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REVIEW PAPER ON SOLAR DRYER

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ABSTRACT

The growing use of fossil fuels and the consequent economic growth in fuel prices has led to the need for alternative energy sources. Solar energy is one of the most renewable and sustainable sources and has attracted the attention of more and more researchers around the world. The reason is mainly due to the abundance in both direct and indirect form. Thus, solar energy is being used as an alternative to agro-industrial and residential energy. Solar dryers have been instrumental in the development of agriculture. The use of solar dryers and drying of agricultural implements to improve the water content of agricultural products can significantly reduce or eliminate food poisoning and increase farmers' improved productivity. Solar dryers are used to generate energy from the heat of the sun, so there is no need for fossil fuels. This paper presents a review of Solar Dryer. Materials and various designs of maximum solar dryer have been presented till date.

I. INTRODUCTION

Preservation of agricultural produce is one of the central problems faced by developing countries. And as time goes on, these problems will be aggravated by the growing dietary needs of the ever increasing population of these countries .[1]

In many developing countries large quantities of fruits and vegetables spoil due to inadequate infrastructure, insufficient processing capacities, and growing marketing difficulties caused by intensifying competition and protectionism in the worldwide agricultural markets. Up to 70 per cent of agricultural products spoil during the traditional process of open-air drying, especially in tropical and subtropical regions.[2] Drying these products can help solve these problems, while also making an important contribution to improving the population's income and supply situation.

Drying is an important form of food preservation that is often carried out at farm level right after harvest, or especially with highly perishable crops, at peak harvest time when local markets are saturated. Drying vegetables, fruits and meat with thermal energy enables longer storage times and easier transportation. Up to 70 per cent of agricultural products spoil during the traditional process of open-air drying, especially in tropical and subtropical regions (INNOTECH, 2012).

Agricultural products can be dried open-air or unimproved, directly in the sun, with biomass or in solar dryers.

Open-air or unimproved drying takes place when food is exposed to the sun and wind by placing it in trays, on racks, or on the ground. The advantage of drying products directly open-air is that almost no costs for fuel and appliances have to be spent by the farmer. However, the dried products are often of lower quality due to varying temperature levels and contamination of the products with dust, vermin's and leafs.[1]

Advantage of solar drying system:

1) Solar Dryer Are More Economical Compared To Dryer That Run On Conventional Fossils Fuel/Electricity.

2) Solar Drying Systems Have Low Operation And Maintenance Costs.

3) The Drying Process Is Completed In The Most Hygienic And Eco-Friendly Way.

4) Solar Dryer Last Longer. A Typical Dryer Can Last 15-20 Year With Minimum Maintenance.

Disadvantages of the solar dryer

1) Drying can be performed only during sunny days, unless the system is integrated with a conventional energy-based system.

2) Issue Due to limitations is solar energy collection, the solar drying process is slow in comparison with dryers that use conventional fuels.

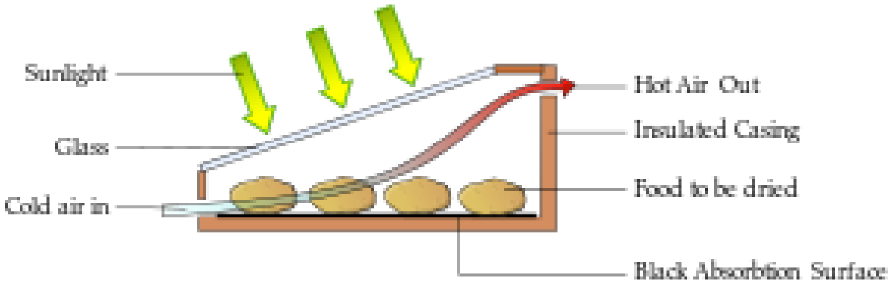
3) Normally, solar dryers can be utilized only for drying at 40-50oC.

