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Investigation on Optimize the Performance of a Solar Powered Drying Rack

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Abstract- Technology based on renewable energy sources fills the gap created by the world's growing energy needs & limited supply of conventional energy sources. The goal of solar drying is to provide the product with more heat than is typically accessible in an ambient environment. the present study was undertaken to evaluate solar dryer integrated with heat storage system for drying vegetables and fruits. Drying rate get reduced due to intermittent sunshine, interruption, and rains. Solar energy is available only during the day, and hence, its application requires efficient thermal energy storage so that the excess heat collected during sunshine hours may be stored for later use during the night. The overall objective of this research project is the conceptual development of a solar dryer for drying agricultural products.

Keywords- Solar Drying, Solar Energy, Drying Agricultural Products, Thermal Storage

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INTRODUCTION

In essence, drying is a simultaneous process of mass and heat transmission. Heat absorption by a substance powers water evaporation. The goal of solar drying is to provide the product with more heat than is typically accessible in an ambient environment. By doing so, the equilibrium moisture content will be reduced, & product's moisture removal will proceed more quickly. The product absorbs direct heat or solar-heated air, and moisture diffuses from the inside to the outside. Hot air from natural or induced convection transports it. This continues until equilibrium moisture is reached. A product's equilibrium moisture content (EMC) is its relative humidity (equilibrium moisture content). Normal formulations for equilibrium moisture content are influenced by the drying air's relative humidity & temperature. Due to the slow drying rate under ambient conditions & high equilibrium moisture content that results from high relative humidity, solar-dried items are not appropriate for secure storage (Tuladhar M.R. et. al., 2008). The nation has researched solar dryers since the 1970s. Solar dryers heat directly, indirectly, or both (Joshi C.B., 2004). These technologies are also being promoted by other organizations.

OBJECTIVES

1. To create a solar dryer with a thermal storage system.
2. To conduct tests outside for a lengthy period of time.

RESEARCH METHODOLOGY

This study evaluates a food-preserving mixed-mode solar drier. Every person living in this region may afford the dryer that will be built after consulting numerous research publications, and it can be produced using materials that are readily available locally. The dryer will be built to prevent unforeseen and unwanted food spoiling caused by a lack of facilities in the area. The drying cabinet's glass roof allows it to directly absorb solar energy, & dryer utilizes hot air from a separate solar collector. The low cost of dryers will be the key goal of this design. The components that make up this design were chosen because they are either inexpensive or easily accessible. The test results will show that the dryer & solar collector had substantially greater temperatures than outside throughout the day.

BASIC DESIGN

The design consists of a rectangular, fiberglass-encased insulation. The overall experimental setup, including the auxiliary collector and thermal storage. The bottom and top of the container include openings that let dry air out and fresh air in. Dull black was used to absorb sun incoming radiation, both inside the cabinet and on the collection plate. The absorber plate warms the air as it travels from the collection to the drying cabinet. The cabinet's perforated trays allow hot air from the collector to ascend through the food & exit at the top.

Dryer Specification

Length - 1 m

Breath - 0.5 m

Height - 0.5 m

Food bed - 0.3 m

Distance between trays - 0.15 m

No. of Trays - 3 Nos.

Design Calculations

Parameters such as angle of tilt (_), average radiation on horizontal surface, air density variation (23), air pressure head (2p), resistance to air flow, volume flow rate, mass flow rate, area of collector, thickness of insulation, total energy transferred & absorbed, heat employed by air, heat energy loss, thermal collector heat flux, collector heat removal factor, collector heat removal factor in terms of transmittance and absorptance, collector ef, and collector ef Based on local ambient conditions during experimentation, basic parameters like sun radiation, atmospheric temperature, air velocity, etc. were assumed. Based on the wide literature review before design, previous researchers' formulas were employed for computations.

