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# Study and Analysis of Solar Cabinet Dryer on Passive Mode by Using Aluminium Foil, Solar Selective Black Carbon Material and Silica Sand (Concrete)

Scholar Sachin Kulshrestha[1], Amit shirivastava[2]
[1] *M. tech,* [2]*Assistant Prof., Department of Mechanical Engineering, Shri Ram college of Engineering & Management Banmore Gwalior, Madhya Pradesh 476444, India*

***Abstract:*** ***In this research work started to study of various article which is related to solar cabinet dryer. In many article do work repetition and some having different type of work analysis. There are work mostly to increase its efficiency, workability and moisture removal rate with changes in different parameters. Some of authors work passive mode solar cabinet dryer and some was work on active solar cabinet dryer. In this study observed that some of researcher use silica sand and metals particles. Every parameter have focused on different purpose of work. After the study of various articles analyze that use of mixture black carbon material and silica concrete as a storage material. That is important for increase moisture removal rate and drying rate. It will also enhance efficiency and workability of solar cabinet dryer. That will use in industry and winter oriented season in future aspects.***

***Keywords:*** ***% of Moisture Remove, Average Dry Rate(gm/sec) solar cabinet dryer, solar selective material, multi layer carbon coating, outside of dryer etc.***

## I. INTRODUCTION

The sun based dryer depends on the straightforward idea of drying of food things utilizing sun powered energy. It is a shut framework where drying chamber gets the hot air from the warmed space and the thing to be dried is spread over the plate put evenly one over the other. Conventional technique for food drying is to spread the groceries in sun in the outdoors[1]. This technique is called open sun drying. In this strategy food item gets polluted effectively and other disadvantage is that it is hard to manage enormous amounts of food since checking turns out to be more troublesome[2]. The essential standards utilized in sun powered dryer are: Trapping of heat:- By confining the external air from inside air utilizing straightforward glass or plastic pack cover. The glass cover permits both short wave and long wave radiation to enter yet captures the short wave radiation and allows long wave radiation to exit. The short wave radiation captured helps in the drying of food stuffs the air inside gets warmed. Moving the warmth to the food:- During development of hot air inside drying chamber it streams over the food item where hot air ingests dampness content from food item by convection[3]. Both the regular convection and constrained convection dryer move sunlight based energy in the warmth structure to the thing kept in the sun powered dryer for drying purposes. In the current examination a sun based dryer was planned, manufactured with locally accessible materials.

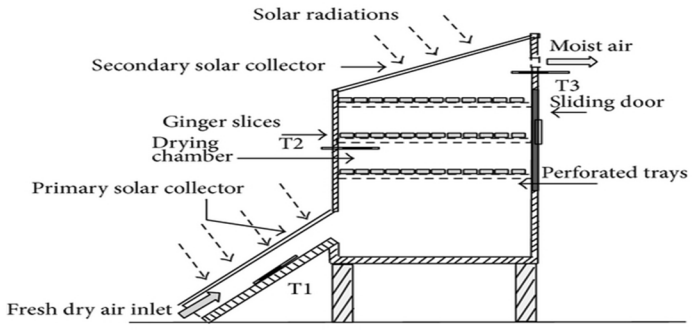



Fig 1: Mixed Mode Box Cabinet Natural Circulation Solar Dryer

Its exhibition was assessed tentatively taking the different factors into thought. This drier is very modest and can be manufactured in mass amounts effectively by semi-talented works.

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With the assistance of this plan the ranchers can create great attractive items at extremely low cost to improve their monetary condition. As the sun oriented energy is free, plentiful, climate amicable, thus sun oriented warm impact ought to be utilized through sunlight based driers as well as through sun powered still, sun based lake, sun powered fireplace, sun based heater, sun oriented cooker, for different human exercises[4]. Jain D et al (2004) played out the investigation to examine the convective mass exchange coefficient and pace of dampness expulsion from cabbage and pea in open sun drying and inside nursery drying. The convective mass exchange coefficient was lower for drying inside nursery dryer with normal mode contrasted with open sun drying furthermore, esteem was twofold if there should be an occurrence of constrained convection in Green house drying. El.- Sebaii A. An et al (2012) directed an examination to discover the best approach to safeguard the natural product getting waste around 30-40% because of absence of asset so to locate the sun based drying framework to quicken the drying cycle at evening time and low force sun based radiation time. This investigation improved the warm presentation of twofold pass level, V-folded and finned plate sun powered air warmer. The plan is ideal contrasted with reasonable capacity media. Sahu T K et al (2016) examined the plan ,execution ,favorable position and detriment of different sorts of sun based dryer. Result discovered that Green house dryer with constrained convection is best for high dampness content[5]. However, for low dampness normal convection is most appropriate and for business reason Photovoltaic coordinated sun based dryer are generally reasonable. Obayopo S O (2018) researched the drying qualities of regular types of fish in the jungles like Catfish and Talpia fish utilizing direct sun based dryer. Drying did under both dry and wet season with various fan speed. under normal mode and under constrained convection with various fan speed. Result acquired was palatable and max. Temperature contrast was 35 ℃.The dampness content of test was 13.97% for Catfish and 13.35% for Talpia. Greatest drying proficiency recorded was 74.3% with constrained convection at fan speed of 3.5 m/s.

