RECENT TRENDS ON SOLAR AIR DRYER FOR AGRICULTURAL PRODUCT – A REVIEW

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ABSTRACT- The work presents a solar dryer system for carpet drying. A flat plate solar air heater was designed for the large scale industry drying process. The thermal performance of the designed collector was tested based, and the test results show that the instantaneous efficiency and heat loss coefficient base on gross area and mean temperature of heat transfer fluid is 0.77 and 5.62W/(m^2 k) respectively. Then, a solar dryer system was designed and constructed for carpet drying, which composed of a 56 m^2 solar air heater field, a dryer cabinet and others subsystems. Performance of the drying system was tested and analyzed, and the test results show that more than 320 kg wet wool and carpet could be dried in 7.5 hours, when the average intensity of solar irradiation got to 800 W/$m^{2.}$

KEYWORDS- Solar drying technologies, Natural circulation solar dryers, Forced circulation solar dryers, Green house dryer, solar tunnel dryer.

1. **INTRODUCTION**- Drying is a simple process of removing excess water content from an agricultural or industrial product; it is oldest method of food preservation. Most of the agricultural products contain the higher moisture of 25–80% but generally for agricultural products around 70%. This value of moisture content is very much higher than the required for long preservation J. Banout et al. [1]. Therefore it is necessary to reduce the moisture content in food stuff for its long preservation. Another case of drying is to remove the total moisture content from food. These dehydrated foods regain its original conditions after re-watering whenever necessary to use. Using solar drying technologies are very much advantages than using fossil fuels for product drying. Most beautiful advantage is pollution free method and reducing emission of carbon particles in atmosphere. Solar drying technologies are broadly classified in to three modes direct solar drying, indirect solar drying and mixed mode solar drying. Solar dryer are the device used for product drying with proper application of solar energy. Solar dryers are classified by air movement in the drying chamber Alireza Azimi et al. [3]. Studied Tha Condori and Saravia Using solar drying technologies are very much advantages than using fossil fuels for product drying. Most beautiful advantage is pollution free method and reducing emission of carbon particles in atmosphere. Solar drying technologies are broadly classified in to three modes direct solar drying, indirect solar drying and mixed mode solar drying [2]. Solar dryer are the device used for product drying with proper application of solar energy. Solar dryers are classified by air movement in the drying chamber.
2. **LITERATURE REVIEW**– A.A. El-Sebaii et al. [4] studied the efficiency of forced convection single and double chamber green house drier. Results showed that double chamber greenhouse dryer is 87% more productive than the same area.
   A new low cost design tunnel-type greenhouse dryer was constructed and tested presented experimental analysis of air speed distribution in a naturally ventilated greenhouse. The result showed due to 0.837 of the regression slope the calculated air speed was lower than measured value Amina benhamoua et al. [16].
   It concluded that average value of air speed in greenhouses is just like a key factor for calculating heat transfers between greenhouse components and interior. It concluded by considering the greenhouse drier as a solar collector, an analytical linear relation is established due to which an improvement of around 160% with respect to the single chamber drier, while the improvement is of about 40% if compared with the double chamber drier V.V. Tyagia et al. [5].

   The presented drying model of a pepper in a naturally ventilated polyethylene greenhouse. The result showed the diversity of product water loss which can be expressed as a function of ventilation rate or induced air velocity, air and product temperature and imparted solar radiation through a greenhouse cover [7].

   It concluded that the drying operation allow the exploitation of polyethylene greenhouses in summer time when not used. studied of convective mass transfer coefficient and performed moisture removal rate from cabbage and peas for open sun and inside greenhouse LyesBennamoun et al. [6].

   It concluded in natural mode, the convective mass transfer coefficient was lower inside the greenhouse drying as compared to open sun drying and in the initial stage of drying, its value was doubled belo Fig. 2.1 Y. H. Hui et al. [14].

A variety of active solar energy dryers exists which could be classified into either direct, indirect or hybrid dryer .