FABRICATION OF THE SOLAR CABINET DRYER

Construction of the Frame

Frame horizontal beams were 1m mild steel square tubes. The frame's upright columns were fashioned from 0.5-meter mild steel square tubes. Two upright columns were leveled. Welded beams connected the uprights. Welded another beam. The front panel was finished. The back panel used 1m beams & 0.75m columns. A level surface supported the back panel. Two 0.5-m bottom side sections were attached to the back panel. These side sections supported the front panel. Clamps supported vertical panels & bottom side pieces. Square tubes joined the front & back panels' tops. The top side sections were welded to meet the 21o inclination angle because the front is shorter than the back. Four clamped joints were used to weld the top side pieces between the front & back panels. To create the bottom vent, a 0.5-m horizontal beam was put into the bottom panel around 4" from the front panel. The dryer structure was finished.

Making the Door

The door's 1m beams & two 0.5m uprights were positioned over the front panel's opening to check size. The door panel was constructed to overlap the frame on all sides. Welded door frame. The drill & sheet metal screws were used to cut and attach a plywood door frame cover. Finishing the door. After finishing, it was attached to the frame.

Addition of Tray Supports and the Heat Absorber

Installing tray supports preceded frame covering. The plywood boards were connected to the dryer frame. Figure 1 shows a heat absorber made from a 1m x 0.5m aluminum sheet. To allow airflow, the absorber & back panel were separated.

Figure 1: Absorber Plate fixed in the Drying Cabinet

Covering the Frame

The welded structure was covered with two polycarbonate sheets, one on top and one on the front panel. Due to polycarbonate's fragility, clamps were tightened slowly. Polycarbonate was attached to the metal frame using metal screws in pre-drilled holes around the perimeter. Plywood cutouts covered the sidewalls. Metal screws attached the boards to the frame. Two even-sized plywood pieces covered the bottom to provide heat storage for entering air. Exhaust vents through a 2" top gap (Refer Figure 3).

Sealing the Gaps, Insulation & Painting

Silicone caulk sealed sheet metal & polycarbonate panel seams and edges. The cabinet's interior was thermally insulated with 25 mm thermocole sheet. To maximize heat absorption, the aluminium sheet thermal collector was painted black.

Making the Drying Trays

Figure 2 shows tray frames designed for simple loading & unloading without damaging the side frames. To eliminate tray corner misformation, rectangular shapes were accurate. Each frame was wrapped with aluminium mesh & stapled firmly.

Guides are two bottom screws. The dryer tray slides in and out easier with these guides.

Figure 2: Tray Frame

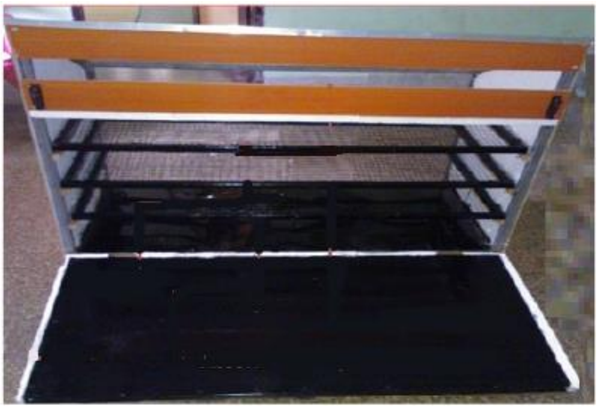

Figure 3: Dryer with the Trays Loaded in Position

Attaching the door

As seen in Figure 4, hinges and a latch attached the door.

Figure 4: Door for Loading & Unloading the Trays

Auxiliary collector unit components were built similarly. The dryer was left in the sun for a few days to release paint & silicone fumes.

Figure 5: Complete Setup of the Cabinet Dryer

Figure 6: Complete Setup of the Auxillary Collector

Auxiliary collector unit components were built similarly. Figures 5 and 6 illustrate the drying cabinet plus auxillary collector setups.

Figure 7: Assembled Drying Unit Front View with Auxillary Collector

Figure 8: Assembled Drying Unit End View with Auxillary Collector

The solar dryer assembled with the auxillary collector shown in Figures 7 and 8 above is a mixture mode, natural convection drier. The dryer was left in the sun for a few days to release paint & silicone fumes.