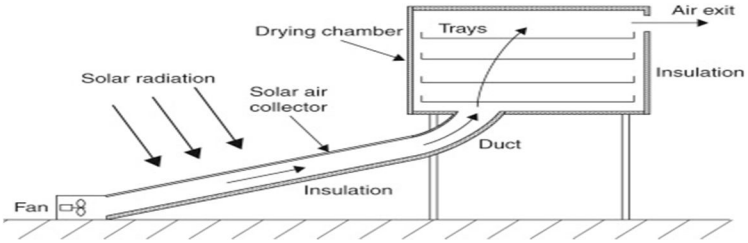



Figure 2 : Active mode solar cabinet dryer

*A. Plan and Fabrication of Solar Dryer*

In view of the writing study, the sun based dryer configuration was concluded as appeared in the photo. This was created from locally accessible material in the workshop of ShriRam College of Engineering and Management, Gwalior. This has three racks of punctured plate and the hot air flow is regular[6]. This is having an arrangement of strong material stockpiling at the base. The examinations were acted in the month of May 2020 with the end goal that 8-9 hours of sun oriented radiation is accessible at Gwalior from morning to night. The fundamental instruments incorporate a

*1)* Advanced thermometer
*2)* An electronic gauging machine and
*3)* A solarimeter MEGGER PVM 210

## II. RESULTS AND DISCUSSION

| | Product Temperature °C | Collector Temperature °C | Drying Chamber Temperature °C | Ambient Temperature °C |
|---|---|---|---|---|
| 07:30 AM | 28.4 | 38 | 35 | 31.1 |
| 08:30 AM | 32.1 | 40.7 | 39.1 | 33.9 |
| 09:30 AM | 37.9 | 47.5 | 46.3 | 38.9 |
| 10:30 AM | 44.5 | 54.4 | 50.9 | 44 |
| 11:30 AM | 49 | 58.5 | 53.8 | 45.3 |
| 12:30 PM | 50.5 | 62.7 | 61.1 | 47.1 |
| 1:30 PM | 53.9 | 71.2 | 65.6 | 50.1 |
| 2:30 PM | 53.1 | 63.7 | 62.1 | 45.9 |
| 3:30 PM | 47 | 55.9 | 53.1 | 45 |
| 4:30 PM | 39.8 | 50 | 46.1 | 38.1 |

Table 1. (Temp. – Time)

Table 1: show temperature of product, collector, drying chamber, ambient during experiment.

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| Time, Hours | Solar insolation (W/m2 ) |
|---|---|
| 07:30 AM | 537 |
| 08:30 AM | 590 |
| 09:30 AM | 619 |
| 10:30 AM | 689 |
| 11:30 AM | 722 |
| 12:30 PM | 868 |
| 1:30 PM | 982 |
| 2:30 PM | 771 |
| 3:30 PM | 565 |
| 4:30 PM | 468 |

Table 2 (Solar Insolation)

Table 2. express solar isolation with different time accordingly temperature variation.

| | 07:30 AM | 08:30 AM | 09:30 AM | 10:30 AM | 11:30 AM | 12:30 PM | 1:30 PM | 2:30 PM | 3:30 PM | 4:30 PM |
|---|---|---|---|---|---|---|---|---|---|---|
| Mass Reduction (Inside Dryer) | 400g | 388g | 377g | 348g | 299g | 228g | 135g | 96g | 67g | 51g |
| Mass Reduction (Outside Dryer) | 400g | 397 | 389g | 372g | 332g | 289g | 239g | 190g | 167g | 154g |