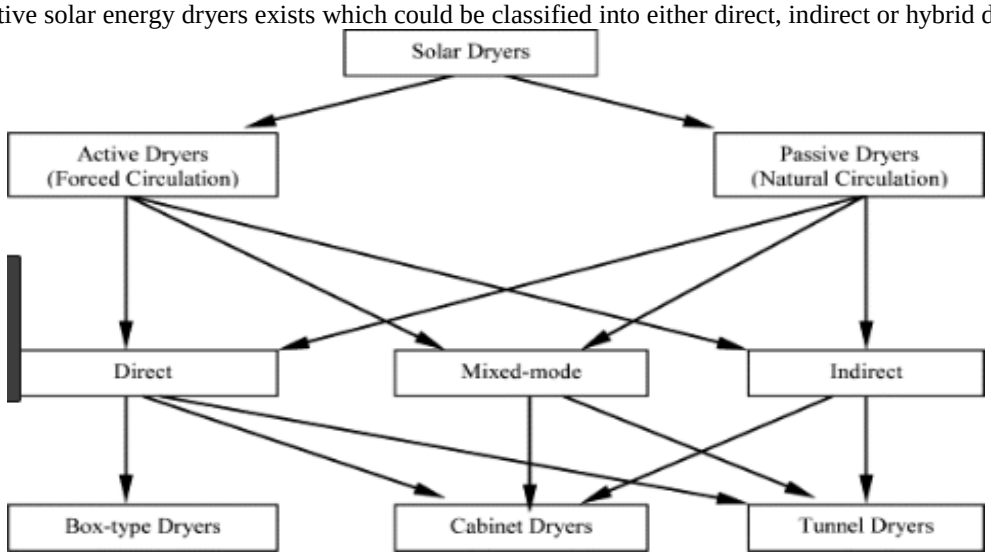

Fig.2.1- Classification of Solar Dryer [14].

Direct solar dryers have a black absorbing surface which collects the light and converts it to heat; the substance to be dried is placed directly on this surface as shown in Fig. 2.2.

The moisture is taken away from the product by the air entering the cabinet from the bottom and leaving at the top of cabinet. From the total radiation impinging on the glass cover, a part is reflected back to the atmosphere and the remaining is transmitted inside the cabinet. A part of the transmitted radiation is then reflected back from the crop surface and the rest is absorbed by the surface of the crop which causes its temperature to increase Amer et al. [8].

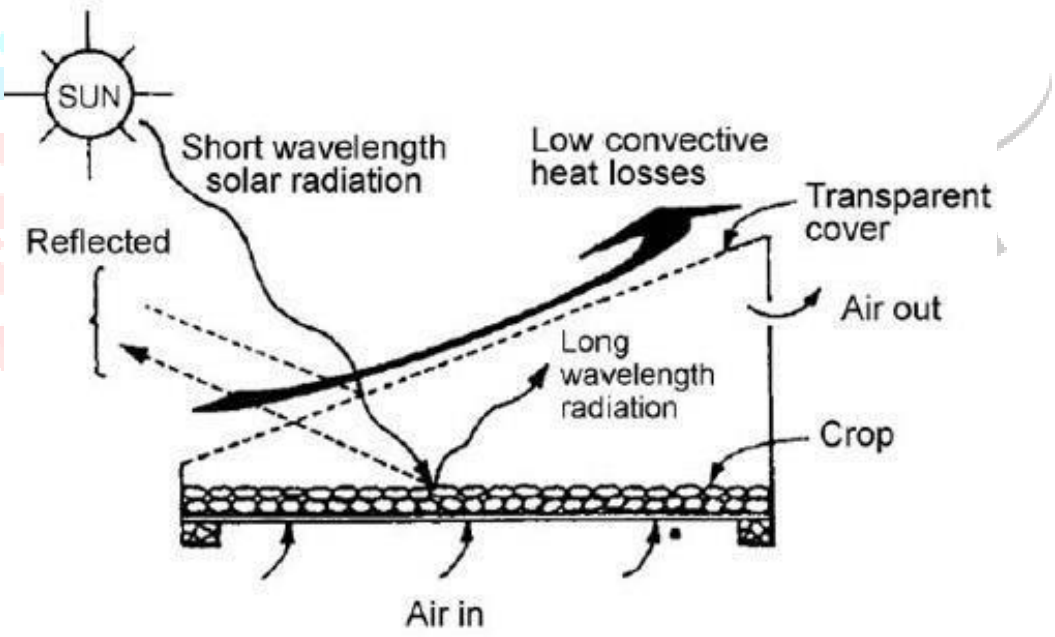

Fig.2.2- Direct Solar Drying [8].

