Short Review on Recent Trends in Solar Drying Systems

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Abstract
Energy obtained from the sun is known as solar energy. Various applications of solar energy include electricity production, water heating, distillation, drying of foods, cooking, etc. In this study we focused on solar drying process and its performance enhancement. With an aim of improving performance further, numerous research works are conducted by solar dryer based researchers. Such highlighted works are consolidated in terms of drying rate, mass of moisture removed, drying efficiency, etc. In addition, this paper also highlights results of various machine learning based papers in the field of solar energy and drying.

Keywords - *Solar; dryer; performance; enhancement; machine; learning.*

I. INTRODUCTION

Drying of food products involves removal or reduction of moisture content. Drying decreases the weight and volume of the products which reduces their packing, storage and transportation costs. The life of the food products can also be increased by drying process and make the product available during off season. Thermal energy is a key factor in dryers for which electric heaters or petroleum products are often used. Solar driers are widely helpful in industrial applications. So the reduction of fossil fuels utilization is possible. Now a days design of solar drier are much more concentrated, such that the obtaining the higher efficiency within the minimum surface area. The main boon of solar drier started when the results of many experiments has good efficiency. The one of the methods of drying the product with simple design consideration has become necessity. This can be achieved in solar heatrier system

II.LITERATURE SURVEY

Shobana Singh et.al [1] has undergone review on variety of solar driers designed for drying the food products. To reduce the complexity in various components of dryer system, there is a need to develop simple and effective theoretical model with suitable boundary conditions that can satisfactorily describe the drying process in all test conditions. They made an experimental setup for drying the food product. They investigated efficiency by varying the size of food product. It is found that dryer with sample thickness of 8mm and loading density of 4.33 kg/m^2 can operate optimally for absorbed energy of $450W/m^2$ and air mass flow rate of 0.017 kg/s.

Ashish Agrawal et.al [2] described that a solar dryer without heat storage provides air with large variations in temperature to the dryer, and drying of food is not possible during partial clouds and late evening hours. They described various reviews of researchers, to store the heat in dryer. Paraffin wax was used as a heat storage material in most of the previous research works because of its low cost and easy availability, but the major drawback of paraffin is low thermal conductivity.

M. Chandrasekar et.al [3] conducted an experimental investigation using the outlet of A/C as an inlet air into the dryer. In this work of sending the hot air inside the dryer, helps a lot in drying the sultana grapes (seedless) at a faster rate than normal mode. A possibility of 13% increase in solar dryer efficiency was demonstrated due to the utilization of solar dryer with A/C condenser unit compared to the conventional indirect solar dryer.

C.O.C. Oko et.al [4] presented the analysis of a coupled heat and mass transfer process in a fixed-bed solar grain dryer. and Humidity of air, moisture concentration, temperature were measured in a solar grain dryer in Nigeria, at the latitude of 4.858°N and longitude of 8.372°E. The process was also modeled, mathematically, by a set of partial differential equations that were coupled within the grain and through the grain boundary with the hot drying air. There was good agreement between the theoretical and experimental results at specified Biot and Posnov numbers, and varying Fourier number. The results of this work will be useful for specifying the design parameters of solar grain dryers.

N. A. Vlachos et.al [5] designed a prototype tray dryer equipped with a solar air collector, a heat storage cabinet and a solar chimney. The dryer is straightforward to construct and operate and may be enforced at low value. Considering the various climatic conditions tested (sunny, cloudy or rainy), the drying method reached full completion altogether tests at an inexpensive rate of dehydration. Experimentation over the night, while not the employment of the centrifugal fan, confirmed the system's smart performance relating to the utility of the warmth storage cupboard since the products' water content continued to decrease though at a lower rate.