EXPERIMENTATION OF DRYER OPTIMISATION

Performance testing of the dryer was determined by using a full factorial design. The factors of the design were: 1) two levels of product density load per tray, 2) dryer with and without auxiliary collector, and 3) dryer with and without thermal storage. The two variables for product loading per tray were high (60% of the tray covered with slices) and low (40% of the tray covered with slices). Thermal storage was done in cans and pipes having phase change material. The variables in thermal storage were thermal storage only with pipes, thermal storage only with cans, and thermal storage with both cans and pipes. Also experiments were done on the effect of adding thermal conductivity enhancers, and variation of PCM quantity. In addition, the slice thickness suitable for drying using this cabinet dryer was also investigated.

PERFORMANCE TESTS WITHOUT THERMAL STORAGE

No Load Test

Dryer temperatures were measured without any food products present in direct mode as part of the first performance investigation of the experimental setup (Figure 9). Variations in collector, drying chamber, fibre glass cover, & ambient temperatures were all measured and recorded at regular intervals. The no-load experiments helped determine the drying chamber's maximum temperature increase in relation to fluctuations in solar intensity, ambient temperature, & air velocity. During these experiments, we monitored the collector's performance by recording key metrics like temperature at various zones & solar radiation intensity.

Figure 9: No Load Setup

In April 2014, experiments were conducted daily. The dryer was direct-tested for several days. On subsequent days, the dryer was tested in mixed mode with an auxiliary collector. These experiments were done at intense sun radiation from 10:00 a.m. to 4:00 p.m.

Determination of Slice Thickness

There are a lot of moving parts involved in the process of preserving food. Fruits & vegetables are plentiful yet perishable. Even though there are different preservation methods, most affect the product's color & texture (Figure 10). Customers seek high-quality, long-lasting products. Solar drying perishable food saves money. This experiment examined how temperature & moisture affect dried product texture and color. The trials used bananas because of their high moisture content and loss in India. This study examined three banana slice thicknesses. This study detailed the rarely recognized effect of slice thickness on dried product quality. Three days of drying determined the slice acceptance rate. Two, four, and six-millimeter sizes were tested. 4 mm slices yielded many good ones. Produce is perishable. Harvested crops breathe. Hence, harvesting can harm them. Moisture loss when drying causes undesired physical changes. Stress from water loss & heating shrinks cells. Shrinkage reduces water absorption in desiccated tissues. Shrinkage is proportional to moisture. Thicker slices dry faster. The trays had slices without overlap. To guarantee thorough drying, trays were shuffled & loaded with a specific size.

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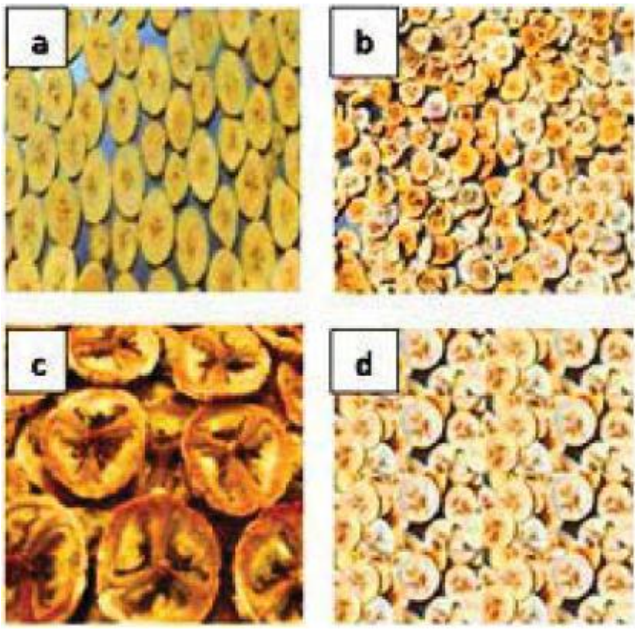

Figure 10: Color & Texture Changes of Slices

The wet and dry weights of the slices were recorded. Removed sticky, shriveled pieces. Slices were examined for color and smell. Separated discolored brownish fragments. Separated were chewy slices with natural flavor. After drying at room temperature, the percentage of mouldy slices was determined. Squeezed pieces were chopped to locate extra moisture in the core. Consequently, unwanted dark, bright, and starchy portions were removed. According to the experimental outcome, 4 mm thick slices were appropriate for drying using this experimental dryer, hence partial load tests, full load tests without thermal storage, & full load tests with thermal storage were performed utilizing specified size slices.

