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INVESTIGATION ON THE THERMAL PERFORMANCE OF THE SOLAR DRYER INTEGRATED WITH THERMAL ENERGY STORAGE MATERIAL –A REVIEW

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ABSTRACT

Solar drying is advantageous over the open drying system. But it has efficient only during sunshine hours. So to increase the efficiency of the existing design of solar dryer some thermal energy storage material is to employ in the existing solar dryers. Due to thermal energy storage material the wastage of the energy is avoided. This paper is mainly focused on the arrangement of Thermal energy storage material coupled with the solar dryer system. Due to the presence of the Thermal energy storage material solar dryer is operative even during off sunshine hours. The objective is to store energy in the form of heat at high temperatures and utilise it for drying purpose.

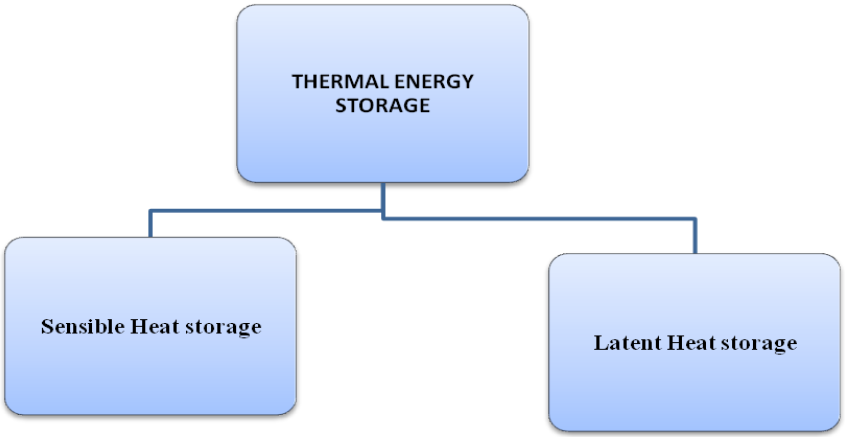
Keywords: ***Thermal Storage Material , Solar Dryer, Sensible Heat Storage, Latent Heat Storage.***

I. INTRODUCTION

[10]Food is the basic need of the human being. So to establish the balance between the production of food and its utilization is necessary. So for establishing its balance the losses of food are to be reduces which occurs due to various reasons.[9] For preservation of food the drying method is very effective one which is being adopted from ancient time. In traditional methods open sun drying is most common one in which the crops like grains vegetables, fruits are spread in large ground and exposed it to sunlight for removing moisture from it. But this process many limitations like uncertainty in atmosphere (rain, wind blown), insect infection, interference of human and animals due to which the loss will occurs in the quality and the quantity of crop .Hence due to such reasons the rate of drying decreases rapidly.

To overcome from these problems solar dryer is one of most effective and efficient option. However the solar dryer works only during the hours of sunshine. So to extend the period of drying up to the off sunshine hours, thermal storage system should be employed. The thermal storage system includes Sensible heat storage system and Latent heat storage system. The objective of the present work is to present a Thermal heat storage material based solar dryer.

II. CLASSIFICATION OF THERMAL ENERGY STORAGE SYSTEM [11]



1. **Sensible Heat Storage: -**In this type of thermal energy storage system the energy is stored by changing the temperature of storage material like water, air, bricks, etc.
2. **Latent Heat Storage: -**In this storage system the heat transfer occurs when the substance like salts of Nitrates, Paraffin wax, etc. changes its phase i.e. from solid to liquid and vice versa.

III. PROCEEDING RESEARCH DONE ON THERMAL STORAGE BASED SOLAR DRYING

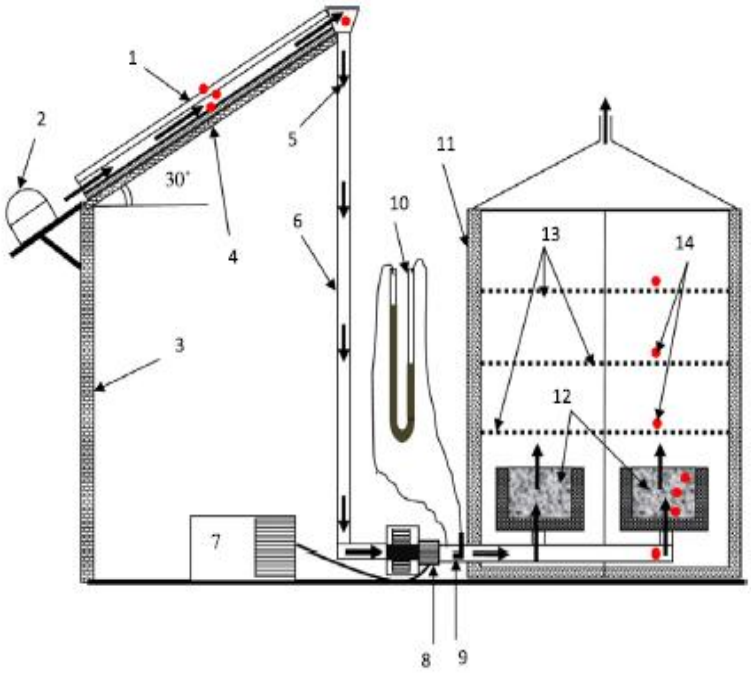
In this Method of drying the air is heated in the solar collector and some part of heat pass towards the dryer chamber which is coupled with the thermal storage material where the storage material absorbs the energy during the day time and release the storage during off sunshine hours. Also remaining part of heat is utilised for drying the crops during sunshine hours. The drying is done by the mechanism of convection and diffusion mode.