Classification of solar dryer:

Solar dryers are available in a variety of sizes and designs and are used to dry a wide variety of agricultural products. Solar dryers are available in the market to suit the needs of the farmers. Primarily all drying systems are classified on the basis of their operating temperature range which is high temperature solar dryer and low temperature solar dryer. The following criteria are required for classification of solar dryers

1) Air Circulation Mode
2) Insulating Material
3) Air Flow`` Direction
4) Arrangement Of Dryer
5) Solar Contribution
6) Types Of Fruit To Be Dried

Direct



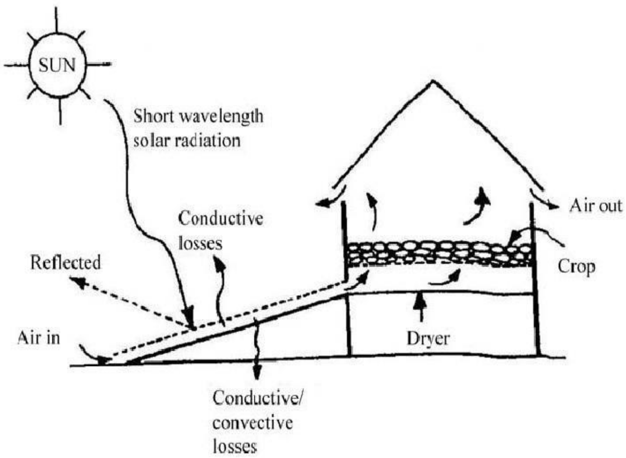
Direct solar dryers dehydrates substance in direct sun light. Ion the past., food and clothing were dried on rocks or with bamboo sticks. In some country, meat and dairy product are still dried in same way, which helps to dry the roots due to the flow of wind along with the heat of the sun. the some goes for soler trays and open cupboards

One of the newer types is black paper, which is used for direct drying. Black paper combines sun light to increase the temperature and can have a glass cover or air vent to keep the increased temperature longer and increase efficiency.

Indirect

In indirect solar dryers, air pass through on the black paper surface. During that time the gets hotter s air passes over the surface of he paint and that hot air is released from the substance into the dryer and then moisture content air pass in to chimney or vent to the atmosphere. During these process hot air absorb moisture content in the substance.in this system the food you eat is made up of a simp0le or heat resistance item like bricks or plywood.so it does not come in contact with any sand or any external elements. that is why drying substances do not contain any chemical or soil.

The maximum temperature of the sun is between 50-55degrees on the earth and for that the harmful rays of the sun do not reach the substance by using polycarbonate sheet or UV preventive glass so that UV rays of the sun do not penetrate the food which leads to degradation of dryed food and the dried material is safe. not only the solar dryer extra sunlight enclosed. So it has no effect from outside (birds dropping, dust, bacteria). So the substance helps to last longer



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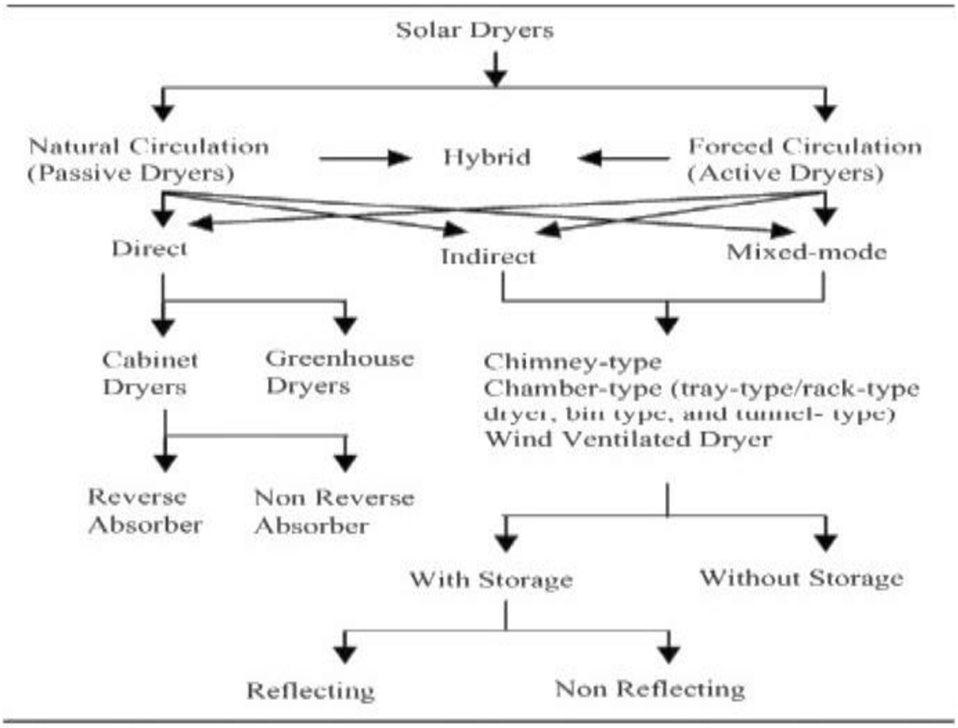
Forced convection solar dryer:

A force convection solar dryer is a fan mounted on one side of the dryer. this allows more outside air to enter the dryer and maintain temperature controls in the dryer. In this way maximum moisture and humidity is absorbed. The forced air circulation system is provides both temperature uniformity and rapid heat recovery.

Natural convection solar dryer:

The working principle of natural convection solar dryer is, the atmospheric temperature flow over the substance and absorb moisture in it. This air will take moisture out of the product and flow out to the ambient air.



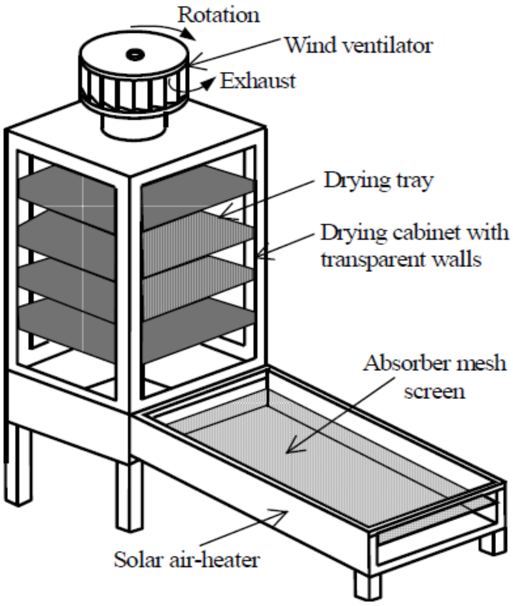
II. LITERATURE REVIEW

1) Diemuodeke E. OGHENERUONA*, Momoh O.L.YUSUF:-

In rural areas, direct natural solar dryers are designed and fabricated to dry tapioca. A batch of 120 kg tapioca requires a minimum of 7.88 m2 solar collector area to dry in 22 hours (two days drying period). The initial and final humidity ratios were calculated on a wet basis of 82% and 12%, respectively. On a horizontal surface of 15 MJ / m2 / day the average ambient conditions with daily global solar radiation events is 34 ° C air temperature and 76% relative humidity. Wari (latitude 5 ° 30 ', long. 5 ° 41'), considering the climatic conditions in Nigeria. A sample dryer with a minimum collector area of 1.095 m.

2) Bukola O. Bolaji.et.al:-

Solar wind-ventilated cabinet dryers designed, constructed and tested at 7.51 latitudes in Nigeria, in comparison, drying by solar cabinet dryers showed better results than open air-drying. During the test period, the average velocity of air through the solar dryer was 1.52 m / s and the average daylight efficiency of the system was 46.47%. The maximum dry air temperature was found to be 64degreeC. The average dry air temperature in a dry cabinet is higher than the ambient temperature in the range of 50degreeC at the beginning of the day to 31.1degreeC in the middle of the day. 80% and 55% of the weight was lost while drying the pepper and yam chips in the dryer, respectively. inside the dryer.



3) Ahmed AbedGatea

Designed and built a solar drawing system for corn kernels with a 2.04 m area U-groove collector, drawing chamber and blower. Thermal energy and heat loss from the solar collector were calculated for each of the three tilt angles (30,45 °, 60 "). Radiation occurred. Several other important results were found to be theoretical thermal energy, experimentally real heat increases. Radiation intensity increased, maximum values fell at 11 a.m. and then gradually decreased. Is more

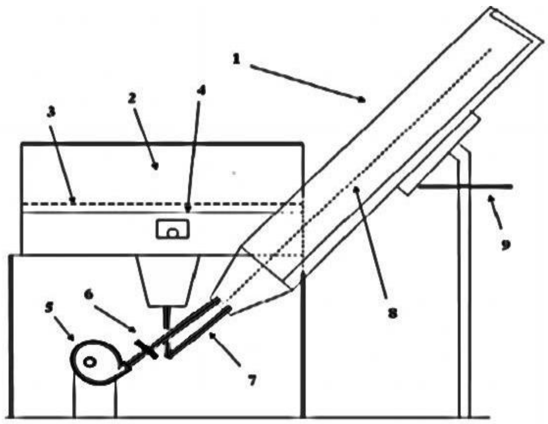


Figure 2. Section of the solar drying system: 1. Solar collector. 2. Drying chamber. 3. Drying tray. 4. Thermostat temperature. 5. Air blower. 6. Air valve. 7. Connecting pipes. 8. Absorption plates of two air passes. 9. Slide rule.

