Analysis of Greenhouse Solar Dryer Performance for Different Designs using CFD

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Abstract: Over the decades, solar energy has been used to support various agricultural products in different regions of the world. From the existing literature it appears that open dehydration is most commonly used for the desired application and its effectiveness is limited to some extent. To overcome the limitations, solar dehydration is proposed and carried out by various researchers. The greenhouse dryer has proven to be the most suitable technique for storing various types of fruit, vegetables and cereal products. Much research has been conducted in recent years to improve the performance of the chosen method. Traditionally it is limited to the empirical form and is then extended to CFD analysis in order to obtain efficient results through simulations. The importance of a solar dryer and the classification of solar dryers is presented in this paper.

Keyword: solar dryer, CFD, ETC, Greenhouse.

I. INTRODUCTION

Greenhouse dryer in agricultural applications, often used to harvest plants in preserved conditions and protect against the effects of insects and diseases. It also serves as a flow dryer for various applications due to its robust construction and lower operating and maintenance costs compared to other existing dryers. Dehydration is a process of reducing the moisture content of food, either by force or naturally Convection.

Solar dehydration is unique in that there is sufficient direct sunlight the amount of thermal radiation on the surface probably helps create the desired floating effect. The rate of decrease in humidity levels indicates the effect of the process, which is enormous Calculations to plot the relationship between predictors under different conditions.

II. LITERATURE REVIEW

M. Purusothaman et al. [1] Innovative technologies are needed to make human life easier. These innovations are particularly useful when powered by renewable energy sources. The solar greenhouse dryer is a drying device. Simulating a Computational Fluid Dynamics (CFD) analysis is performed on a greenhouse solar dryer when exposed to room temperature on a warm, sunny day to allow for free convection and forced convection. The mass flow rate and the material thickness of the polycarbonate sheet have been changed. The average temperature of the dryer is analyzed by simulation. The maximum temperature is reached with a forced convection of 71 °C for a mass flow rate of 0.025 kg / s. The temperature reached in forced convection is 41% higher than the temperature obtained in natural convection.

E.Veeramanipriya [2] For drying cassava slices in Thanjavur, Tamilnadu, India weather conditions, a prototype of a hybrid photovoltaic thermal dryer (PV-T) with a vacuum collector (ETC) is presented. In addition, the morphological, structural and physical properties of thin-film drying kinetics are examined and compared with natural drying in the sun. The designed dryer reduces the moisture content of cassava from 91.5% (wb) to 10.67% (wb), which is considered a safe level for storage in 8 hours. There is a wide possibility of saving conventional fuel by using the designed solar dryer, as the air temperature in the chamber increases by 30-40 ° C compared to the ambient temperature.

Sukhmeet Singha at el. [3] This article introduces a new type of indirect solar dryer in active mode, which consists of a highly efficient ventilated vacuum tube collector for air heating. A DC fan powered by a solar photovoltaic (PV) module provides forced airflow through this dryer. The dehydration chamber is of the tray type with a load capacity from 6 kg to 45 kg, depending on the dried product. The dryer has been evaluated to dry fenugreek leaves (Trigonella foenum-graecum) and turmeric (Curcuma longa) in semi-continuous mode; and the overall thermal yields were respectively 34.1% and 23.6%. The respective thermal efficiency during full sun drying (OSD) was 5.7% and 5.4%. The quality of dried fenugreek leaves and turmeric was better than the OSD.

Sanjay Salvea et al. [4] The abundant and unpredictable use of fossil fuels is accelerating the ongoing search for an alternative source in this field. Most researchers are attracted to solar energy, which is one of the most renewable and sustainable sources of energy. Based on the current scenario, the energy demand will be extremely high in the future. Efficient use of solar energy can reduce the problem of enormous energy needs in all sectors of agriculture, industry, housing and power generation. In agriculture, one of the areas is drying technology. Drying technology is one of the applications of solar energy. During the drying process, moisture is removed from agricultural products. From our ancestors to modern humans, there have been various improvements in the solar drying system. Indirect solar drying with integrated flat collector is the most popular plant drying system, simple in design, economical, maintenance free and easy to use.

III. Need and Importance of a Solar Dryer

One of the traditional uses of solar energy since ancient times has been the drying of agricultural products. The drying process removes moisture and helps preserve the product. The associated disadvantages are that there is no control of the drying rate and therefore no uniform drying of the food product. Slow drying can cause food spoilage due to fungi and bacteria. If the food product is excessively dried, it causes discoloration, loss of germination, dietary changes, or sometimes complete damage. Rain, storm, birds, insects, etc. cause significant damage due to dust, flies, etc. during drying.

Solar dryers are devices that use solar energy to dry substances, especially food. Food drying is an excellent application of solar energy because drying food mainly requires heat and solar radiation can be easily converted into heat. When drying with a solar dryer, the drying speed is affected by weather conditions such as solar radiation, temperature, relative humidity, wind speed and moisture content of the product and the drying time. Solar dryers can be used for various household purposes. You will also find many applications in industries such as textiles, wood, fruit and food, paper, pharmaceuticals and agriculture.