Table 3. Mass reduction without storage material

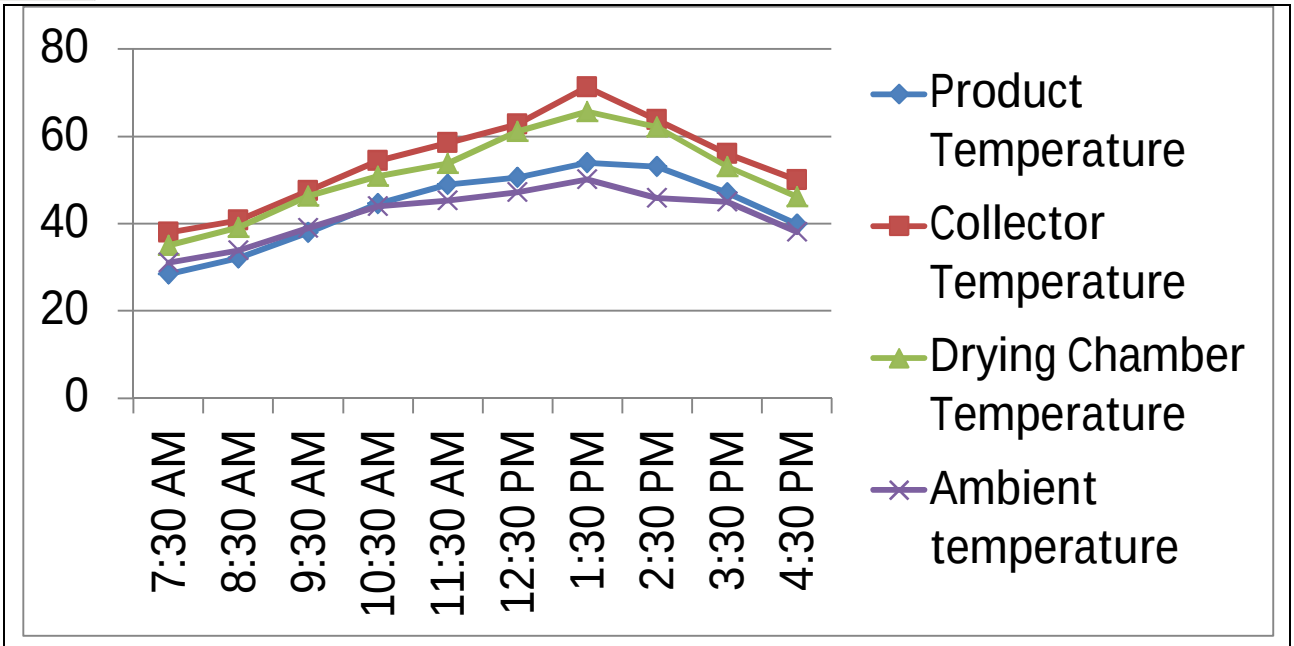
In this experimentation The drying on coriander leaves is led in sun powered dryer for assessment of execution of dryer, item quality and sustenance esteem. In the underlying 400g green coriander leaves are stacked in dryer at 8:00 am and same amount is spread in open sun drying to think about the drying rate. Experimentation is proceeded till least required dampness is accomplished[7]. The outcome got is appeared in Graphs. The surrounding temperature variety was from least 31.1 ℃ at 7:30 AM to greatest 50.1 ℃ at 01:30 am during drying period. The other examination is likewise done by utilizing stockpiling material underneath authority plate of dryer for better drying[8]. The temperature of dryer was seen to be 3 ℃ higher in the event that with capacity material contrasted with without it. Likewise mass misfortune was additionally higher by 14g. The sunlight based insolation minor departure from that specific day was 537 W/m2 to 982W/m2.

Table 3 and 4 are described mass reduction rate inside and outside of the dryer without and with storage material.

| | 07:30 AM | 08:30 AM | 09:30 AM | 10:30 AM | 11:30 AM | 12:30 AM | 1:30 PM | 2:30 PM | 3:30 PM | 4:30 PM |
|---|---|---|---|---|---|---|---|---|---|---|
| Mass Reduction (Inside Dryer) | 400g | 390g | 370g | 344g | 292g | 208g | 134g | 89g | 56g | 39g |
| Mass Reduction (Outside Dryer) | 400g | 397 | 389g | 372g | 332g | 289g | 239g | 190g | 167g | 154g |

