RESEARCH PAPER ON EXPERIMENTAL PERFORMANCE OF SOLAR GREENHOUSE DRYER FOR DRYING VEGETABLES & FRUITS

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ABSTRACT

In present Analysis it has done some modifications in existing solar greenhouse dryer here it incline the roof of dryer according to the latitude of Bhopal city and also we use black plastic film to increase the absorbing capacity of the dryer with the use of fans for forced convection purpose.To check the effect of inclination with black plastic film, simple greenhouse dryer has been made and itcompare results in two different conditions.The performance of modified, simple and open sun drying compared in terms of drying rate in two conditions and also with visual appearance of dried potato flakes.To minimize the obstacles, the roof of dryer is inclined and black plastic film was used with forced convection method by which the heat absorbing capacity is increased.It is found that the dryer with black plastic give better result than the dryer with all side transparent plastic. The modified green-house gives best result in all the condition of atmosphere. It gave better condition for drying potato flakes such as high temperature and less humidity than simple greenhouse dryer and atmosphere.

Keywords: *Solar Drying System, Simple Green House Dryer (GHD), Modified Green House Dryer (MGHD), Potato Flakes etc.*

1.0 INTRODUCTION

Solar energy is the most attractive and abundant type of renewable energy source and solar thermal technology is rapidly achieving acceptance for reducing the conventional energy consumption in the field of agriculture applications. Drying fruits and vegetables is one of the oldest preservation methods that have received great attention due to high nutrition content. Solar drying is most attractive method used for preservation of food especially in India where most of the crops and grain harvests are lost to fungal and microbial attacks, by providing appropriate drying technique these wastage could easily prevent, which will

enhance the storage of agriculture products. The solar dryers are effective devices which are used for completing drying operations which work based on different classified categories such as:

- Direct Mode
- Indirect mode
- Mixed mode

This experimental study is performed with two types of solar dryers and obtained results are compared in order to get appropriate process of drying. Simple Green House Dryers (GHD) and Modified Green House Dryers (MGHD) were used for performing experimental study in different conditions.Mamdohet.aldeveloped a new modified natural convection solar dryer used for drying fruits is presented; taking into account the local climatic conditions prevailed in Jordan during summer season. sahuet.alit analyseddirect drying and indirect drying can be done using greenhouse dryer which can further be classified as greenhouse dryer with natural convection (passive mode) or with forced convection (active mode). Baradey et.alit analyse the drying is a water removal process from foods commonly used for storage purposes. Acharya et.alinvestigate how the use of solar dryer is slowly finding its way for food drying in Nepal. For household purpose the use of direct type dryer is being common but if we see the indirect type dryer still has limited application.

2.0 EXPERIMENTAL SETUP AND PROCEDURE

In this one of the roof of the dryer (MGHD) is inclined to the latitude of Bhopal i.e. 23^{o}in such case the centre of one side become 48 cm and wall height become 32cm. The other side central is become 88.9 cm and wall height become 72.9 cm with floor area of 95× 62.5 cm^2. The drying tray is simple and made up of wire mesh with an effective area of 93× 56 cm^2. The tray is also inclined in MGHD and which is parallely inclined to the roof and built up of black wire mesh for absorbing maximum solar radiation. For incoming of atmospheric air inside the dryer, we provide two small circular passage of 10 cm on the south wall side just below the tray position from where we put tray into the drier. We provide forced circulation of air to dry the potato flakes in less time. One AC exhaust fan of 2 cm diameter with power of 20W, 0.15A having 2500 RPM is used to exhaust the inside air in both the green house drier simple and modified.

Fig. 1: Experimental Set-up

(a)(b) (c)

Visual appearance of potato flakes in different drying condition. Fig (a) is for modified Green House potato flake Fig (b) is for simple green house dryer flakes Fig (c) is in for open condition when the flakes are dried in open atmosphere. At inlet we use four other small fans to provide much more forced convection they work simultaneously and they are connected in series. They are not taking too much power they are very light and easily assembled in the set up.

