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Performance and Experimental studies on Vortex-Circulating Bed Solar Dryer: A review

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Abstract - *The unpredictable rise and frequent scarcity of fossil fuel accelerated the continuous search for an alternate power source. Solar is one of the renewable and sustainable source of energy. It is abundant in both direct and indirect form. In many tropical countries, agricultural products dried under the open sun. This is the oldest technique used by mankind. However this way of drying degrades the quality of the dried product due to interference for external impurities and uneven drying rates. Numerous types of solar dryers have been designed and developed in various part of the world. Various topics in sun and solar drying are discussed in many scientific reports, research manuscripts and books. This review paper focused on fabricating and testing for drying chillies by using flat plate collector and vortex- circulating bed solar dryer. The advantage of the vortex circulating bed is to provide constant movement of the chillies over the bed in order to enhance the resident time with hot air. Vortex circular motion technique provides efficient agitation. The model can predict the change in the temperature of air, relative humidity, the moisture content and the dryer thermal efficiency.*

***Key Words*: solar flat plate collector, relative humidity, vortex- circulating bed, moisture content, dryer thermal efficiency.**

1. INTRODUCTION

Drying particularly of crops is an important human activity and globally the use of dried products is widespread. For preservation, quality improvement and processing purposes, moisture must often be removed from both organic and inorganic materials. Sun drying and mechanical dehydration using fossil fuels are the most common technologies used, Sun drying is a low-cost drying method but the final quality is variable, while mechanical dehydration is an energy intensive process and contributes substantially to energy use and greenhouse gas emissions. The shortage of energy is an issue in many countries, particularly those in the developing world. Even where conventional energy is plentiful, there is pressure to reduce the amount of fossil fuels used. Concern over global warming is universal and this has focused our attention on energy intensive processes like drying where fossil fuels can often be replaced by renewable and non-polluting sources of energy. The solar dryer consists of flat plate collector, a blower with pipe connections, and vortex circulating bed. The blower is use to circulate the hot air from the collector to the bed. In this solar dryer, it consists of 1) Flat plate collector, 2) Blower, 3) Vortex-Circulating Bed technique is use, where the Flat plate collector is used to heat the ambient air into hot air. The blower is used to circulate the hot air from the collector to the bed and Vortex-Circulating bed of the solar dryer is circulating while drying chillies that are present in it, this model can predict the change in the relative humidity of air across the bed with digital hygrometer, change in the air temperature, change in the moisture content and the efficiency of the dryer.

2. REVIEW OF WORK CARRIED OUT

S. Shanmugamle, KumarAR. Veerappan et al, [01] had worked on a mathematical model for drying agricultural produce using a solar dryer capable of oscillating its bed while kept at an inclined position with respect to vertical. A model of the solar dryer with double-pass flat plate collector and an oscillating-bed has been fabricated and tested for drying agricultural produce. The model can predict the change in the absolute humidity of air across the bed, the temperature of the air, the moisture content, and the dryer thermal efficiency

UmeshToshniwal, S.R Karale et al, [02] had worked on different types of solar dryer. In this review paper he had classified different types of solar dryer on the basis of their operating temperature that is on High temperature solar dryer and Low temperature solar dryer. He had mentioned the following criteria's are required for classification of the solar dryer: 1) Air movement mode, 2) Insulation exposure, 3) Air flow direction, 4) Dryer arrangement, 5) Solar contribution, 6) Types of fruit to be dried.

R. VidyaSagarRaju et al, [03] had worked on that, the section comprises of literature review on studies in the past in relation to solar dryer and present. It also discuss the different types of solar dryers, its advantages and disadvantages, comparison of using open sun drying and solar drying technology. He also mentioned that drying may be an interesting method in order to prevent fresh fruit deterioration. There is spoilage of fruits and other fresh foods that could be preserved using drying techniques in India and other developing countries. Seasonal fruits like mangoes are not presently dried for export, or for local consumption during period of scarcity.

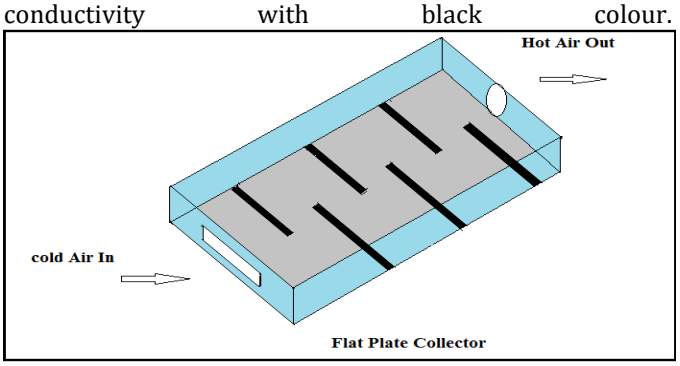
Seini 'ElaUatekiniVaipulu et al, [04] had worked on different drying techniques for drying agricultural products were reviewed in the study to develop a suitable dryer for drying sea cucumber as it is a high export value product gaining importance in the international markets now a days. A conceptual prototype solar dryer for drying sea cucumber was designed which has its advantages over the traditional open sun drying methods such as reducing the loss due to damage caused by insects, birds, rodents and adverse climatic conditions. The drying period using the conceptual solar dryer is 1 -2 days whereas it takes 4 -14 days in the traditional open sun drying methods.

