Methodology for Analysis of Greenhouse Dryer with Inclined Roof and Insulated Wall

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ABSTRACT: To minimize the lack of sun drying, various drying techniques are suggested. Among them, previous greenhouse drying efforts were presented in this study. It can be used to dry cereals, fruits, vegetables, spices, etc. at low temperature. In this research work, design of solar dryers of existing greenhouses is improved by tilting the roof and north wall. The basic concept and functionality of the two greenhouse dryers were understood through experience.

1. INTRODUCTION

Solar is very large and inexhaustible source of energy. The sun is large sphere of very hot gases having diameter about 1.39 ×106 km and the heat is generated by the various kind of fusion reactions and the earth's diameter is about 1.27 × 104 km. The mean distance between sun and earth is 1.496 × 108 km. Solar energy can supply all the present and future energy needs of the entire world on continuing basis. It is one of the most promising of the unconventional energy source. Solar energy is environmentally clean source of energy. On the earth's surface the intensity of global radiation on one square meter area in unit time is depend on the geographical latitude, season of the year, time of the day and on the weather conditions especially cloud cover of the sky. Fig. 1 shows the sun's path in summer and winter seasons It is known that earth rotates about its own axis which is tilt by approximately 23.4˚ from perpendicular plane to orbit and simultaneously travels around the sun throughout the year. Because of this the seasonal change occurs on the earth. Fig. 2 shows the earth's movement around the sun and seasonal changes.

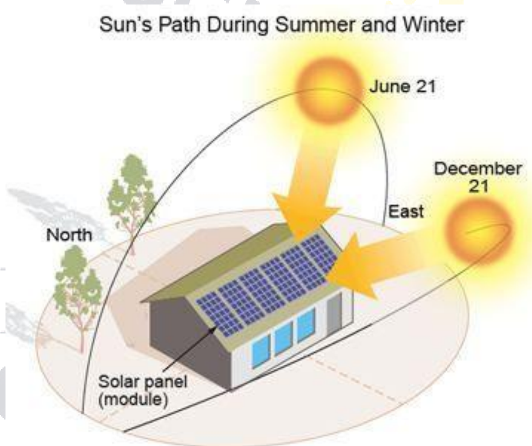

Fig. 1 Sun path during summer and winters

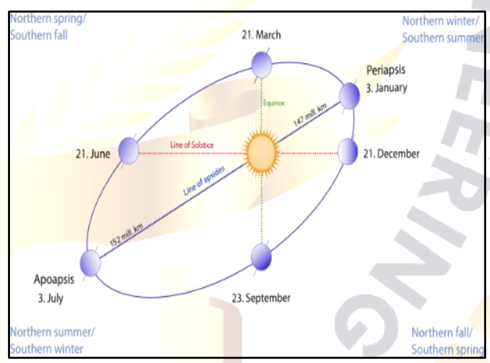

Fig. 2 Seasonal changes on earth

The angle calculated for solar panel tilt from vertical it was 83˚ in month of May where as 90˚ in month of Jun as shown in Fig. 3.

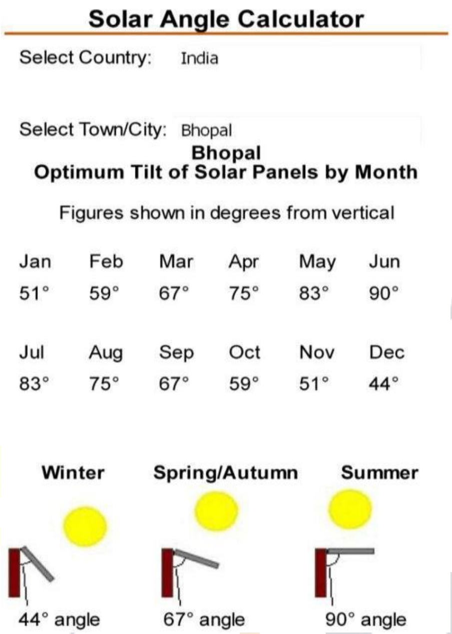

Fig. 3: Optimum tilt of solar panel

The solar energy can be utilized in two types directly and indirectly. Directutilization of solar energy includes thermal and photovoltaic conversion. Solar energy is being traditionally used for drying agricultural products. In drying process the moisture is removed and it is done for preservation of products. Primarily in earlier times drying was done in the openly in sun, but today to dehydrate foods many types of sophisticated equipment's and methods are used. When the product is heated directly by the sun's rays in direct solar drying it is called sun drying and removal of moisture is possible by natural circulation of air due to density differences.

