# Experimental Analysis of Thermal Performance on Active Greenhouse Dryer

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***Abstract*- Solar energy has been used for the preservation of agricultural produce since generations all over the world. Recent research on drying reveals the shortcoming of the open sun drying. In order to minimize the shortcoming of the open sun drying, various drying techniques are proposed. Among them previous effort on greenhouse dryer has been presented in this study. It can be used to do low temperature drying of cereal grains, fruits, vegetables, spices etc. The greenhouse dryer is operated in the two different modes of drying— natural convection and forced convection. Recently development of greenhouse dryers namely solar tunnel dryer, solar tent dryer, improved solar tunnel dryer, and roof type even span solar greenhouse dryer has been studied. An organized approach for the categorization of greenhouse dryers has evolved. A simulation model for drying performance proposed by authors has been studied. Products dried in the greenhouse dryer are found to be superior in quality as compared to those in open sun drying. In addition, the product is completely protected from external calamities such as rain, insects, and animals. All recent developments in greenhouse drying are emphasized in this communication.**

## 1. INTRODUCTION

Greenhouse dryer is an enclosed structure having transparent walls and roofs, made up of glass, polyethylene film etc. The working phenomenon of greenhouse drying as given in fig. 1 where the product is placed in trays receiving the solar radiations through the plastic cover and moisture is removed by natural convection or forced convection. This technology improves the product quality and reduces the drying period

Taking structure as basis, greenhouse dryer is classified into two types that is dome shape and roof even type. Objective and advantage of dome and roof type greenhouse dryer is to maximize utilization of global solar radiation and is the proper mixing of air inside the dryer respectively. On the basis of heat transfer, it having two types namely greenhouse dryer under passive mode (natural convection) and greenhouse dryer under active mode (forced convection). The use of greenhouse dryers is to improve the quality of the product, to prevent the infection by insects, microorganisms and bacteria, and fall of drying time interval.

## II.DESIGN OF GREEN HOUSE DRYING SYSTEM

Greenhouse dryers are constructed with a principle that they have a rigid load- bearing frame which is placed at certain spans and not deformed under the loads acting on them and a transparent cover material placed on them which allows short wave solar radiation to enter and is partially opaque to the long wave radiation leading to a greenhouse effect. Design of greenhouse should depend upon sound scientific principles that facilitates controlled environment for plant growth. Orientations of greenhouses are negotiating for wind direction, latitude of location and type of temperature control and avoid dropping of shadow on the nearby greenhouses.

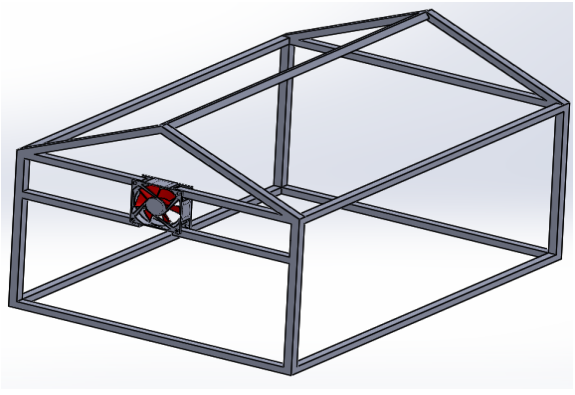

*Figure 1. 3D model*

## III.COMPONENTS USED

*A. Assembly of Gable roof frame*

Design of greenhouse should depend upon sound scientific principles that facilitates controlled environment for plant growth. Orientations of greenhouses are negotiating for wind direction, latitude of location and type of temperature control and avoid dropping of shadow on the nearby greenhouses.

Fig 5.1 Gable roof frame

*B. Polyethylene sheeting (film)*

It has a big role in offering plastic protection. It is used in construction as vapor retarders, window films, flooring and counter top protection, and even in roofing. Polyethylene sheet can be used to seal off rooms, cover building materials, and be used in lead abatement projects. There are so many variation of the film, each one engineered for its project. The key is to educate yourself of the options so you get the most useful film to make your job easier. For example, why use a drop cloth on carpeting when you can use self adhesive plastic that sticks to the carpeting. If you knock over the paint can, the carpet won't get ruined. A drop cloth can easily be moved and not protect where you thought is was.

Even though polyethylene sheeting takes a hit from environmentalists for its slow rate of decomposition, HDPE plastic sheeting is there to protect he ground water from toxic chemicals from oil drilling or from landfills. It is used to slow run-off on hills, and keep lead out of the ocean during shipbuilding projects. Polyethylene sheeting is such a versatile product used in all aspects of life.

*C. Exhaust fan*

A vital way of maintaining good health is appropriate air circulation. Good ventilation keeps bad odors, impurities and other unsafe gases away, and stops the formation of harmful mold inside your home. A proper ventilation device keeps your home away from unfortunate damage. Exhaust fans are a means to make sure the appropriate ventilation in your home. The major areas where it should be installed are the restroom as well as the kitchen as they usually contain most of the moisture and odor. Who likes to sit in room full of odour? You guessed it right, nobody. Presenting to you with the ideal solution to all your odour problems, The Havells range of domestic exhaust fans removes stale odors, leaving your rooms fresh and healthy. Their noiseless operation along with aesthetic looks, high utility and performance make these multipurpose machines a must have. With a sleek and trendy design, Havells exhaust fans are lightweight and carry out their functions silently. These fans also last for a longer period as they have a rust proof body and blades. Though, it is essential that these fans are taken good care of so that they last and function for long.

*D. Blower*

There are two quite different uses of the term “blower” in automotive contexts, although they are both pieces of equipment used to move air around. Almost every modern car has a multi-speed blower in the climate control system, to move air past the heater core or air conditioning evaporator and out the dashboard or floor vents.