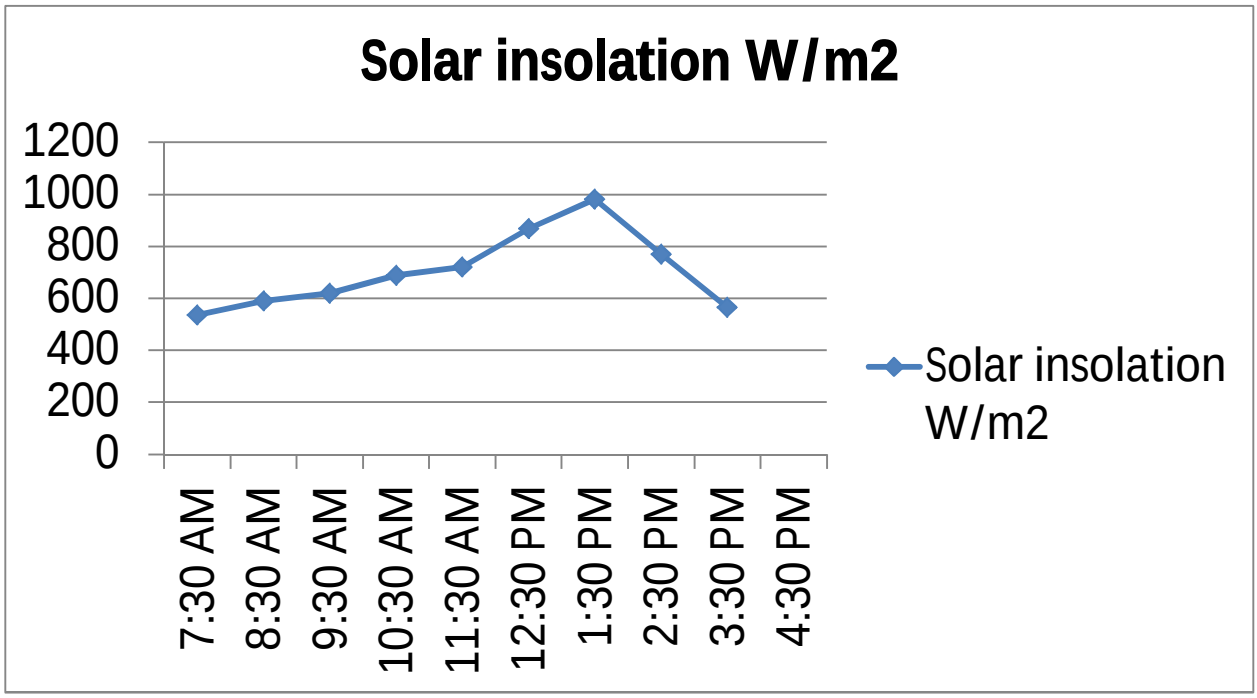
Table 4. Mass reduction with storage material

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Graph.1Distribution of (1) Product Temperature,(2) Collector Temperature,(3) Drying Chamber Temperature, (4) Ambient Temperature

Graph 1 portrays the temperature variety at various areas with the hour of a regular day in the period of May 2020. It is seen that the most noteworthy worth happens around 1:30 pm when the sun oriented insolation is having the most elevated worth 982W/m2.