2.1 Materials

Fresh potatoes of 3 kg were procured from the market in Bhopal, India. The potato was manually chosen and we take the potato approximately of same size such that they easily cut and putted on the tray. All the potatoes were washed by water and we see that the dirt was totally removed from the potatoes. Then after cleaning the potatoes each one is cut into flakes of 3 to 4 mm thickness so that we not do anything after that that is without further treatment.

3.1 WORKING PROCESS

There are two combinations we made in every week of the month in which for the First three days in our experiment we use transparent plastic film in both the dryers that is with simple greenhouse dryer and modified greenhouse dryer and then after for next three days we use black plastic film for the analysis in both dryers. MGHD is basically is built in the latitude of Bhopal. After this we take an average for the readings we found in the experiment and see the changes occurs due to the forced convection method and also due to use of black plastic film.

We compare the results of this modified greenhouse dryer and simple greenhouse dryer in different condition/setup we used. We also take the reading without using any of the set up that is in open sun drying. Simply we put the potato flakes separately under no load condition and measure the weight and compare all the reading with each other and see which is much more optimal.

The drying procedure of the potato flakes are performed in two different modes – modified greenhouse drying, simple green house drying and in open sun drying under forced convection.

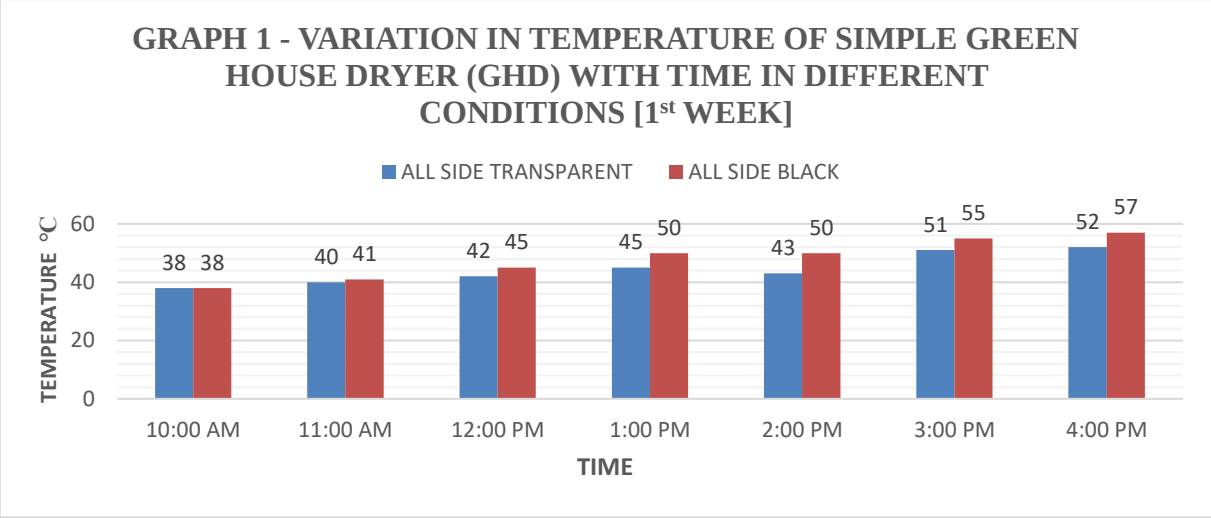
4.0 RESULTS AND DISCUSSION

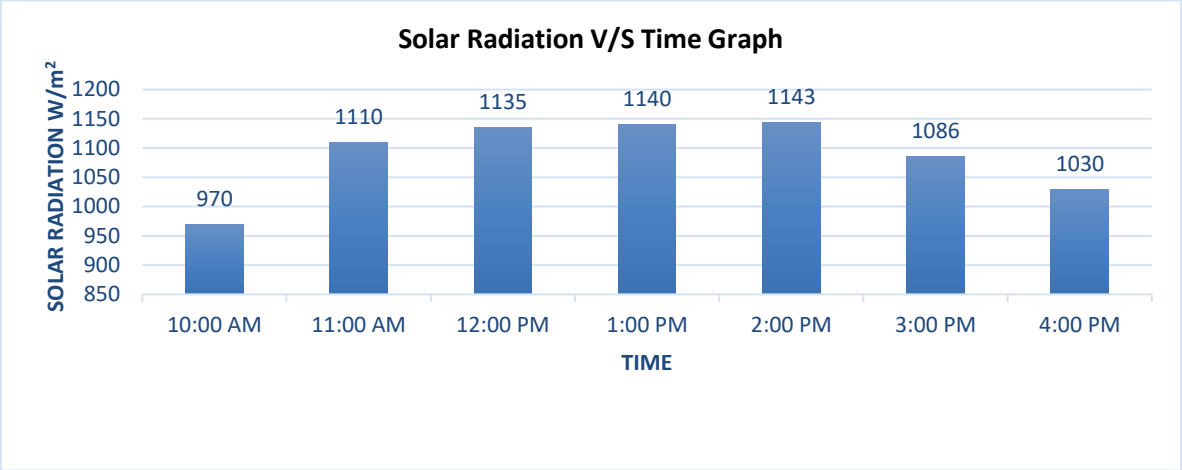