Alejandro Reyes, Andrea Mahn, etal [1] they conducted experimentation on dehydration of Mushrooms. Which were dehydrated in hybrid solar dryer who is coupled with a solar panel. The total surface area which was exposing was $10m^2$. The Mushrooms were cut in 8mm or 12mm slice. The hybrid solar dryer used in that experimentation consists of Paraffin wax as a thermal storage material. The air temperature obtained at output is about 60℃ which were 30℃ more than that of ambient temperature. The efficiency of the system fluctuated between 22% and 62%.

S.Esukkimathu, Abdel Hakim Hassbou, et al.[2] has conducted experimentation on the latent heat storage based solar dryer unit. In which they considered HS58 and inorganic salt base phase change having ball sized particles. For obtaining constant rate of charging and discharging they provide the constant mass flow rate of PCM as 200Kg/hr. From their investigation they concluded that as the mass flow rate increases the efficiency of collector is also increases. This is due to reduction in heat losses associated with increase in coefficient of heat transfer at high mass flow rate..

S.M. Shalby , M.A. Bek [3] has conducted experimentation on Novel indirect solar drying system (ISD) with phase change material as an energy storage medium. The indierctsolar drying system was tested under no load and with and without phase change material at wide range of mass flow rates i.e. from 0.0664 – 0.2182Kg/sec.

After completion of experimentation they found that after using PCM the temperature of air higher than 2.5 – 7.5°Cafter sunset for 5 hours. They achieve final moisture content in 12-18 hours in the case of implementing PCM.



1- Solar air heater 2- Pyranometer 3- The room wall 4- The room roof 5- Flowing air 6- PVC tube 7- Inverter 8- Three phase induction motor coupled with fan 9- Pitot tube 10- U tube manometer 11- Drying compartment 12- PCM 13- Trays 14- Thermocouple positions.

FIG. S.M. Shalby , M.A. Bek Experimentation Arrangement

Sari Farah Dina, Himsar Ambarita,etal [4] they carried experimentation on continuous solar dryer integrated with desiccant thermal storage for drying coca beans.This experimentation was carried out in April – June 2013 at Indonesia. They made drying chamber with diamensions of 50cm*50cm*50cm . The thermal storage material were placed in an open container having diamensians 30cm*30cm*5cm. The experimentation is carried out with two type of desicant viz. CaCl2 and molecular sieve 13. The maxium temperature occurs was 40-54°C.Which is higher than the ambientemperature.

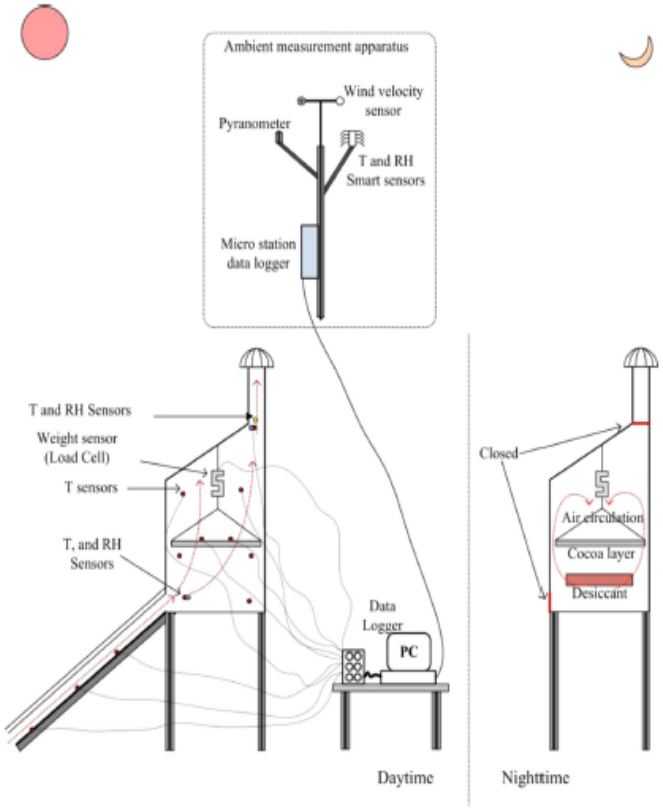


FIG. Sari Farah Dina, HimsarAmbarita, et al Experimentation arrangement

S.M. Shalby , M.A. Bek [5] carried experimentation by considering Nerium Oleander in the indierect solar dryer integrated with phase change base material an energy storage medium. 12kg of paraffin wax were used as an energy storage material. The maximum temperature obtained is 50℃.And PCM improves the thermal performance of a dryer.The final moisture content achieve after 14 hours.