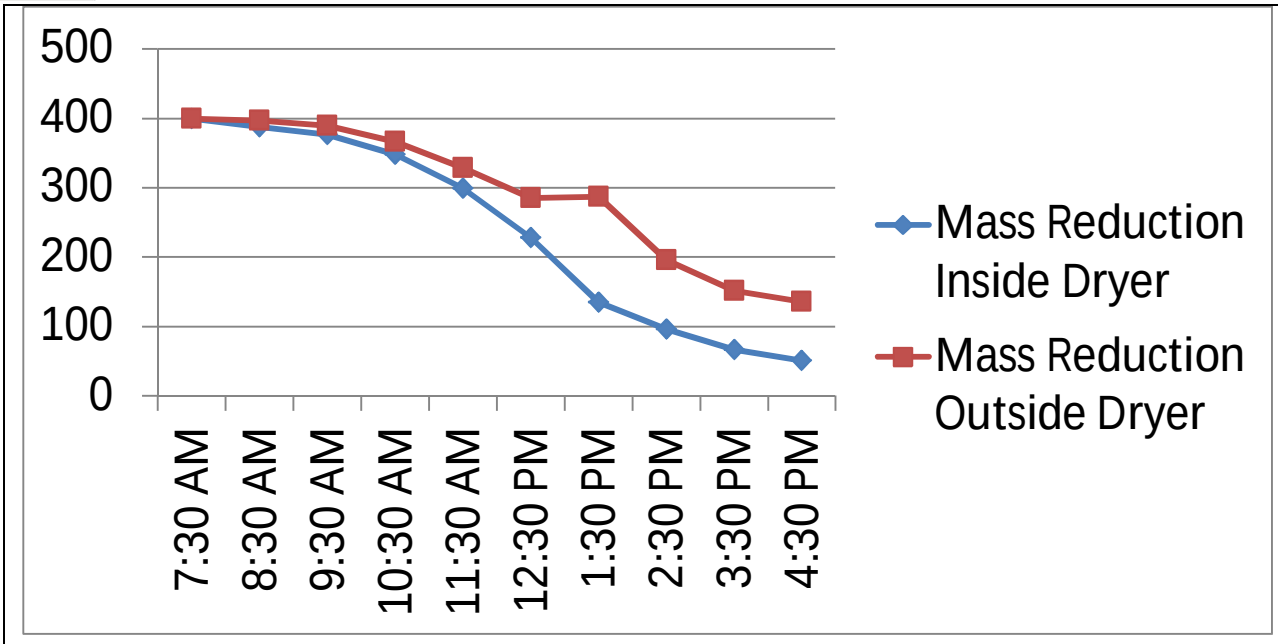



Graph. 2 Solar Insolation variation

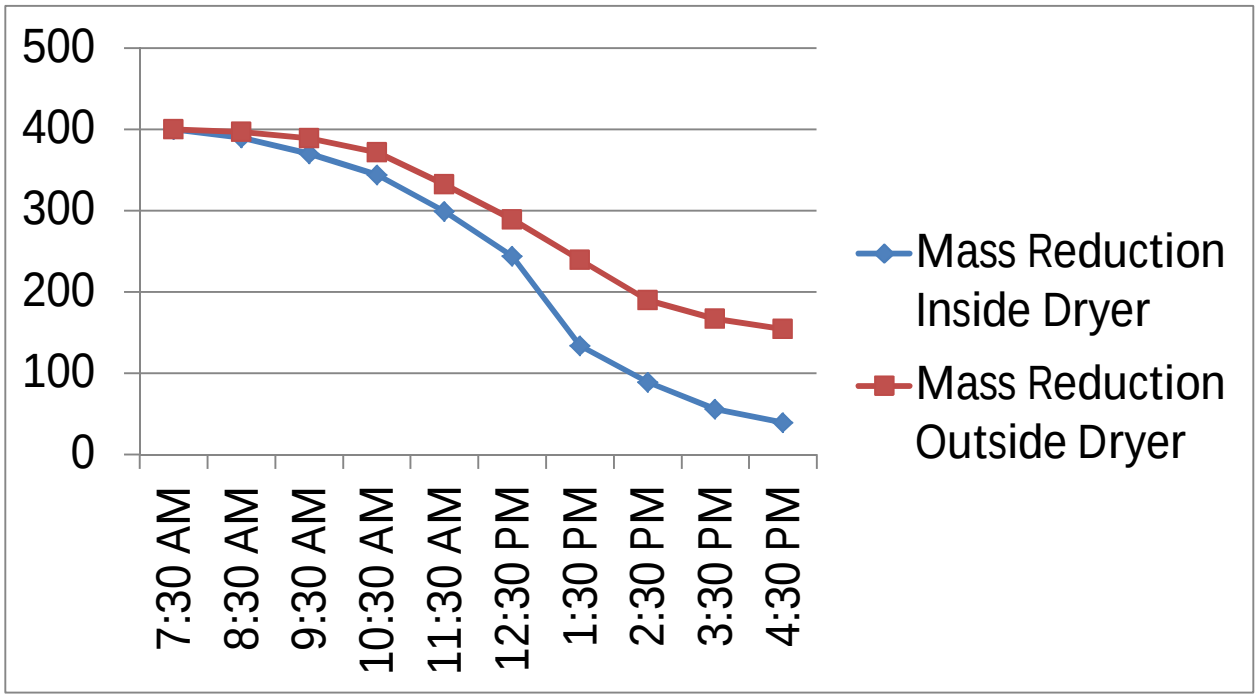
In Graph 2 sun oriented insolation has been appeared for the exact day of temperature estimation as appeared in past Graph 1. True to form the hour of most elevated sun powered insolation and temperature in the dryer is a similar that is around 2p.m.

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graph. 3 Comparison of Solar Drying with Open sun drying without storage material.




Graph 4: Comparison of Solar Dryer Drying with Open sun drying with storage material.

Hourly moisture loss for the case of open drying and drying with dryer has been demonstrated in Graph 3 & Graph 4 for the case of without heat storage material and with heat storage material respectively. It can be observed from both the curves that in first 3 hour drying rate is almost the same which may probably be due to the effect of sensible heating. After 11:00 am the drying rate is higher in case of storage material put in the dryer as expected.

The shape of both the curve for both the graph 3 and graph 4 are almost the same except the fact that the presence of solid heat storage material improves the performance.

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Fig 3: (Photograph of Solar Dryer)

Drying performance of coriander inside drying chamber with and without using black carbon material with concrete and outside the dryer

Total mass losses in % = $\frac{M1-M2}{M1}$x100

Where

M1 – Mass of the product earlier drying process

M2 – Mass of the product later drying process

Comparison of mass loss % of coriander with and without black carbon material with concrete and OSD