The emitted long wave radiation is not allowed to escape to the atmosphere due to glass cover. The overall phenomena increase the temperature of the crop inside the dryer BenaoudaNour-Eddinea et al. [9].

The glass cover in the cabinet dryer thus reduces the loss of convective heat lost from the cabinet. indirect solar dryers, the black surface heats. The incoming air, rather than directly heating the substance to be dried. This heated air is then passed over the substance and exits through a chimney, taking moisture from the substance with it Fig. 2.3 [13].

The crops are placed in the trays or shelves inside drying cabinet and a separate unit called solar collector receives the solar energy and supplies heated air to heat the cabinet. The additional resistance generated for the air movement due to this arrangement of the tray is achieved by the chimney effect, which creates a density difference of air dryer between the cabinet and the atmosphere A.R. Celma et al. [10].

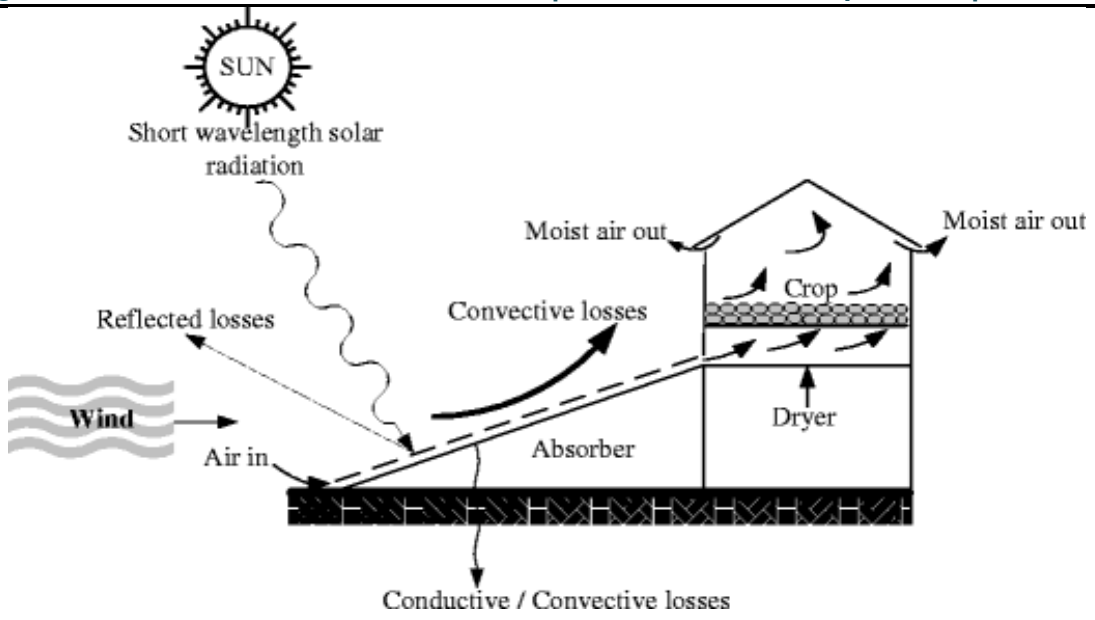

Fig. 2.3.Indirect Solar Drying [13].