4) M. MOHANRAJ, P. CHANDRASEKAR

The performance of the indirect forced convection solar dryer combined with heat storage material was designed, fabricated and tested for chilli drying. A dryer with heat storage material enables the air to maintain a constant temperature in the dryer. The inclusion of heat storage material increases the drying time by about 4.5 hours per day. Chilies were dried in the bottom and top trays at 72.08% from the initial humidity to the final humidity, 9.12% and 9.72% (on a wet basis), respectively. He concluded that a forced convection solar dryer is more suitable for small holders to produce high quality dry pepper. The thermal efficiency of the solar dryer is estimated to be approximately 22% and the specific humidity removal rate is about 0.88 kg / kW h

5) Bukola O. Bolaji.et.al

Created a simple and inexpensive blended mode solar dry local source material. The temperature in the drying cabinet rose to 23 ° C (74.2%) immediately after 12.00h (noon). The drying rate for yam chips, collector efficiency and moisture removal percentage (on a dry basis) were 0.628 kgh-1, 55.5 and 85.5%, respectively.

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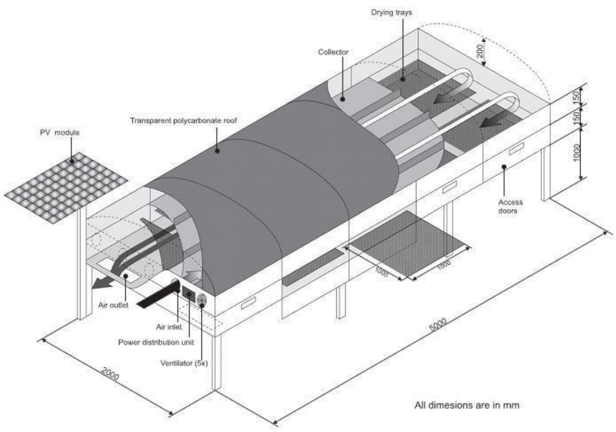
The dryer has sufficient capacity to dry food at reasonable humidity level at safe humidity level and also high quality of dried product.

6) J. Banout et.al

The Double Pass Solar Dryer (DPSD) was designed to dry red chillies in central Vietnam, and the DPSD is compared to a cabinet dryer (CD) and a traditional open dryer. They found that the average drying temperature for DPSD, CD and open air drying in the sun was 61 ° C, 52.2C and 34.8 ° C and the corresponding humidity was 33%, 44% and 64%, respectively. The total drying efficiency of DPSD is 20.2% which is typical for a forced convection solar dryer. The humidity of fresh red pepper was almost the same in all drying tests, where initial values were 9.19kg kg.9.27kg kg and 10.30kg kg (db) for DPSD, CD and open air sun drying, respectively. Where the final humidity of DPSD 0.04kg / kg reached after 23.3 hours, 0.08kg / kg for CD after 29.5 hours and 0.19kg / kg after 37 hours in open sunlight (excluding night). The performance of the newly designed DPSD has been compared to that of traditional CD and sun drying for drying common CDs and red peppers. DPSD has resulted in minimal drying time to meet the desired humidity of the pepper (10.50% wb. Which is related to the highest drying rate compared to other methods. So, the double pass solar dryer was found to be technically and economically suitable for drying red chillies under certain conditions in Central Vietnam.



7) M.A. Hossaina and B.K. Bala

Mixed mode type Force Convection Solar Tunnel Dryer is designed and developed for drying hot red and green chillies in the tropical climate of Bangladesh as shown in the figure. In dryer (1.Air inlet 2.Fan; 3.Solar module; 4.Solar collector; 5.Side metal frame; 6.Collector outlet7.Wold support; 8.Plastic net; 9.Plastic cover roof structure; 10. Base structure to support dryer; 11. Rolling bar, 12, drying tunnel outlet.) Red pepper humidity in solar tunnel dryer decreased from 2.85 to 0.052 kg / kg (db) in 20 .5hours and humidity was 0.08 and 0.41 kg / kg (db). It took 32.5 hours to subside.) In modified and traditional sun drying methods, respectively.

