Experimental Analysis on Conventional, Modified and Modified Green House Dryer Assisted With Reflector

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Abstract : The use of solar energy is among the most effective and optimum cost application for drying the agricultural crops but there are also some disadvantages related with open sun drying, such as crops are affected by dirts and other impurities declination in the taste and quality of the food products, to overcome the problem created due to open sun drying, solar green house drying is best alternatives. In proposed work a modified green house dryer with opaque north wall and assisted with the reflector will be designed for drying of potatoes flakes. For comparing the results obtained by modified green house dryer also a conventional green house dryer will be made. The projected greenhouse dryer is of inclined roof even kind made of rectangular iron pipes wrapped by clear polyethylene sheets .For reduction in heat transfer from bottom surface it is covered with black color plastic. The drying tray will be made up of mesh wire with black color to trap most of the falling solar radiation. For entrance of air inside the dryer two circular holes will be provided on the south wall below the tray position. One exhaust fan will be applied in upper portion of north side wall of the dryer for exhausting the air by forced convection mode. To magnifying the insolation roof of the dryer is inclined to 23.15° N, same as latitude of Radharaman institute of technology and science, Bhopal, where all the reading and experiments will be performed.

Keywords- solar greenhouse dryer, modified greenhouse dryer, forced convection mode.

I. INTRODUCTION

Potato is one among the highly grown vegetables. According to FAOSTAT available from 2012-2017 China mainland's, India, Russia, Ukraine along with United States of America are the top among potatoes producing country. India stands at second among above top five producers. In India from 2012-2017 the average production of potatoes was 45,901,340 tones. The production of potatoes has enlarged at a very quick rate in last couple of years. In 2010 it was only 36,577,300 tones which reached to 48,605,000 tons in 2017. To reduce the losses after post harvesting, long term storage and to meet with the future demands preservation of vegetables is needed. Solar green house drying is one among the highly suitable and economical ways for preserving the vegetables. By solar crop drying wetness of the product transferred out by method of evaporation. It is a complicated method during heat and mass is transfer coincidentally. In drying process volume of the crop is reduced while cost of the crop increases. By the drying of crop various physical as well as structural changes occurs. Crops can be dried in their original sizes or may be cut in to slices or quarters. Solar energy is identified as one among the highly projected renewable energy source of forthcoming time and moving towards replacing the use of conventional energy and increase production acceptances. Solar energy is mostly used for solar drying. The basic function of this domestic solar dryer is based on greenhouse effect principle in which the insolation trapped in the green house and so, results in increases the temperature of the drying chamber. A solar drier is a closed unit which allows the solar radiation to pass through a glazing and get trapped .the heated surface, in turns, heating the air which passes through the food items and results in their drying. The solar dryers were a widely discussed topic of research since the late 70s and many researchers have worked on various parameters analysis of these dryers. Various solar dryers were used in the past for efficient use of solar energy. Solar dryers can be divided on the basis design of system components and mode for optimum use of solar energy.

Natural convection solar dryer; among the solar cabinet dryer is very simple, and contain mainly a small Wooden box. The sides and down portion of the cabinet can be transferable and made from wood or metallic sheet. A transparent plastic cover was used on top surface. Air holes are given on sides of the drier for passage of air. A transportable direct type natural convection solar dryer, rectangular shaped with transparent upper and blackened internal surfaces transparent plastic sheet was placed around the heating space for solar radiation to heating the air. Black plastic sheet was also used in the space for absorbing the heat and to remove wetness from the ground. Ventilation holes were not given in the sides but an opening in the front of the unit provided ambient air to enter the heating space and another opening at the back of the drying chamber helped moist air to exhaust from the unit. This dryer may also be used as active dryer for crops that are not affected by bleaching if the product is kept directly into the heating chamber. In both dryer, flow of the air is very low and, what next, that the improvements unable to significantly improve the working of the dryer.

Forced convection dryer; direct mode forced convection dryers used external agent like blower to force the air across the product, a drying chamber, covered by a transparent sheet. Indirect mode forced dryer having a solar collector assisted with blower, and a solar drying chamber. The air is pre heated by the collector and send to drying chamber.