Load Test

Bananas were used to test the dryer's performance. The tests were analyzed using collector efficiency, system thermal efficiency, and drying efficiency based on product load density. After two days, the bananas' moisture level dropped below 20%, allowing storage.

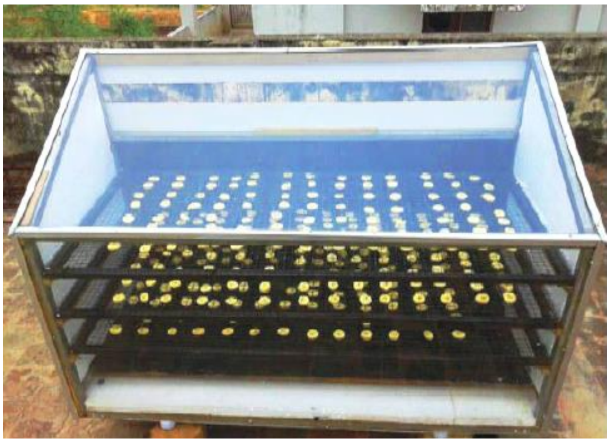

Figure 11: Dryer with Partial Loading of Banana Slices

Hygiene was valued. Agro-products were fully matured. Removed moldy materials. Discarded were rotten, damaged, or infected. Since drying rate depends on slice uniformity, uniform slices were utilized. Washing and cleaning trays prevented contamination. Loading occurred quickly after slicing to prevent sticking. The trays had slices without overlap. To guarantee drying, the trays were rotated. Each tray has one slice layer. This ensured no drying overlapped.

Partial Load Test

This study dried using solely sun energy. Outside air, dryer, & collector output temperatures were measured regularly. Before oven drying, the products were measured for moisture. Drying continued till weight loss stopped. We calculated the produce's moisture loss as it dried utilizing these initial moisture contents & weight measurements at regular intervals. The dryer's efficiency was measured. These figures compared load tests. Trays were loaded with 40% & 60% product.

Dryer Full-Load Tests Without Thermal Storage

The studies ran without PCM cans and pipelines for several days. Outside air, dryer, & collector output temperatures were measured regularly. Sunset measurements revealed performance without thermal storage. Observations estimated performance.

RESULTS

No Load Tests on the Solar Dryer Without Thermal Storage: The experimental setup's performance was assessed by monitoring the dryer's temperature without materials. Collector, drying chamber, fiber glass cover, & ambient temperatures were monitored regularly. No-load trials determined the drying chamber's maximum temperature increase based on solar intensity, ambient temperature, & air velocity. These investigations measured collector efficiency using zone temperatures & solar radiation.