S.M. Shalby , M.A. Bek , et al [6] they present the review on application of phase change material in the solar dryer. They investigated the advantages of phase change materials over the sensible heat storage material. Also it explains the importance of paraffin wax as it contains graphite which is helpful for improving the thermal performance of dryer

ShilpaChoudhary**,** Sridhar Kumar et al [7] they carried the experimentation on family sized solar dryer integrated with phase change material and high heat capacity material for dying the medicinal plants . The result shows the drying of plants occurs in a single day without losing its vitamins.

V.R.Badgujar [8] carried experimentation on a solar dryer integrated with desiccant material as an energy storage material by force convection method for multicrops. The dryer has a capacity to dry 20 kg peas and pineapple slices. The drying chamber's wall was made by wood with the size of 1.2m*1.2m*2m.The perforated tray was provided to store the 100kg of desiccant material. The desiccant material is a mixture of 60% bentonite, 10% calcium chloride, 20% vermiculite and 10% cement and is moulded in the shape of cylinders. The useful temperature rise of about 15˚C was achieved with mirror, which reduced the drying time by 3 h and 4 h for green peas and pineapple.

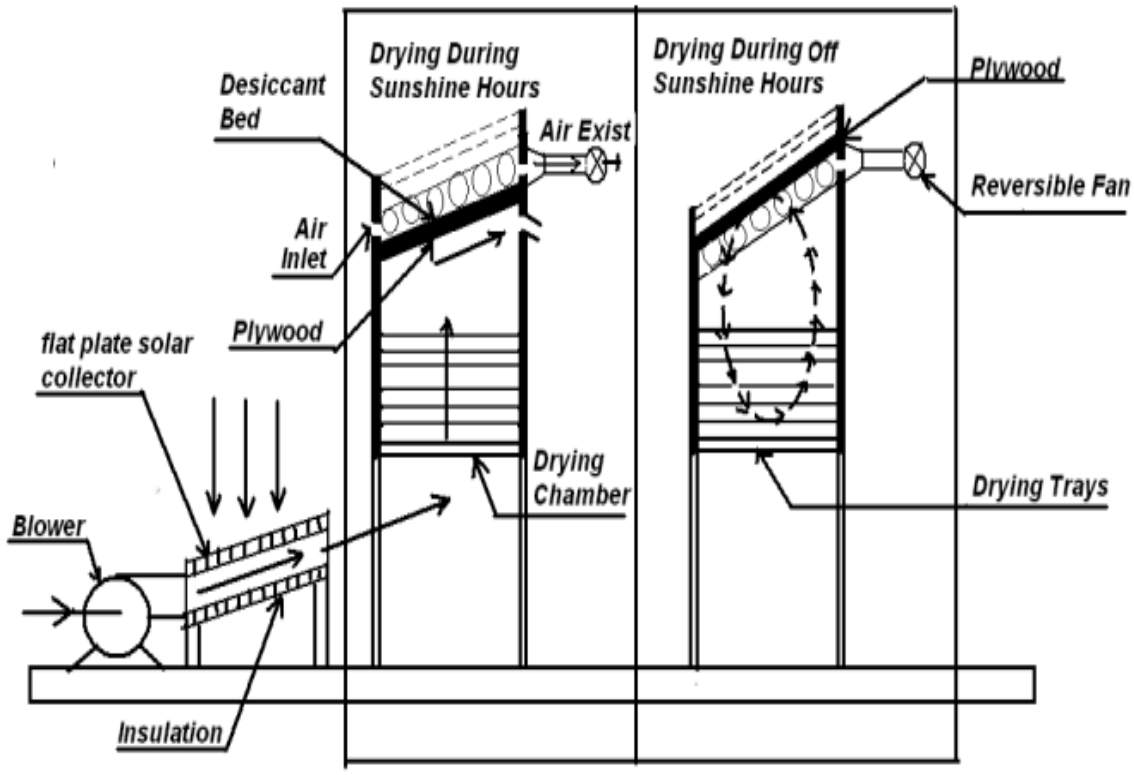


FIG. : V.R.Badgujar's Experimentation arrangement

IV. CONCLUSION

It can be concluded from the present review that various types of thermal energy storage material investigated by various researchers and found that the thermal performance of the solar dryer is improved and make it operative even during off sunshine hours.

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