Greenhouse drying has been used since more than three decades. There are various heat transfer method that has been employed to increase the thermal performance characteristics of solar greenhouse dryer however It is known that inside a completely closed single polyethylene(PE) cover greenhouse (east–west orientation),a temperature rise in temperature between (12-16°C) above the outer air temperature (38–42°C) in the extreme summer seasons. But, for decreasing the internal humidity, side and top passage have to be used in natural convection mode or an exhaust fan has to be installed for forced convection mode. By this opening of ventilators, increase in the inside air temperature of the greenhouse is restricted to about 10–12°C (under natural convection mode).While use of exhaust fans for exhausting the inside hot and moist air results in lowering the inside air temperature rise to only7–9°C (under forced convection mode). This increase in the inside air temperature is generally unable to effective crop drying and the crop takes respectively longer time to achieve to the required moisture content of the dried product. To solve this problem we can modify the green house dryer for rapid solar drying by applying aluminized reflector sheet on the north wall inside the greenhouse dryer. The reflector wall will helps in blocks the part of solar radiation which was passing from the north wall and reflects it back onto the product to be dried (placed ahead to the north wall on a tray) for further increment in temperature of drying chamber.

II. LITERATURE REVIEW

Pushpendra Singh et al.[1]. reviewed "Recent developments in greenhouse solar drying: A review". Various contemporary researches are elaborated in the paper. This paper provides the information of antecedently created solar greenhouse that the researchers will develop new and changed the structure of solar green house To support this, varied researches of present time are analyzed and bestowed during this review. Various results found in this review are; Greenhouse dryer working active mode is suitable in respect to passive mode, Forced convection is appropriate for prime wetness content crops whereas natural convection are often used for crops having low moisture content, appearance, quantity,flavour and nutrient value are higher in green house solar drying on compare of open sun drying.

Mahdiyeh dorouzi et al.[2]. investigated on "Tomato slices drying in a liquid desiccant assisted solar dryer along with a photovoltaic thermal regeneration systems" in this paper a solar dryer with liquid desiccant was designed for drying purpose of slices of tomato. In such sort of dryer a electrical phenomenon thermal reflector wont to get the required current and regenerate the sedative the designed drier was able to provide the specified electricity freelance of grid with drying at the temperature of 60-65 degree Celsius and regeneration pump activation ratio of twenty eight.

Bhagyashri dhurve et al.[3]. performed "experiment investigation of open type, simple type and modified solar greenhouse dryers for drying of tomato flakes" in During this work an experimental analysis using flakes of tomatoes has been performed for comparing the rate of drying for conventional and modified greenhouse dryers. During this investigation it is found that higher room temperature for modified greenhouse solar dryer is forty eight degree Celsius while in traditional greenhouse dryer it is forty seven degree Celsius. Minimum value of relative humidity was found minimum for modified greenhouse dryer (17.5%) while in greenhouse it was (18.8%).Rate of drying was found higher for modified greenhouse dryer compared to greenhouse dryer of conventional type and open sun drying. Better drying conditions- high temperature & low relative humidity are found out to be for modified greenhouse dryer.

Karunaraja et al.[4].studied on "Convective solar drying of *Vitis vinifera* & *Momordica charantia* using the thermal storage of materials" in this paper A relative analysis was done for the solar dryer (by using and not using the thermal storage materials) and direct sun drying to measure the effectiveness in drying the samples. There was considerable decrements in drying time and also in wetness removal rate (85% to 10% in 27 hrs and 88% to18 6% in 6 hrs) by using the solar tunnel dryer (By using and not using the thermal storage materials) relative to the open sun drying.

Rintu kumar et al.[5].investigated on "Numerical Simulation of Solar Greenhouse Dryer Using Computational Fluid Dynamics" in this paper simulations was performed on modified greenhouse dryer to study the temperature variations with change in velocity of wind. Multiple radiation range has also been observed at different location in the dryer. CREO 5.0 was used for modeling of computational model for solar green house dryer while Fluent 14.0. Was used for analysis of greenhouse dryer having multiple wind velocity. For both normal convection as well as forced convection dryer has been simulated. From the above study it is found that value of temperature is lesser for forced convection as compared to natural convection.