The hybrid solar dryer has a solar collector, drying chamber and biomass back up heater/energy source. The backup energy source may be solar PV, biomass, LPG, diesel or electrical. Direct and indirect dryers can work on the principle of active and passive mode. Active dryer semploy an external means, such as fans or blowers, or moving the heated air from the solar collector to the drying chamber, while passive dryers use only the natural movement of heated air. In a passive solar dryer air is heated and circulated by buoyancy force or as a result of wind pressure or combination of both A. Saleh et al. [11].
In indirect solar dryer, the black surface heat incoming air, rather than directly heating the substance to be dried. this heated air is then passed over the substance to be dried and exit upward often through a chimney, taking moisture released from the substance with it. they can be very simple just a tilted cold frame with black cloth to an insulated brick bulding with active. one of the advanteges of the indirect system is that it is easier to protect the food, or oter substance Parm Pal Singh et al. [15]. They are primitive, inexpensive in construction with locally available materials, easy to install and to operate especially at sites far away from electrical grids. The advantages and disadvantages of various drying methods is listed in the Atul H Patel et al. [12].

3. OBJECTIVE

The main objective of this project is to investigate the thermal analysis of a solar drier system by doing the following.

1. To experimentally investigate the performance of this new solar dryer.
2. To find out the percentage of moisture removed from the Banana & Agricultar product
3. To compare the drying time for the fruit in the solar dryer with granite sheet and drayer without granite sheet as well as with open sun drying.

4. METHODOLOGY- Solar drying refers to a technique that utilize incident solar radiation to convert it into thermal energy requir for drying purposes. most solar dryer use solar air heater and the heated air is then passed through the drying chamber to be dried. the air transfer it is energy to the material causing evaporation of moisture of the material. the simplest method to dry biomass by exposing the biomass under direct sunlight. The solar cabinet dryer traps solar heat to increase the temperature of the drying chamber. The transparent glass is fixed at an inclination of 21° to achieve a maximum absorption of solar radiation. The wall of the drying chamber is made up of three different layers, i.e. fibre glass, wood and aluminium. Fiber glass is used as the outer layer because it makes a good heat insulator that prevents heat loss to the surrounding. Wood issue as the middle layer due to its low cost. The inner layer is made of aluminium which has high resistivity against rust and corrosion. the design of the drying chamber is similar to a drawer cabinet that has two drawers. The drawer compartments are made up of aluminium and they are designed in such a way that they allow a maximum flow of hot air through the biomass. The whole ventilation system is driven by direct current (DC) generated from solar panels (PV).The air flow rate of the ventilation fan is 70 cubic feet per minutes (CFM). The temperature of position parts of the drying chamber is measured using type K thermocouple. The bottom is made up of aluminium and painted in black to increase the radiation absorptivity and emissivity. The top of the absorber is covered by a dark glass. The black surface will absorb the radiation and changes it into heat energy to heat up the incoming fresh air. This paper is conducted based on research and experiences into risk management its potential to prevent and eliminate risk and learning from performance team in industry which matched by an application in project refurbishment in Batam manufacturing.

5. CONCLUSION - Solar air dryer is best suited for the drying process one of the most important potential application of solar energy. In this paper, a review of the research paper is state that, the solar dryer is beneficial from than the sun drying techniques . Solar dryers do have short comings. They are of little use during cloudy weather. During fair weather they can work too well. Although solar dryers involve an initial expense, they produce better looking, better tasting, and more nutritious foods, enhancing both their food value -and their marketability. They also are faster, safer, and more efficient than traditional sun drying techniques. Solar dryer is the best alternative technology to avoid disadvantages of conventional drying methods. Solar dryer is designed for a particular crop and atmospheric conditions of location. Various types like mixed mode, natural circulation, forced circulation, green house type and tunnel type of solar dryer are reviewed with design parameters and performance. In mixed mode of drying the product may dry in less time compared to direct and indirect mode drying. But indirect mode of product drying will essential whenever requires avoiding direct exposure of product to the solar radiation. Forced circulation solar drying shows better result with reduced drying time than open air solar drying and natural circulation solar drying. But natural and forced circulation solar drying should use for limited quantity of product. For large quantity of product drying, it is better to use the green house type solar dryers.

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