8) F.K. Forson.et.al

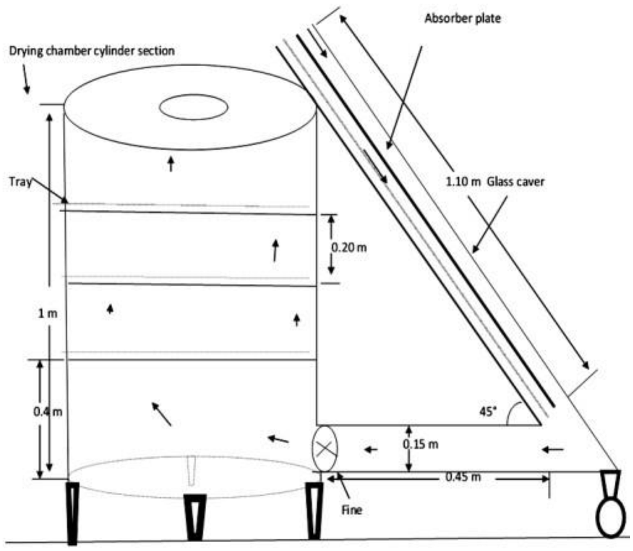
The Mixed-Mode Natural Convection Solar Dryer (MNCSCD) is designed for drying cassava and other crops. A batch of 170 kg cassava by mass, in which the initial humidity is 67% on a wet basis from which 101 kg of water must be removed so that it has to be dried to the desired moisture of 17.5% wet base, is used as dry load. Drying time for the expected test location (Kumasi; 6.72N, 1.62W) is assumed to be 35-37 hours with ambient conditions with an average solar radiation of 410W / m2 and 24 IC and 76.8% relative humidity when designing the dryer. They concluded that a minimum of 40.4m^2 solar collection area is required by design for 11.5% expected drying efficiency. With an average ambient condition of 28.2 IC with 340.4W / m^2 solar radiation and relative humidity of 72.12%, 35 hours drying time was observed and when tested under a fully designed load process the drying efficiency was assessed as 12.35%, indicating that the design ratio Is. That's enough.

9) EL- Amin Omda Mohamed Akoy.et.al

A natural solar dryer (cabinet type) was designed and built to dry the mango pieces. He concluded that the dryer designed with 16.8m2 collector area, 195.2 kg fresh mango (100 kg chopped mango) on 81.4% to 10% wet basis is convenient to dry in one to two days during April to June harvest period. A prototype of the dryer has been designed and built with a maximum collector area of 1.03m^2.

10) Ahmed AbedGatea

A cylindrical section of the solar drying system was designed and the efficiency is analyzed. The system consists of a solar collector flat plate 1.11 m long and 1.11m wide and a fan was built and designed for the purpose of drying 71 kg of bean crop. The performance of the solar air collector has been tested using three air flow rates. The highest temperature (71.4 degree C) of the outlet solar collector is received at 11 a.m. 751 W/m^2 was obtained for air flow of 0.0400 kg / s at radiation intensity and minimum temperature (41.0 degree C) was obtained when air flow rate at radiation intensity was 0.0674 kg / s 460 W / m' was obtained. The maximum value of average thermal efficiency is 25.64% with an air flow rate of 0.0675 kg / s of the solar air collector and the minimum average thermal efficiency is 18.63% with an air flow rate of 0.0405 kg / s. The initial humidity of soybeans was 70% and final 14% when air flow rate was 0.0405 kg / s 18% d, b flow rate of 0.0540 kg/s and air flow rate of 0.0761 kg / s was 20% d.b.



III. CONCLUSION

Solar dryness has proven to be technically and economically valuable for many crops. However, it is necessary to develop a large number of dryers which can be used to attract farmers for various products throughout the year. Protection from UV radiation, dust, insects, mold and other contaminant sources, as well as temperature and relative humidity control, and to improve product quality is essential. Similarly, the storage conditions of sunlight products should be commensurate with the crop and long shelf-life is required if the packaging is optimized.

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