S. R. Kalbande et al.[6]. perform "Design of Solar Dryer Assisted with Reflector for Drying of Medicinal Crops" in this paper fundamental objective of the dryer is welfare of the marginalized and needy farmers those are unable to afford costly devices and equipment's to preserve their agricultural products. Drying safed Musli by open sun drying require more time and affected its quality. To maintain the quality and to extend adequate temperature within drying chamber during winter, morning and evening hours, a solar appliance assisted along with reflector was designed. After the experiments the mean drying efficiency of safed Musli samples dried in solar domestic dryer with and without reflector was observed 22.92 and 20.32 and drying time for six kilo of Safed Musli to reduce its moisture content from eighty six to seven percent (wb) was 8 hour and 8.5 hour respectively.
M.m.morad et al.[7]. investigated on "Thermal analysis and performance examination of a solar tunnel greenhouse dryer for drying peppermint plants" in this paper Three even type solar tunnel dryers having forced convection were employed for purpose of drying the peppermint plants. Performance of solar tunnel type greenhouse dryer was analyzed as results of changes in plant situations, rates of air flow and loads for double fan condition systems and examined in terms of system temperatures, drying rate, drying efficiency, product taste, color and quality and drying cost. The results data shows that drying pepper mint as leaves minimize the drying time and gain the highest percent of volatile oil compared with drying whole plants.

Om prakash et al. [8]. investigated on "Performance of modified greenhouse solar dryer with thermal energy storage" In this process, the main target is to do yearly performance, environomical analysis, energy as well as exergy evaluation of the modified greenhouse solar dryer working on active mode (AM) as well as passive mode (PM).For medium wetness content crop, both MGD under AM and PM show comparatively identical drying performance. The payback time of the modified solar greenhouse dryer in passive mode is 1.11 years while, for the active type of the modified greenhouse solar dryer it is found 1.89 years. The exergy efficiency is among 29%–86% in MGD under PM and 30%–78% for MGD under AM. Variation in Heat utilization factor(HUF) in MGD under PM is between 0.12–0.38 and 0.26–0.53 for MGD under active mode.

M.u.h. suzihaque et al. [9].studied the "Effects of Solar energy, Buoyancy of Air Flow and Optimization Study of Coffee Drying in a Heat Recovery type Dryer" in this study, A mathematical model was prepare in start based on a thin layer wise drying model for the coffee, added with analysis of air circulation in the dryer, which was divided in four parts. The first was the relation among the coffee bed and nearest air, which is just above the coffee bed while the second part deals with the first segments and upper parts of the air which is nearest to the roof. The third parts deals with the relation between air which is below the roof and ambient air. Finally results were showing that relationship between all three segments is due to driving force of buoyancy. The model was updated by adding comparatively advanced solar radiation modeling and additionally by the modeling condensation effects based on the boundary layer theory.

Ahmed fudholi et al.[10]. investigated "Energy and Exergy Analysis of Hybrid Solar Drying System" In this study energy and exergy analysis was performed on salted silver jewfish using a hybrid solar drying system (HSDS). A HSDS contains V-groove solar air collector, rotating rack-drying chamber, fans and diesel burner along with PV array. A hybrid solar drying system was examined for 51 kg of salted silver jewfish. The solar collector and drying system having efficiencies of 41% and 23%, respectively, at an average isolation of about 540 W/m^2 and an air flow rate of 0.0778 kg/s. the minimum and maximum collector efficiency is 25% and 68%, respectively, was observed, while value of specific energy consumption was found 2.92 kWh/kg and variation in Exergy efficiency is between 17% and 44%.

