing has been kept as 10 cm for natural air flow through the dryer. At the bottom and sides, a thermocole insulation of 5 cm is provided. A GI sheet painted dull black is fixed above thermocole using 1 cm thick spacers. The GI sheet is painted dull black and it acts as absorber of solar radiation. The spacers are used between GI sheet absorber and thermocole so as to avoid direct contact between the hot absorber and thermocole. The glazing is 4mm thick transparent glass sheet. The opposite ends of this duct are open for ambient air inlet and hot air outlet to drying chamber.

Drying chamber

At the top of solar air heater is a drying chamber for holding the product to be dried. It has been made to achieve semi-continuous drying. For achieving semi-continuous drying, two trays one above the other have been provided andair flows through them. At the start, the fresh product is loaded in the lower tray up-to the top. During subsequent drying days, the partially dried product from upper tray is mixed with product in lower tray and fresh product is again loaded in the upper tray. This causes better utilization of heat in drying air before exhausting to atmosphere. Thelower tray has 108.0 cm x 48.5 cm cross-section and 19.5 cm height. The upper tray cross-section is 106.5 cm x 47.0 cm and 6.5 cm height. Both the trays are made of GI sheet with wire mesh at the bottom. The overall dimensions of the drying chamber are 123.0 cm x 63.0 cm cross-section and 37.0 cm height. The height of plenum is 10.0 cm. The chamber is insulated from bottom and sides with 7.5 cm thick thermocole insulation. Four openings of 8 cm diameter have been provided for air outlet in the side's walls of the drying chamber near the top. Four thermostatically controlled DC electric fans of rating 3W each are fixed in the four openings provided near the top so as to maintainthe air temperature at inlet to drying chamber below permissible limit. These fans are operated by 20 Wp solar photovoltaic panel using DC temperature controller.



3)FABRICATION OF SETUP

Material required

Iron rod

Insulator (glass wool)

Plywood- the casing (housing) of entire system

Transparent sheet- cover for collector

Wire mesh- for dryer

Insect net- for air inlet & outlet

Nails

Adhesives

Black paint

Hinges and handle- for the dryer's door

Temperature sensor

Humidity sensor

NodeMCU- ESP8266

Breadboard

Jumper wire

USB Cable

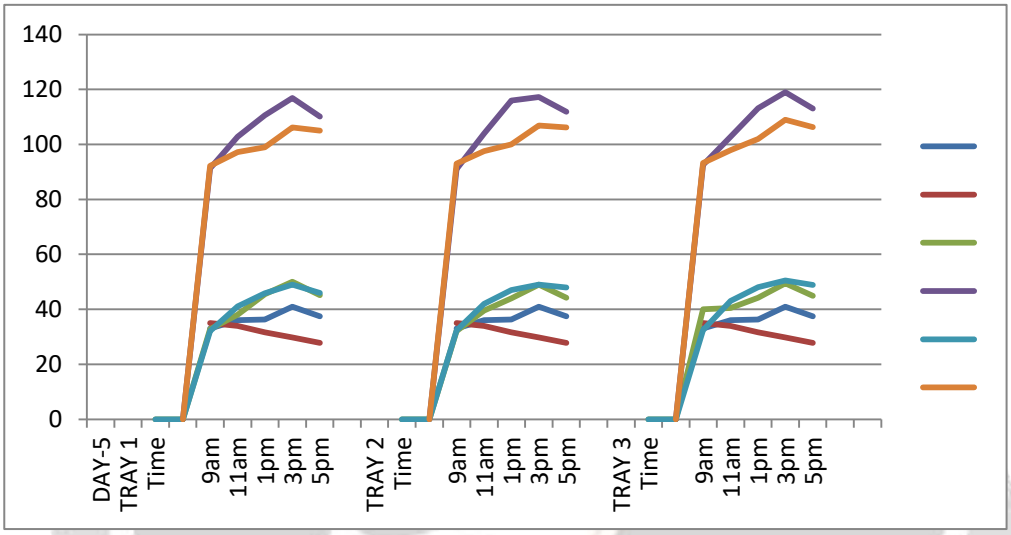



4)RESULT

TRAY 1						
Time	**Ambient temp**	**Humidity %**	**Temperature**		**Heat Index**	
			C'	**F**	**C'**	**F**
9am	32.5	37	32	91	32.1	92.2
11am	35	35.5	38.1	101.3	41.1	96.6
1pm	36.1	33	41	109.2	45	98
3pm	39.5	30	45.5	114.3	47.9	105.5
5pm	37	28	43	110.1	46	105
TRAY 2						
Time	**Ambient temp**	**Humidity %**	**Temperature**		**Heat Index**	
			C'	**F**	**C'**	**F**
9am	32.5	37	32.1	91	32	92.3
11am	35	35	38.9	101.9	41.5	96.9
1pm	36.1	33	41.1	110.2	46	99

3pm	39.5	31	45.5	115	48	106
5pm	37	28.3	43.1	110.3	47.3	105.2

TRAY 3						
Time	**Ambient temp**	**Humidity %**	**Temperature**		**Heat Index**	
			C'	**F**	**C'**	**F**
9am	32.5	36.9	32.9	92	32.5	93
11am	35	35	39.5	102	42.6	97
1pm	36.1	32.8	42	111.9	47.2	101
3pm	39.5	30	46.1	116.1	49	107.5
5pm	37	28	44	111	48	106



5)Result validation

In above chapter we have put the graph between time and temperature on the basis of experimental analysis now this data needs to be validate with the arduino logic data. Here we find the percentage of error between experimental data andthe temperature we get from arduino logic approach, this should be put in the below table-

SN	Time	Experimental Result of leaves	Arduino Result	Percentage Error
1	9 am	27.2	29.5	7.79
2	10 am	34.6	33.3	-3.9
3	11am	38.4	43.1	10.9
4	12 pm	43.9	46.2	4.97
5	1 pm	45.1	46.4	2.8
6	2 pm	46	46.2	0.43
7	3 pm	47	45.6	-3.07
8	4 pm	46.8	52.6	11.02
9	5 pm	46.2	55.5	16.75

Conclusion

It has been found that evacuated tube in close system result is much better then open system, because due to covering the setup heat loss through convection is minimized. It has been found that maximum water temperature has been found 47 ^{o} C, when ambient temperature is 42 ^{o} C. the experiment has been performed with open system at the same temperature means 42 ^{o} C at this temperature 40 ^{o} C has been achieved. In overall experiment it has been found 5 ^{o} C temperature enhancing.

In this research work arduino based mathematical model has been developed and result has been validated from this model. From this model we achieved very close result in terms of experiment. The maximum percentage of error is 16.75% and minimum is -3.9% that is very close with experimental result.

Future Scope

IOT is much more popular as well as efficient technology for domestic applications having wide range of temperatures from low to high and with the arduino logic application it makes it perfect for uses in hotels, hospitals, industries etc.