Sujata Nayak et.al [6] tested the mint and comparison was made to fresh samples. The results are recorded for eight different samples in fresh and dried conditions. it has seen that fresh samples had substantially higher moisture content than the dried samples. Among the dried samples, leaf powder (open) (4-OLP) had the highest moisture content at 5.13% (wb), whereas the lowest moisture content was recorded for the stem powder sample (2-GSP) at 3.23%. Due to the lower moisture content in dried samples, storage life will be longer. The results clearly show that the fat, protein, ash, crude fiber, and total chlorophyll content in dried samples were higher than the fresh samples on a fresh weight basis.

B. S. Rawat et.al [7] made an detailed analysis in energetics of a low cost, locally fabricated, natural convection type solar crop dryer in India which may helpful to know different components of dryer. Locally grown chilli has been dried to evaluate the energetics of the dryer. Energy payback period has been evaluated when displacing different conventional fuels and found to be 1.1 0, 1.55, 1.32 and 1.77 years in the case of fuel wood, light diesel oil (LDO), coal and natural gas respectively. The energetics of such a straightforward and reasonable drier ought to be more analysed to scale back national and international energy demand.

Ilhan ceylan et.al [8] designed and manufactured a new type of solar dryer. In this experimental study, tomatoes were wont to take a look at the drying method. The drying air was heated by the heat pipe collector and forced through the tomatoes by a blower fan during the daytime. The photovoltaic cells, which were wont to run the fan, were also used to charge the batteries during the day. These charged batteries were used for running the group lamps throughout the night, when the halogen lamps were used to heat the drying-air-assisted photovoltaic cells. During the drying amount, the drying air temperature, relative humidity, air flow rates, radiation, and loss of mass were measured in the solar dryer.

Mohsen Mokhtarian et.al [9] set forth an work on comparison of three drying method. Two perforated trays of drying chamber were covered with single layer of fresh pistachio and dried with circulated ambient air heated and another method without air recycling. A cotton cloth was placed on the ground, covered with a single layer of fresh pistachio and exposed to direct Sunlight. The pistachio dried with technique I used a lot of less energy than those dried with different strategies and had the next quality than those dried with business driers because of drying temperature < 50°C.

Jose vasquez et.al [10] experimentally evaluated an advanced multivariable control system using fuzzy logic was implemented and applied to a solar dryer equipped with thermal energy storage system, with a capacity of 25 (kg) of agro-products. The aim of this control system is to improve the drying efficiency, since, by decreasing relative humidity. The opening of the valves in both control systems was performed properly with variations of solar radiation, ambient temperature and air moisture during the dehydration of mushrooms, plumbs and peaches. Solar drying, at the side of a correct system, reached eightieth energy savings compared to standard drying.

Om Prakash et.al [11] had undergone comprehensive review of the varied styles, details of construction, and operational principles of the wide variety of practical designs of solar energy drying systems. Two major teams of star dryers may be known, viz., passive or natural-circulation star dryers and active or forced convection star dryers. Low-cost food drying technologies may be without delay employed in rural areas to scale back spoilage and improve product quality so leading to overall process hygiene. Scientifically designed active solar dryers are generally found to be more effective than the natural-circulation types. Therefore, star photovoltaic-thermal (PV/T) drier is united to be appropriate.

I. Farkas [12] integrated the solar energy for crop drying in this paper. The background of star drying, current solar drying practices, and drying of biological products such as grain, fruit, vegetables, hay, etc., are discussed. Additionally, associate integrated energy/technology approach so as to maximize alternative energy usage and Thereby meet the drying needs has been introduced. This will aid in achieving a classy answer for drying method management, as well.

N. M. Khattab [13] made a study to save electrical energy consumed in a hybrid solar heating system consisting of a solar air heater and an electric heater to augment the solar energy to provide a constant inlet air temperature to the drying chamber. The study super imposing pebble storage onto the system. Minimum consumption is attempted to be realized through the proper dimensions of the air heater length and pebble bed height, taking into consideration the effect of increasing material and fan costs. For each operating temperature in the range recommended for drying of agricultural products (30"-7d"C), a condition of minimum savings is obtained.