P.s.chauhan et al.[11]. investigated on "Heat transfer analysis of north wall insulated greenhouse dryer under natural convection mode" in this paper A greenhouse dryer having north wall insulated was designed, fabricated and tested in zero load condition for natural convection mode. Experiments were done for cases namely-Case-1 and Case-2. Case-1is with solar green house dryer with north wall insulated and with air heater collector along with it while Case-2 having north wall insulating solar dryer with absence of air heating collector. Losses in the radiation by the north wall were reduced successfully by application of the reflector on the north wall for maximum use of solar radiation. Problem of thermal losses was also reduced by application of thermocol on exterior of insulated north wall. From this experiment it is found that The solar green house dryer having north wall insulated is highly effective green house dryer for purpose of drying of agricultural product in remote and less resourceful area of developing country.

Yefri chan et al.[12]."studied the Performance of a recirculation type integrated collector drying chamber (ICDC) solar dryer". In this paper recirculation type ICDC solar dryer was designed, fabricated and analyzed. The proposed dryer was successfully decreases the moisture content from 28.4%wb to14.3%wb in five hrs. The temperature drying air was 50°C while RH was 21.73%.The efficiency of the solar dryer was found 23.6% and the overall specific energy (with addition of solar radiation) was 14.6 MJ/kg of water evaporated.

Om prakash et al.[13]. investigated on "Thermal performance analysis of modified active greenhouse dryer" in this paper modified solar dryer of active mode was developed and tested in zero load conditions. Analysis on dryer was performed for maximizing and controlling the air exchange rate which will be beneficial for drying purpose. The main aim of taking maximum air exchange rate is to analyze the complete potential of dryer hence by which suitable crop of greater moisture content can be dried. by applying black pvc sheet on floor of dryer and using mirror on the north wall it is found a decrements in heat loss and, and it creates more useful atmosphere for drying: reduction in internal relative humidity of drying chamber thus increasing green house temperature.

James stilling et al.[14]. studied the "Performance examination of an enhanced fruit solar dryer along with concentrating panels" in this paper it is found that by using concentrating type solar panels method of solar drying of Roma tomato has been improved. This paper gives a performance evaluation between two mixed-mode type dryers. The dryers were even type, but one of them have movable and simply adjustable flat concentrating solar panels to enhance the catchments of falling insolation on the dryer. The value of temperature as well as relative humidity in the CSP dryer was found high on compare to that of a simple mixed-mode dryer having same design. By using a movable concentrating solar panels with mixed-mode dryers, drying rate is improved and observed that the concentrating solar panels utilized in the experiments enhance the effectiveness of selected mixed-mode type solar dryer. so, future studies and changes in the fabrication of concentrated solar drying using different reflectors must be done to enhance performance considerably.

Suberna maiti et al.[15]. investigated on "Performance evaluation of a small scale indirect solar dryer with static reflectors during non-summer months in the Saurashtra region of western India "in this paper planning related with fabrication of an indirect, natural convection mode batch-type solar dryer assisted with North–South reflectors. By using the reflectors it is found an increments in collector efficiency at no-load condition from 40.0% to 58.5% at peak solar irradiation conditions throughout typical day time in January in Bhavnagar, Gujarat, India. The respective calculated values by heat transfer equations were 36.5% and 50.3% respectively. The required time of drying (ca. 12%, wet basis) of 'papad' – a popular Indian wafer – could be gain within 5 h in static dryer having 1.8 m^2 area of the collector and calculated loading capacity of 3.46 kg. The starting and mean values of the drying efficiency were 16.3% and 4.1%, respectively. Despite the loading of the dryer, as shown by the increment in drying potency to 13% in a smaller dryer which is loaded with the same load of wet papad.

III. CONCLUSION

1. Temperature of the heating space can be increased by using green house solar dryer without using fossil fuels.

2. Green house solar dryer using active mode is comparatively better than passive mode.

3. Forced convection is better for high moisture content crops while natural convection can be used for crops having low moisture contents.

4. Modified green house dryer have found faster drying rate as compared to conventional green house dryer

5. There were considerable decrements in drying time as well wetness level removal rate using the solar tunnel dryer as compared to direct sun drying.

6. Crop dried inside the green house dryer are found to be more nutrient rich and qualitatively superior than directs sun dried crops.

7. The north wall insulated green house dryer is most suitable dryer for agricultural crop drying in developing country.

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