4.1 FOR SIMPLE GREENHOUSE DRYER

The ambient Parameters acquire and Plays very important criteria to know the different phenomenon of drying of crop in any type of drying. table1 gives the changing trend of solar radiation with time. These are the readings of solar radiation on an average basis for the first week in the month of May. We see that the solar radiation and temperature was quiet high which is very much beneficial for our analysis. In table 5.1 the changing trend of temperature is shown for simple green house dryer in two different conditions. For the First week of experiment we take average of all and the solar radiations varied from 970 W/m^2 to 1143 W/m^2 with maximum value at 2 pm. And the ground temperature also changes with time and it also calculated on an average basis and which varies from 40℃ to 59℃ with maximum value at 3 pm. As if we applying all side black film there is significant increase in temperature of the room. Maximum temperature is reached with all side black film that is 57℃ which is our requirement for drying the potato flakes rapidly. We apply 4 fans at inlet to the dryer so by this we increase the air quantity as well as moisture containing capacity of the air as if it come and flow rapidly then it pickup moisture in more amount and goes away.

Time	Solar Radiation (W/m^2)	Ground Temperature ℃	Simple Green House Dryer (GHD) Room Temperature ℃	
			All Side Transparent	All Side Black Plastic
10:00 AM	970	40	38	38
11:00 AM	1110	45	39	41
12:00 PM	1135	49	42	45
01:00 PM	1140	55	45	50
02:00 PM	1143	54	43	50
03:00 PM	1086	59	51	55
04:00 PM	1030	58	52	57

Table 1- Variation In Solar Radiation And Temperature Of Simple Green House Dryer (GHD) With Time [1st week]