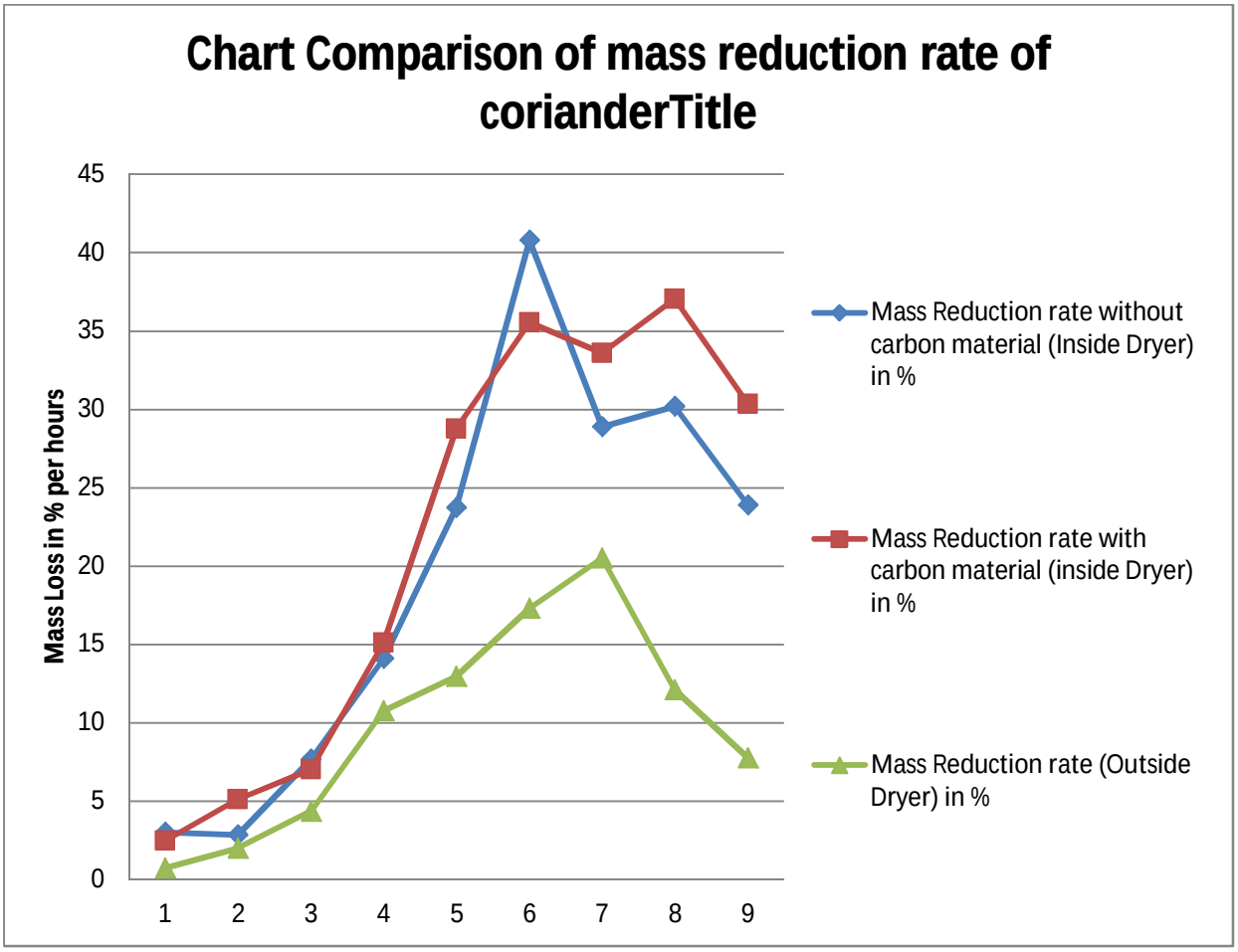
| Period of time | I$^{st}$ hours | II$^{nd}$ hours | III$^{rd}$ hours | IV$^{th}$ hours | V$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ Hours |
|---|---|---|---|---|---|---|---|---|---|
| Mass Reduction rate without carbon material (Inside Dryer) in % | 3 | 2.83 | 7.69 | 14.08 | 23.74 | 40.78 | 28.88 | 30.20 | 23.88 |
| Mass Reduction rate with carbon material (inside Dryer) in % | 2.50 | 5.12 | 7.02 | 15.11 | 28.76 | 35.57 | 33.58 | 37.07 | 30.30 |
| Mass Reduction rate (Outside Dryer) in % | 0.75 | 2.01 | 4.37 | 10.75 | 12.95 | 17.30 | 20.50 | 12.10 | 7.78 |

Table 5 Comparison of mass reduction rate of coriander.

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This is comparison table of mass reduction rate of coriander leaves. That are showing black carbon and concrete material highly affected to reduction rate of moisture content which is application use in future aspects.




Graph 5: Comparison of mass reduction rate of coriander.