2. LITERATURE REVIEW

Solar energy has the potential to meet the current and future needs of the world. It has been used by humans since ancient times to dry food and protect it for new times. Drying agricultural products prolongs their life and offers advantages in terms of reduced weight for transport and small footprint, which ultimately leads to reduced transport and cost savings [1]. Sun drying is one of the intended uses of solar vitality. Sun drying can be seen as a further development of sun drying and is an effective way to utilize the vitality of the sun. The drying process takes place in two stages. . The state of the second phase depends on the properties of the material to be dried [2]. The drying speed of the item depends on various parameters such as solar radiation, wind speed, relative viscosity, air and soil temperature, item type, output humidity, l absorption of the product and the mass of the article per unit discovered [3, 4]. It is generally gradually understood that creating a gradual and better diet is not enough and must be done as an inseparable unit with appropriate post-harvest protective measures in order to minimize accidents and thereby expand the range and l accessibility of dietary supplements, which does not create the financial stimulus for more [5] As a result, the introduction of solar dryers in the founding states can reduce crop accidents and improve the overall nature of the dried item, unlike the strategies of usual drying, eg. B. Dry in the sun or in the shade [6]. Solar drying processes are generally divided into four categories based on the mechanism by which the energy used to remove moisture is transferred to the product [7]. Solar or natural dryers, direct solar dryers, indirect solar dryers, mixed solar dryers. Condori and Saravia examined the efficiency of one and two chamber greenhouse dryers with limited convection. . A new construction of drywall for greenhouses with minimal effort has been developed and tested [8]. Wang et al. showed an exploratory study of the velocity distribution in a normally ventilated greenhouse. The normal estimate of air speed in nurseries was considered a key variable in calculating the heat exchange between greenhouse segments and indoor air [9]. Condori and Saravia presented a logical study showing the realization of a greenhouse dryer. Finally, the greenhouse dryer is seen as a sun-facing collector, a straight-line connection of survey is made, resulting in a change of about 160% as with the single-charge dryer, while the change is by about 40% when contrasted and the double dryer is loaded [10]. Farhat et al. presented the model of drying a pepper in a naturally ventilated polyethylene greenhouse. It is believed that the drying process allows polyethylene nurseries to be misused in late spring when not in use [11]. Jain and Tiwari examined the convective mass exchange coefficient and calculated the moisture expulsion rate of cabbage and peas for sun and greenhouse drying [12].

3. METHODOLOGY

The greenhouse dryer is of inclined even span roof type which is made of rectangular iron pipes and is covered with transparent plastic film. The bottom surface of the dryer is packed by black colored plastic sheet for reduction in heat losses through ground. The roof of the dryer is inclined to the latitude of 23˚ such that center of one side of the dryer of the dryer is 48 cm high and corners are at height of 32 cm. The other side central and wall height are 88.7 cm and 72.7 cm respectively with floor area of 96 × 62.4 cm². The drying tray is made of wire mesh with an effective area of 94 × 58 cm². The tray is also inclined with respect to inclined roof and made black for absorbing maximum solar radiations. For entrance of air inside the dryer, two circular holes of 10 cm are provided on the south wall below the tray position. One AC exhaust fan of 12 cm diameter with specification of 20W, 0.14A having 2600 RPM is used to remove the inside air. The velocity of air at exit is approximately 3.5m/sat the upper portion of north wall of the dryer in forced convection mode. All parameters are same as for inclined roof greenhouse dryer. The drying procedure was performed in three different modes open sun drying, simple green house dryer and improved greenhouse dryer under forced convection.

The drying procedure was performed in three different modes- open sun drying, greenhouse drying and improved greenhouse drying under forced convection (active mode) and natural convection (passive mode). In natural convection mode the fan is not used and moisture from inside the dryer is removed by the natural convection and naturally circulation of air. In open sun drying the area used for drying of flakes is same as the effective area of the drying tray of improved greenhouse dryer i.e. 94 × 58 cm².

Fresh tomatoes of 3 kg were procured from local market. The tomatoes were manually sorted for color and same size. All the tomatoes were washed by water to remove the dirt from the skin of the tomatoes. Now after cleaning process they were cut into flakes of 2 to 3 mm thickness without further treatment. About 1 kg of flakes was kept on the wire mesh of both dryers and on open plastic sheet for drying each day. The drying of tomato flakes is performed in open sun drying, greenhouse dryer and improved greenhouse dryer under both forced and natural convection modes. The model is constructed and installed. The experiment is performed between 11 AM to 4 PM from 17 Oct 2019 to 22 Oct 2019. The dryer is kept on the ground which is far from shade of the buildings and trees. All the experimental observation is carried out on hourly basis.

4. CONCLUSION AND FUTURE WORK

Experimental analyses have been done for drying of tomato flakes in open sun, greenhouse dryer and improved greenhouse dryer. The conclusions are as following: Solar greenhouse drying is found out to be economical and pollutant free technique for drying agricultural products. It gives better drying rate as compared to traditional drying process. The improved greenhouse dryer gives better condition for drying tomato than convectional greenhouse dryer & open sun. The relative humidity of both greenhouse rooms was always found out to be less than atmospheric relative humidity. Relative humidity inside the improved green house dryer was less than simple greenhouse dryer room. Relative humidity also affected by temperature and wind velocity, such that when temperature is high and wind velocity is low, relative humidity decreases whereas when temperature is low and wind velocity is high it increases. Solar radiation affects the temperature of ground, atmospheric, greenhouse dryer room and improved greenhouse dryer room such that it increases with solar radiation in morning and decreases with solar radiation during last stage of observations. Drying in both the dryer was found to be faster as compare to open sun drying and drying in improved greenhouse dryer is observed faster as compared to simple green house dryer. Visual appearance of tomato flakes dried in both greenhouse dryers were found to be better than open sun drying because the dried flakes are free from any type of dirt etc.

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