Benjamin TernengeAbur et al, [05] in this paper, solar drying technologies for drying fruits, vegetables, spices, cereals, grains, legumes, medicinal plants and fish for global food security are reviewed. For nutrient preservation of dried products and superior drying speed, the indirect forced convection type solar dryers are preferred but power requirement increase the cost of drying as well as limit their use in the rural areas. Natural-circulation type solar tunnel dryers, wind ventilated type solar dryers with heat storage units and
greenhouse dryers are more suitable for rural applications. Solar-biomass hybrid dryers overcome the limitations of solar drying during cloudy conditions and night hours, operational procedure and effectiveness in promoting better product quality should be consider in the design and production of solar drying systems.

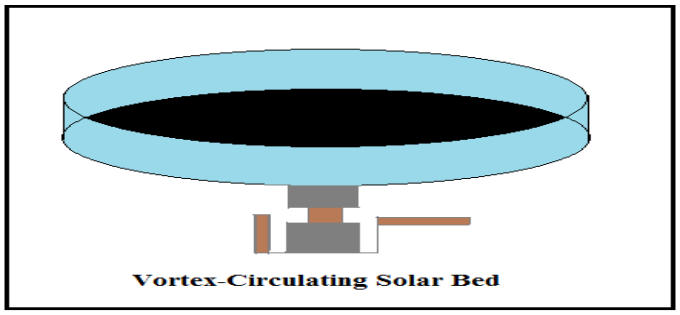
Chandrakumar B Pardhi et al, [06]. Based on preliminary investigations under controlled condition of drying experiments, a mixed-mode solar dryer with forced convection using smooth and rough plate solar collector was constructed. This paper describes the development of dryer considerations followed by the results of experiments to compare the performance of the smooth and the roughed plate collector.

3. METHODOLOGY

The solar dryer system consists of a flat plate collector, blower with flexible pipe connections, and vortex circulating-bed. The flat plate collector is used to heat the ambient air into hot air. The flat plate collector consists of collector plate, absorber plate with baffles. The material use for absorber plate is aluminium having good thermal conductivity with black colour.



Collector plate is made up of glass which can be use for trapping the solar radiations. The blower is used to suck air from atmosphere and circulate hot air from the collector to the bed.



The chillies are fed in the bed and are spread over the bed as a thin layer due to bed circulation. The advantage of the vortex circulating bed is to provide constant movement of the chillies over the bed in order to enhance the resident time with hot air.

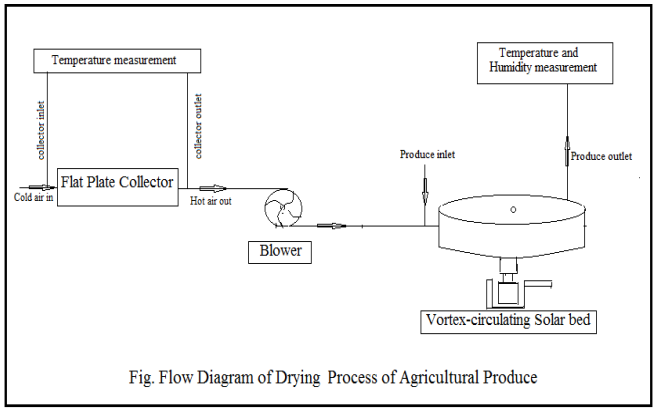


Fig. Flow Diagram of Drying Process of Agricultural Produce

The moisture present in the surface of the chillies is evaporated first because of the hot air contact; after that, the chillies themselves are rotated because of the vortex motion

of circulating bed. The hot air entering the bed with a low relative humidity and high temperature picks up the moisture from the chillies and leaves the bed with a high relative humidity and a low temperature. In order to improve the drying performance of the solar dryer, on an hourly basis, the reflective mirrors and the bed cover will be propose to be use on the model.By using the vortex circular bed the resident time of the chillies or agricultural produce can be increases with hot air so that it can dry rapidly. Equal amount of energy is supply to all chillies and time taken by agricultural produce can be reduces, efficiency of the dryer is increase.

4. CONCLUSION

The advantage of the vortex circulating bed is to provide constant movement of the chillies over the bed in order to enhance the resident time with hot air. Vortex circular motion technique provide efficient agitation and moisture removal of product, Achieve the uniform drying and reduce the over drying of food products. So, this method improves the efficiency of Vortex-circulating bed solar dryer.

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