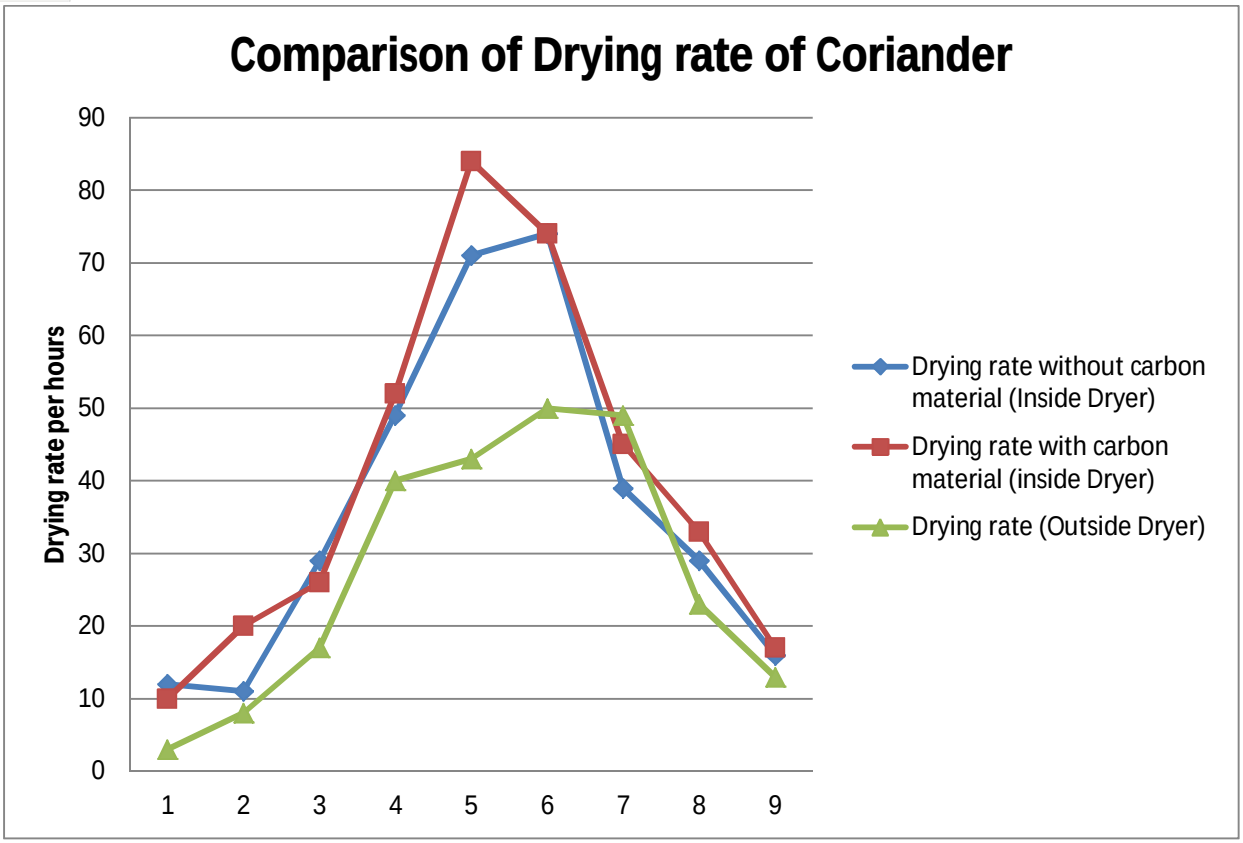
It is graph of mass reduction rate in dryer with and without storage material and OSD.

| Period of time | I$^{st}$ hours | II$^{nd}$ hours | III$^{rd}$ hours | IV$^{th}$ hours | V$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ hours | VI$^{th}$ Hours |
|---|---|---|---|---|---|---|---|---|---|
| Drying rate without carbon material (Inside Dryer) | 12 | 11 | 29 | 49 | 71 | 93 | 39 | 29 | 16 |
| Drying rate with carbon material (inside Dryer) | 10 | 20 | 26 | 52 | 84 | 74 | 45 | 33 | 17 |
| Drying rate (Outside Dryer) | 3 | 8 | 17 | 40 | 43 | 50 | 49 | 23 | 13 |

Table 6 Comparison of Drying rate of coriander.

This is table of drying rate of coriander leaves. That are showing black carbon and concrete material highly affected to drying rate of moisture content which is application use in future aspects[9].

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Graph 6: Comparison of Drying rate of coriander

It is graph of drying rate in dryer with and without storage material and OSD.

## III. CONCLUSION

In this work thermal performance evaluation of greenhouse solar dryer is being carried out in no-load condition. The greenhouse dryer was tested under passive mode with three floor different conditions Experimentation gives the following results :-

*A.* Concrete floor and floor covered with tarpaulin/concrete prevents the heat loss to the ground resulting in higher ground temperature as compared to uncovered floor.
*B.* Higher room temperature was observed maximum upto 71.2 °C in case of concrete floor as compared to maximum temperature of 65.1 °C and 56.9 °C in case of tarpaulin covered floor and uncovered floor respectively.
*C.* Lower relative humidity were found in case of tarpaulin covered and concrete floor.
*D.* Maximum value of overall heat transfer coefficient of tarpaulin covered floor and concrete floor is 2.41 $W/m^{2}°C$ and2.48 $W/m^{2}°C$ in respectively.
*E.* Experimental results in case of tarpaulin covered floor was almost close to concrete floor condition and much better than uncovered floor condition. As tarpaulin is easily available in rural area so it can be used for low-cost greenhouse drying[10].
*F.* These experimental values helps in selection of suitable crops for such dryer.