Performance Analysis

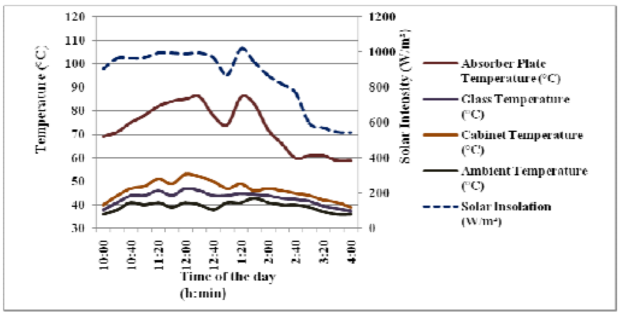

Figure 12: Typical Results under No Load without Thermal Storage – Direct Mode

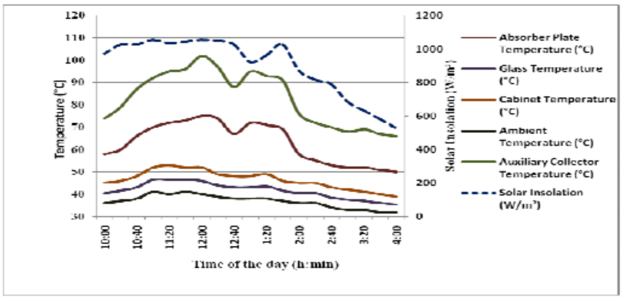

Figure 13: Typical Results under No Load without Thermal Storage– Mixed Mode

Figures 12 & 13 illustrate typical direct & mixed mode no load test results. April 2014 experiments lasted six days. Direct mode tested the dryer for 3 days. After adding an auxiliary collector, the dryer was tested in mixed mode for three days. These tests were done at 10 a.m. at peak sunlight. until 4 p.m., during peak sun radiation.

On day 3 of direct mode experiments, solar insolation reached 1018 W/m2. The first day of mixed mode experimentation had the greatest average solar insolation of 1054 W/m2. The 2nd, 3rd, & 6th days of experiments recorded 42°C ambient temperatures, whereas the 4th day recorded 32°C.

On the third day of direct mode testing, the absorber reached 86°C. The day's maximum average absorber temperature was 73°C. During the second day of mixed mode investigation, the auxiliary collector reached 102°C. On the same day, the auxiliary collector reached 85°C. The mixed mode cabinet hit 56 degrees Celsius on the second day of testing. On days two and three of the research, mixed mode maintained a cabinet temperature of 49°C.

The collectors obtained their maximum ratings only at the highest outside temperature. The cabinet temperature rises by around 10oC in the afternoon when solar insolation is at its height, then drops again in the evening when the sun sets.

The main collector received 400.5 W to 450 W of heat during the six-day experiment. The first three days of direct mode testing used 120.60 W to 136.68 W of heat, whereas mixed mode testing used 160.8 W to 181 W. The main collector's efficiency ranged from 30% to 31% in direct mode & 38.22% to 42.29 in mixed mode. Although while heat incident on the 3rd day of inquiry under direct mode (428.5 W) approximately matched that of the 2nd day under mixed mode (428 W), efficiency under mixed mode (42.29%) was 10.39% greater than under direct mode (31.9%). Consequently, mixed mode was used for further testing because the dryer performed better.

Load Tests on the Solar Dryer Without Thermal Storage

Since bananas contain so much moisture, they were used to test how well the drier dried them. Collector efficiency, thermal efficiency, & product drying efficiency depending on load density were used to evaluate the testing. In two days, the bananas' moisture content dropped below 20%, preserving them.

The slices were homogeneous in thickness and diameter due to the drying rate. We loaded shortly after cutting to avoid the slices sticking together. The platters kept the slices apart. Regular tray rotation ensured thorough drying. Slices were stacked on each tray. This ensured no drying overlapped.

Partial Load Test on the Solar Dryer Without Thermal Storage

In this experiment, drying was done solely with the help of the sun. The ambient temperature, the dryer's output temperature, and the collector's output temperature were all measured at predetermined intervals. Before being dried in the oven, the products' moisture content was determined. The drying process continued until further loss of weight would occur. We were able to compute the weight loss of the produce as it dried out by using the initial moisture levels and a series of weight measurements conducted at regular intervals.

Performance Analysis

The tests were conducted over the course of six days in the height of summer in 2014. Both 40% and 60% product loading densities were used on the trays. The dryer was run at 40% load for three days, and then at 60% load for another three days. The dryer's clothes-drying performance was assessed. These numbers were used to make comparisons across loads.