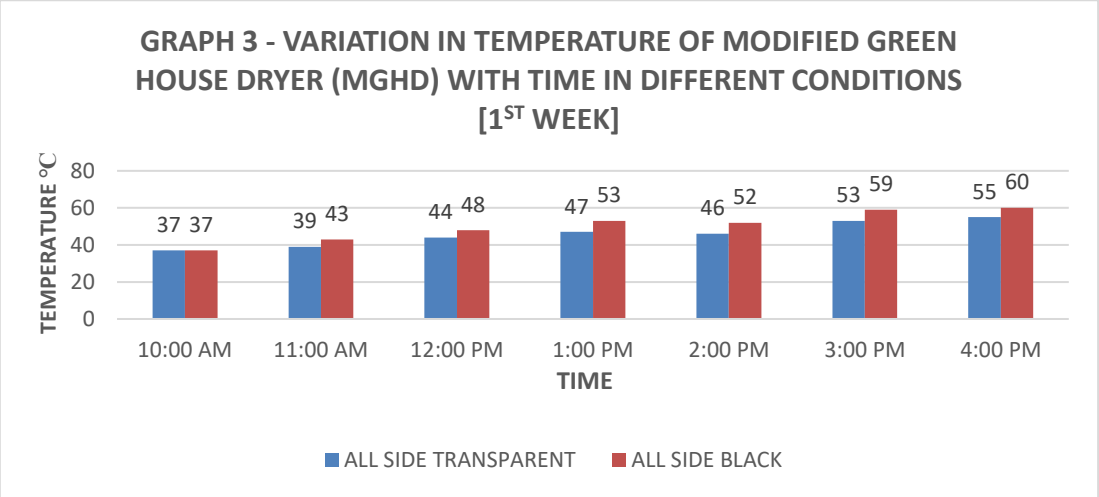
4.2 FOR MODIFIED GREENHOUSE DRYER

Now in table 2 we see the effect of the modified Green House dryer which was tilt in the latitude of Bhopal. In this the temperatures are greater than the simple green house dryer and also there is change in maximum temperature. In simple green house dryer on an average basis with all side black the temperature was 57℃ where as in modified case with all side black the temperature was 60℃. So, we see there is much more benefit if we modify our Green House dryer. When the solar radiations are less the ground temperature is also change with it that is it also decreases.

Time	Solar Radiation W/m^2	Modified Green House Dryer (MGHD) Room Temperature^{0}C	
		All Side Transparent Plastic	All Side Black Plastic
10:00 AM	970	37	37
11:00 AM	1110	39	43

12:00 PM	1135	44	48
01:00 PM	1140	47	53
02:00 PM	1143	46	52
03:00 PM	1086	53	59
04:00 PM	1030	55	60

Table 2: Variation In Temperature Of Modified Green House dryer (MGHD) With Time In Different Conditions [1st Week]