A.E. Kabeel et.al [14] investigated the effect of rotary desiccant wheel on the thermal performance of the solar dryer unit. The theoretical models of the chemical agent wheel associate degreed reflector are valid exploitation experimental information. Also, the consequences of chemical agent wheel rotation speed on the performance of this technique area unit investigated. using rotary chemical agent wheel within the star drying units, the temperature of drying air increased from 65°Cto 82 °Cwhile the humidity ratio decreased from 15 to 8.8 gwater/kgdry air compared to the star drying units while not employing a chemical agent wheel, at an equivalent close conditions.

S. Lokeswaran et.al [15] presented the experimental and numerical analysis of a natural convection solar greenhouse drier. A simple experiment is dole out and noted on a star greenhouse drier at no load condition to live the temperatures at totally different points. A solar greenhouse drier model is developed in the preprocessor GAMBIT and analyzed using the Fluent 6.3.26 package.

Experimental results area unit valid by wide used process fluid dynamics software system Fluent half dozen.3.26. The results square measure found to be satisfactory with a mistake rate below 2 hundredth.

Alireza Mohajer et.al [16] investigated a new hybrid system which facilitates a dual-purpose solar collector to simultaneously support a dryer system and provide consumptive hot water. The system includes a 100 l water storage tank, a solar dryer with 5 trays, and a dual-purpose collector. Experiments were carried out to dry a mixture of vegetables (parsley, dill and coriander) at constant air and water flow rates. Besides, an electrical heater has been used as an auxiliary source for heating. The results indicated that the system optimally dried the vegetables and simultaneously provided the consumptive hot water.

A.G.M.B. Mustayen et.al [17] undergone a detailed study various kinds of solar dryers that are widely used today. The indirect, direct, and mixed mode dryers that have shown potential in drying agricultural product within the tropical and subtropic countries area unit mentioned. Aside from characteristic the active and passive mode star dryers, and conjointly highlighted the environmental influence on solar power (harnessing) that plays a significant role within the star drying sector. They also presented the related technologies that can help improve existing solar dryers.

Sumit Tiwari et.al [18] proposed and developed numerical computations with the help of program made on MATLAB 2013and the results are validated with experimental values. Characteristic curves are developed for drying and system potency with experimental validation. Theoretical and experimental values of overall thermal energy found to be 1.92 kW h and 2.03 kW h respectively. There is good agreement between theoretical and experimental value with r = 0.98, e = 10.76.

Mahesh Kumar et.al [19] reviewed various types of solar dryers namely, direct solar dryers, indirect solar dryers, hybrid solar dryers and their various drying applications. Among them indirect mode forced convection dryers have been reported superior in drying speed and quality drying. Due to high drying rates and energy effectiveness, they have been observed suitable for low solar insolation and high humidity climate zones. Since solar air collector unit is the most important part of indirect solar dryers and hence a significant improvement in it could lead to better drying performance of the system.

Lyes Bennamoun [20] given detailed review dealing with the integration of PV cells in drying systems with an overview of the design aspects and a comparison of the respective performances. Particular care is given to the design of solar dryers with a detailed presentation of the influence of the different parameters like the surface of the PV cell, geographical location, and materials used.

III. CONCLUSIONS

1. Solar dryers are closed chamber which are capable of removing moisture from a product naturally [1, 2, 3, 4 & 5].
2. An optimal design of solar dryer converting the input into effective output is under recent study by many researchers [6, 7, 8, 9 & 10].
3. Conversion rate and time taken to dry food product by a solar dryer depends on area occupied by it [11, 12, 13, 14 & 15].
4. Performance of solar dryer can also be increased by integrating its input with output of various thermal devices like A/C, solar air heater , etc [16,17, 18, 19 & 20]
5. Artificial intelligence based performance predictions of solar dryers are identified as trending research gap [21].
6. Introduction of IOT in to the field of solar dryers is expected to have increased performance in comparison to manual mode of operation [22].

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