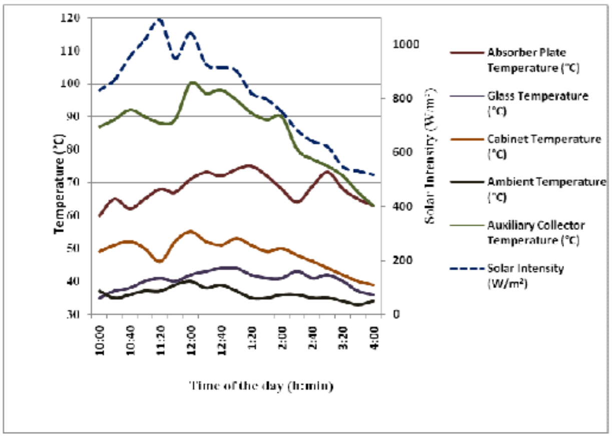

Figure 14: Time Vs Temperature under 40% load

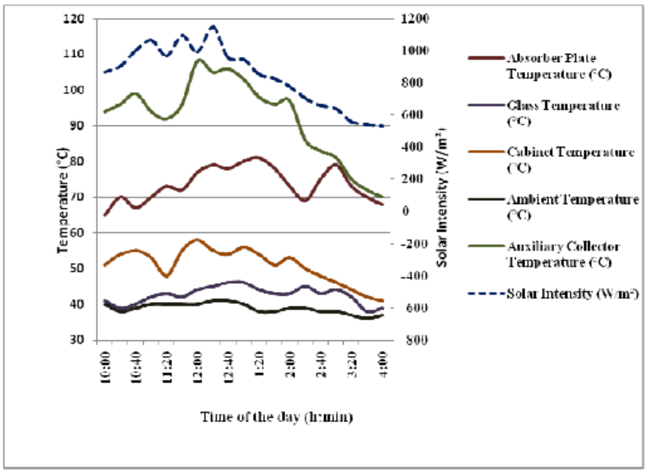

Figure 15: Time Vs Temperature under 60 % load

Dryer temperature variations at 40% and 60% load are depicted in Figures 14 & 15, correspondingly. On day five of the experiment, the highest solar insolation reading was 1146 W/m2. The average solar insolation that day was also the greatest ever measured at 843 W/m2. Similarly, the ambient temperature ranged from a low of 29 degrees Celsius on the second day of study to a high of 41 degrees C on the fifth day of experimentation. On day five of testing, the absorber temperature reached an all-time high of 81.1 degrees Celsius. While the peak temperature of the auxiliary collector was recorded as 108°C on the fifth day of inquiry under mixed mode, the maximum average temperature of the auxiliary collector was measured on the same day as 89°C. On day five of the inquiry, the highest temperature recorded in the cabinet was 54 degrees Celsius (the average of the highest temperatures recorded in the trays). On the same day, we also measured 47°C as the average cabinet temperature (the mean of the trays' temperatures).

At the hottest point of the day, the collectors also achieved their maximum temperatures. If we look at the average temperature outside from 10 a.m. to 2 p.m. The average temperature rise of the cabinet was between 7 and 9oC between the hours of 2 and 4 p.m. Throughout the course of the six days of testing, the insolation incident on the primary collector ranged from 405.5 W to 421 W. Over the course of the 6-day study, the range of heat consumption was 162.81 W to 184.92 W. At 60% load, the efficiency of the main collector fluctuated between 41.38% and 42.33%, whereas at 40% load, it was between 40.15% and 44.99%. There was a range of 18.62% - 20.67% in system thermal efficiency at 40% load, and 19.15% - 20.21% at 60% load. Under 40% load, the drying efficiency ranged from 42.59% to 47.92%, whereas at 60% load, it was between 45.24% and 48.84%. With these testing findings in hand, it's clear that the dryer's performance is consistent throughout a wide range of loads. This suggests the system will be able to dry as intended.

Full Load Tests on the Solar Dryer Without Thermal Storage

In order to further assess the dryer's drying potential, full load tests were run for three consecutive days throughout the summer of 2015. A thermal storage unit was proposed to reduce the number of days needed for drying after it was discovered that drying efficiency did not change much depending on the load, but drying time may increase depending on the load, especially at full load, due to the shading effect after staking of slices arranged in the trays. After installing the thermal storage unit, we ran the no-load and full-load tests again to ensure there were no thermal losses and the system was back to peak performance.