## IV. FUTURE SCOPE

It is observed that the performance of Solar dryer system varies according to the few independent parameter but no one has give the level of parameter for optimum result .A need of formula for maximum performance is required. Use special material of concrete and black carbon which is improving level of heat absorption.
The purpose of this study is to efficiently the optimum parameters for achieving the maximum efficiency of solar cabinet dryer system and to design a mathematical model for maximum performance. Comparison of mass loss of product, drying rate of product by using with and without black carbon material with concrete and outside of solar cabinet dryer.

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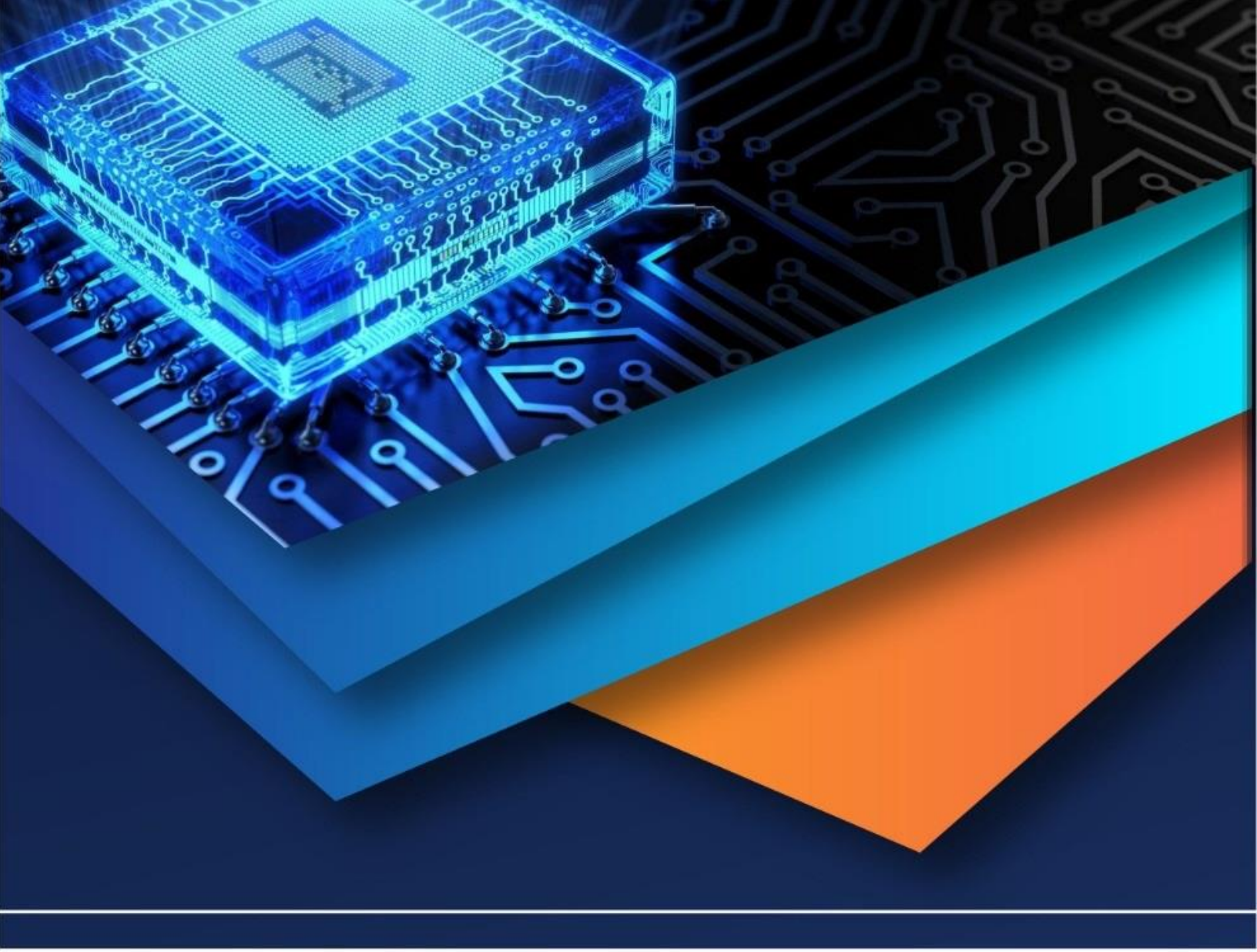
It is a typical practice that verdant vegetable like c cabinet dryer.

It is a typical practice that verdant vegetable like coriander, spinach and mint leaves are dried in season time and saved for to be devoured in the slow time of year. For such reason the drying of coriander was considered in a sun oriented dryer created from locally accessible material basically compressed wood, glass having thickness 3mm, G.I. sheet painted with dark and three aluminum Trays with square formed holes[9]. The investigation results in the end that verdant things ought to be dried in the sun based dryer just as open drying brings about discolouration, loss of flavor and once in a while the deficiency of nourishment esteem and the danger of defilement due to air contamination[10]. Further it was seen that the drying cycle will be finished in one day just as against other thing like bean stew, grapes and so on.

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