## IV.EXPERIMENTAL ANALYSIS

A UV stabilized polyethylene sheet has been fitted over the structural frame of the dryer which helps in creating the greenhouse effect. It also prevents unnecessary circulation of ambient air and thus maintains the desired temperature inside the greenhouse. The air that entered at the bottom of the dryer would get heated up and flow through the wire mesh thereby removing the moisture content from the grape surface. This hot air was removed forcibly from the dryer by a DC fan through the vent; this method is called forced mode of drying. The speed of the fan was directly related to the output of the PV panel which in turn depended on the solar radiation.

Thus the speed of the fan varied with the amount of radiation. The experiment was conducted for duration of 7 hours per day.

A. Temperature variation and Moisture removal for different conditions

Calculation of moisture content Calculate the moisture content on a wet-weight basis using the following formula:

Moisture content (%)

$$M = \frac{W_2 - W_3}{W_2 - W_1} X100$$

where,

W1 = weight of container with lid;

W2 = weight of container with lid and sample before drying; and

W3 = weight of container with lid and sample after drying

The amount of moisture removed from the Groundnut is maximum at noon because the moisture from the surface of the grape is easily removed without much radiation, and then the extent of moisture removal decreases as the time elapses. As expected, the amount of moisture removed from Groundnut in the greenhouse (closed system) is more than in the open system.

Table 1 temperature variation and moisture content on open system

| Sl no. | Time | temperature | Moisture | moisture content |
|---|---|---|---|---|
| | AM/PM | $^0$C | Gm | % |
| 1 | 9:00 | 38.3 | 400 | - |
| 2 | 10:00 | 42.5 | 398 | 13.00% |
| 3 | 11:00 | 45.6 | 396 | 13.50% |
| 4 | 12:00 | 51.6 | 390 | 15.00% |
| 5 | 1:00 | 57.8 | 384 | 16.50% |
| 6 | 2:00 | 57.4 | 379 | 17.75% |
| 7 | 3:00 | 56.2 | 374 | 19.00% |
| 8 | 4:00 | 47.3 | 371 | 19.75% |
| 9 | 5:00 | 38.7 | 369 | 20.25% |

B. Temperature variation and Moisture removal on closed system

The temperature variation and moisture removal rate on ground net were carried out in gable roof system.

In the greenhouse system, the speed of the fan plays an important role in moisture removal. The effectiveness of the dryer could be increased by removing the hot air from the dryer. In order to obtain maximum amount of moisture removal, the fan speed should be more than the wind velocity. Moisture removal was at its peak in the closed system during midday and decreased gradually due to reduced fan speed. On a cloudy day if the light intensity is sufficient to drive the fan at rated speed, then the moisture removal will be at its highest in a closed system of drying. It has been observed from the experiments that more the air velocity, more the moisture removal from the system.

Table 2 Temperature variation and Moisture removal on closed system

| Sl no. | Time | closed system | | |
|---|---|---|---|---|
| | | temperature | Moisture | moisture |
| | AM/PM | $^0$C | Gm | % |
| 1 | 9:00 | 38.5 | 400 | |
| 2 | 10:00 | 42.4 | 396 | 13.50% |
| 3 | 11:00 | 44.4 | 389 | 15.25% |
| 4 | 12:00 | 56.6 | 385 | 16.25% |
| 5 | 1:00 | 57.1 | 377 | 18.25% |
| 6 | 2:00 | 57.2 | 373 | 19.25% |
| 7 | 3:00 | 56.9 | 372 | 19.50% |
| 8 | 4:00 | 47.3 | 372 | 19.50% |
| 9 | 5:00 | 37.8 | 367 | 20.75% |

Table 3 Temperature variation and Moisture removal on closed system with Blower and exhaust fan

| Sl no. | Time | closed system with Blower and exhaust fan | | |
|---|---|---|---|---|
| | | Temperature | Moisture | moisture |
| | AM/PM | $^0$C | Gm | % |
| 1 | 9:00 | 38.3 | 400 | |
| 2 | 10:00 | 41.5 | 396 | 13.50% |
| 3 | 11:00 | 45.6 | 389 | 15.25% |
| 4 | 12:00 | 50.3 | 375 | 18.75% |
| 5 | 1:00 | 56.9 | 365 | 21.25% |
| 6 | 2:00 | 57.3 | 357 | 23.25% |
| 7 | 3:00 | 56.2 | 351 | 24.75% |
| 8 | 4:00 | 48.5 | 346 | 26.00% |
| 9 | 5:00 | 38.6 | 345 | 26.25% |

## V.CONCLUSION

During the drying of Groundnut, solar radiation increases sharply from 10 am to noon, reaches its

peak and then decreases considerably. Hence the maximum amount of moisture removal is observed during the afternoons. In the greenhouse dryer, moisture removal depends on the speed of the fan. Since the radiation varies from 10 am to 4 pm, the speed of the fan also varies according to it. During noon, the fan rotates at its maximum speed. Thus the greenhouse dryer is most effective during the afternoon. The weight of the greenhouse Groundnut was lesser than those in the open condition by the end of the experiment implying that the amount of moisture removed from the Groundnut in the greenhouse is more than that in the open system. The measurement results illustrate that the drying rate for greenhouse is more than in the open system. However, during cloudy days, the drying rate for both systems is nearly equal. From the experimental studies it is observed that the amount of moisture removed from greenhouse is higher than that in the open system, even without using a DC fan. Though on an experimental basis, the exercise has made it clear that the greenhouse solar dryer is a promising appliance since it is based on renewable energy and with effective marketing can be used for various drying purposes.

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