Performance Analysis

The 2015 summer trials lasted for three days and were conducted without the use of PCM cans or pipes. At regular intervals, we took readings of the ambient temperature, the humidity, the temperature in the drier, and the temperature at the collector's output. As there was no way to keep the temperature constant for the course of the experiment, data collection continued past dusk.

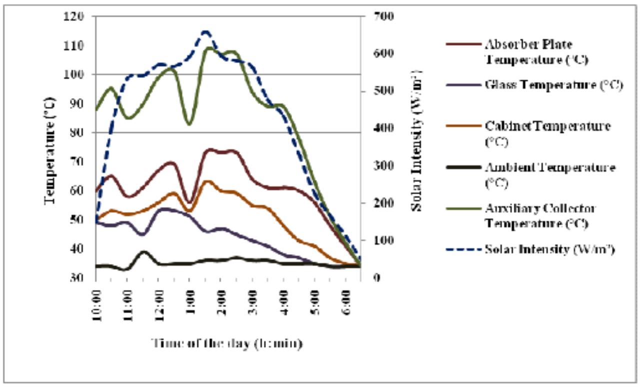

Figure 16: Performance of dryer under full load

The usual results under full load are depicted in Figure 16. The greatest sun insolation reading during the thermal storage trials was 659 W/m2 on day three. In addition, the highest ever recorded average solar insolation was measured that day at 419 W/m2. On the other hand, the ambient temperature ranged from a high of 40°C on the first day of experiments to a low of 34°C during the days of inquiry.

On day three of the probe, the absorber reached a peak temperature of 73 degrees Celsius. The highest average absorber temperature recorded that day was 60 degrees Celsius. On the same day that 108 degrees Fahrenheit was measured, the auxiliary collector reached its maximum temperature. On the same day when 83 degrees Celsius was measured, the auxiliary collector averaged its highest temperature ever. On day one, the cabinet reached a peak temperature of 55 degrees Celsius, which was the mean of the trays' highest temperatures. Similarly, on days 1 and 2, the average cabinet temperature (the average of the tray temperatures) was 46°C.

The collectors' maximum ratings were only reached when the ambient temperature was extremely high. The average temperature inside the cabinet was about 10-11°C higher than the daily average ambient temperature observed between 10 a.m. and 4 p.m.

The primary absorber was subjected to temperatures ranging from 201 W to 210 W during the course of the three days of testing. The amount of energy that the air absorbed ranged from 79 W to 93 W. The main collector's efficiency ranged from 37% to 43%. The thermal efficiency of the system was anything from 15-18%. The percentage of successful drying ranged from 41% to 43%. These tests have shown that the dryer's performance is somewhat insensitive to changes in load size. This suggests the system will be able to dry as intended.

CONCLUSION

In this analysis, we evaluate how well a solar dryer with a mixed-mode design can keep food safe from spoilage. Every person living in this region can afford the research-based dryer design because it is made from inexpensive, readily available materials. Due to a lack of infrastructure in the area, the dryer was built to prevent unplanned & erratic food rotting. The dryer takes in solar energy both indirectly (via the glass roof) and directly (through the hot air from a separate solar collector). As was previously said, one primary motivation for this design was to make the dryer's price as cheap as possible. We opted on inexpensive and readily available components for this layout. Thermal storage capacity of the dryer can be investigated using different phase change materials. Different PCM container materials and geometries can be employed for further investigation.