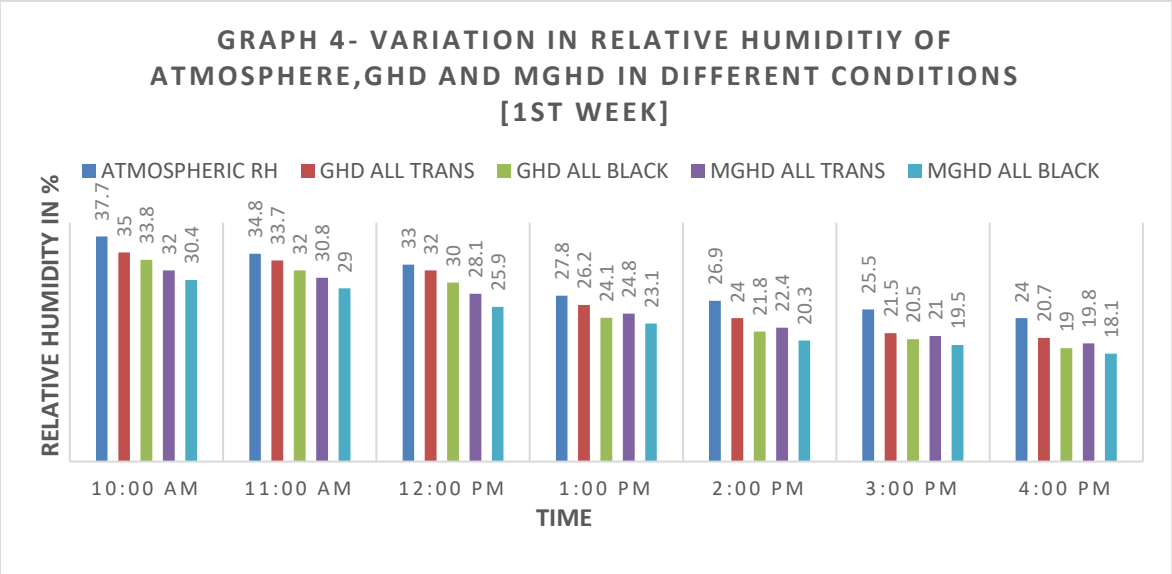


4.3 EFFECT OF RELATIVE HUMIDITY AND WIND VELOCITY IN DIFFERENT CONDITIONS [1stWEEK]

Time	Atmospheric Relative Humidity In %	Simple Green House Dryer (GHD) Room Relative Humidity In %		Modified Green House Dryer (MGHD) Room Relative Humidity In %	
		All Side Transparent	All Side Black Plastic	All Side Transparent	All Side Black Plastic
10:00 AM	37.7	35	33.8	32	30.4
11:00 AM	34.8	33.7	32	30.8	29
12:00 PM	33	32	30	28.1	25.9
01:00 PM	27.8	26.2	24.1	24.8	23.1
02:00 PM	26.9	24	21.8	22.4	20.3
03:00 PM	25.5	21.5	20.5	21	19.5
04:00 PM	24	20.7	19	19.8	18.1

TABLE 3– Variation Of Relative Humidity With Time In Simple Green House Dryer, Modified Green House Dryer And Of Atmosphere. [1st WEEK]

Table 3 shows the change in the relative humidity which is in % with time. The atmospheric RH changes from 37.7% to 24% and it was also on average basis where as in GHD room relative humidity is decreases slowly as compared to modified and also the humidity decreases rapidly when we cover all side with black plastic film. It is seen that with all side transparent and all side black there is significant change in relative humidity because as the temperature is more with all side black the humidity will be less.



GHD relative with all side black is 33.8% in starting which decreases to 19% at 4:00 pm. Where as in MGHD with all black relative humidity was 30.8% in starting and decreases to 18.1% at 4:00 pm. It is seen that RH increases with wind speed and decreases with temperature. It decreases with decrease in wind speed and increase in temperature. Wind speed also affects the temperature in such a way that when the velocity is high the temperature Reduce slightly. For any type of crop high temperature with less RH is most favourable condition which occurs in MGHD with all side black plastic film.

5.0 CONCLUSION

Analysis for the drying of potato flakes in MGHD and GHD with all side transparent plastic film and all side black plastic film and also in open sun drying are as Follows:

1. Solar greenhouse dryer was found to be optimum and economical with pollutant free technique for drying any type of agricultural products. It provides better result than the traditional ones.
2. MGHD with all side black plastic film provides better conditions for drying any type of agricultural crop.
3. We found that in forced convection mode the relative humidity in both rooms of dryers are less than RH of atmosphere. RH of modified dryer also found to be less than the simple dryer.
4. RH with black plastic all side is always less than the RH with all side transparent in any dryers.
5. Relative humidity is also affected by wind velocity, temperature, intensity of solar radiation, such that when temperature is high and speed of wind is low RH decreases whereas when temperature is low and speed of wind is high it increases.
6. Solar radiations Affects many parameters like ground temperature, MGHD room temperature, GHD room temperature. Temperature increases in morning as the solar radiation intensity increases and decreases as in the last stages due to decrease in intensity of solar radiation.
7. Atmospheric wind velocity also affects many parameters like ground temperature, MGHD room temperature, GHD room temperature. Such that when wind speed was high the temperature was start to decrease and vice versa.
8. Drying in dryers is found to be more Faster than open drying. And with use of black plastic film it is much more. Drying in modified dryer is also faster than GHD.
9. Drying in a dryer is also good because it is free from any type of dirt etc.
10. The payback period of MGHD is only 1.8 years that approximately 21 to 22 months.
11. With the use of black plastic all side instead of transparent on we get better results. And temperatures reached in the dryers are also higher.
12. The use of fans is also providing very much impact on drying process as with use of these fans we provide forced convection which was very much beneficial for the drying process.

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