REFERENCES

1. Amer, B., Hossain, M.A., Gottschalk, K., (2010), Design and Performance Evaluation of a New Hybrid Solar Dryer for Banana, Energy conversion and management, 51: 813-820.
2. Amir Hematian,Yahya Ajabshirchi and Amir Abbas Bakhtiari,“Experimental analysis of flat plate solar air collector efficiency”, Indian Journal of Science and Technology, 5, 2012 .
3. Amir, E.J., Grandegger, K. Esper, A. Sumarsono, M. Djaya, and Mühlbauer, W., (1991), Development of a multi-purpose solar tunnel dryer for use in humid tropics, *Renewable Energy*, 1(2): 167-176.
4. Anobil SS. A safe and clean way of reducing the rate at which farm produce deteriorate after harvest. Journal of Energy and Natural Resource Management (JENRM). 2017;4(3).
5. AR. Umayal Sundari, P. Neelamegam, and C. V. Subramanian “An Experimental Study and Analysis on Solar Drying of Bitter Gourd Using an Evacuated Tube Air Collector in Thanjavur, Tamil Nadu, India” Hindawi Publishing Corporation Conference Papers in Energy Volume 2013
6. Arinze E.A., Schoenau, G., Bigsby, F.W., (1979), Solar-energy absorption properties of some agricultural products, ASAE paper, 71-79.
7. Aritesty, E., &Wulandani, D. (2014). Performance of the rack type-greenhouse effect solar dryer for wild ginger (curcuma xanthorizzaroxb.) drying. Energy Procedia, 47, 94-100.
8. Arun Kumar Shukla and Shravan Kumar Vishwakarma, “Design, construction and performance study of Photovoltaic Integrated Forced Flow Solar Dryer”, Proceeding of International Conference on Energy and Environment, 2009, pp:19-21.
9. Arun, K.R., Srinivas, M., Saleel, C.A., Jayaraj, S., “Active drying of unripened bananas (Musa Nendra) in a multi-tray mixedmode solar cabinet dryer with backup energy storage,” Solar Energy, 188, pp. 1002-1012, 2019.
10. Associated Chambers of Commerce of India (2019), “ The Assocham Bulletin”. https://www.assocham.org/userfiles/Assocham%20Bulletin% 202019 (1).pdf
11. Atalay, H., Kincay, O., Kincay, O., “Modeling of the Drying Process of Apple Slices: Application with a Solar Dryer and the Thermal Energy Storage System,” Energy, 2017.
12. Ayensu. A and Asiedu-Bondzie.V,“Solar drying with convective self-flow and energy storage”, J.of.Solar and Wind Technology, 3, 1986, pp: 273-279.
13. Azaizia Z, Kooli S, Elkhadraoui A, Hamdi I, Guizani A. Investigation of a new solar greenhouse drying system for peppers. International Journal of hydrogen energy. 2017 Mar 30;42(13):8818-26.
14. Babagana G, Silas K, Mustafa BG. Design and construction of forced/natural convection solar vegetable dryer with heat storage. ARPN Journal of Engineering and Applied Sciences. 2012;7(10):1213-7.
15. Babar OA, Tarafdar A, Malakar S, Arora VK, Nema PK. Design and performance evaluation of a passive flat plate collector solar dryer for agricultural products. Journal of Food Process Engineering. 2020 Oct;43(10):e13484.

16. Bal LM, Satya S, Naik SN. Solar dryer with thermal energy storage systems for drying agricultural food products: A review. Renewable and Sustainable Energy Reviews. 2010 Oct 1;14(8):2298-314.
17. Bala, B. K., Mondol, M. R. A., Biswas, B. K., Das Chowdury, B. L. and Janjai, S., (2003), Solar drying of pineapple using solar tunnel drier, *Renewable Energy*, 28(2): 183-190.
18. Bala, B., and Mondol, M., (2001), Experimental Investigation on Solar Drying of Fish Using Solar Tunnel Dryer, *Drying Technology*, 19(2): 427-436.
19. Balogun MB, Anafi FO, Kulla DM. Performance Evaluation of a Double Compartment Solar Dryer. Nigerian Journal of Solar Energy. 2017;28.
20. Baniasadi, E., Ranjbar, S., Boostanipour, O., “Experimental Investigation of the Performance of a Mixed-Mode Solar Dryer with Thermal Energy Storage,” Renewable Energy, 112, pp. 143–150, 2017.
21. Bansal. N.K., M.Kleemann and M.Meliss, “Renewable Energy Sources and Conservation Technology”, Tata McGraw Hill publishing company Ltd., New Delhi, 1990,pp: 111.

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