IV. Classification of Solar Dryers

Norton & Brian have divided solar dryers into two broad categories: direct dryers and indirect dryers, described below,

A. *Direct solar dryer*

Direct solar dryers expose the substance to be dehydrated or dried in direct sunlight. They have a black absorbent surface that captures sunlight and converts it into heat. The substance to be dried is placed directly on the surface to be dried. These dryers may have a housing, glass lids and / or ventilation slots to increase efficiency. This is shown in figure 1.

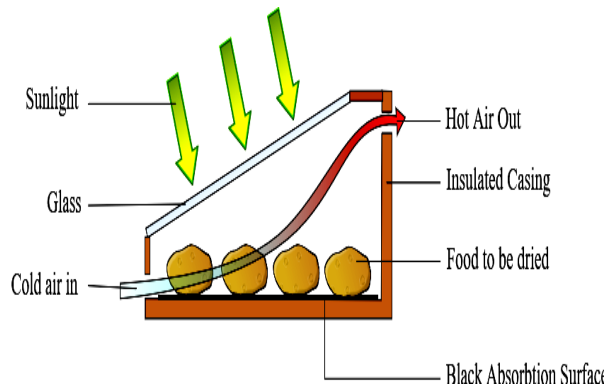


Figure 1: Direct solar dryer

B. *Indirect solar dryer*

In indirect solar dryers, a black absorbent surface absorbs sunlight and converts it into heat. A vent allows air to circulate over the hot surface, flowing air gains heat as it flows over the absorption surface.

The hot air then passes through the substance to be dried. Air removes moisture from the substance and thus drains it. He is evacuated by a chimney. In indirect dryers, solar energy is collected in a separate solar collector (air heater) and the heated air then circulates through the grain bed, while in a mixed mode dryer, the heated air d A separate solar collector it passes through a bed of cereals and at the same time the dryer absorbs solar energy directly through the transparent walls or the roof.

Dryers can be roughly divided into fossil fuel dryers (better known as traditional dryers) and solar powered dryers depending on their heating sources.

High-temperature dryers run on fossil fuels, while low-temperature dryers run on fossil fuels or solar-based systems.

According to Ekechukwu, solar dryers can be basically classified by taking into account their heating methods and how solar heat is used. Basically two main groups, namely

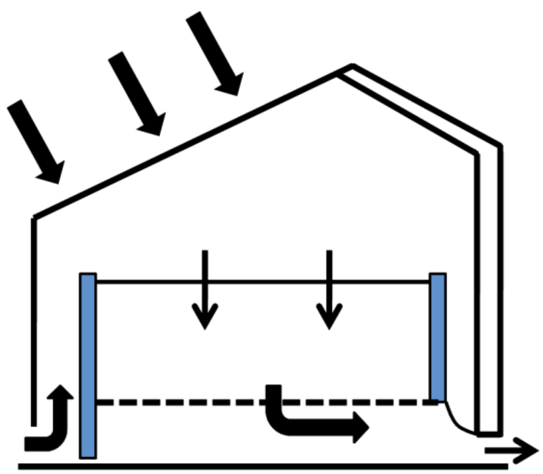
1. Passive solar: energy drying systems (natural convection or circulation solar drying systems).

2. Active solar: Energy drying systems, one of these systems is often referred to as a hybrid solar dryer when an auxiliary heating system is added. There are three different subclasses of passive or active solar drying systems,

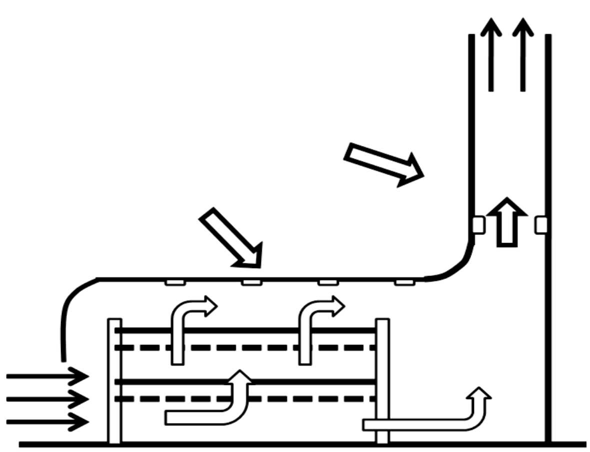
a) Integral – type solar dryers. These are direct solar dryers, may be passive or active.

b) Distributed – type solar dryers. These are indirect solar dryers, may be passive or active.

c) Mixed – mode solar dryers. These dryers may be passive or active.



(a) Integral Direct Active dryer



(b) Integral Direct Passive dryer

Figure 1.5: (a)(b)Integral Direct type solar dryer

C. Some specific solar dryers:

With some modifications to the basic passive (tent, box, swing, and cabinet) and active (dryers with active ventilation and backup heating) solar dryers, many solar dryers have been developed and people have started using them. Africa in Asia and other countries they enjoy good sunshine almost all year round.
Some of the dryers are,

- ❖ Greenhouse dryers
- ❖ Tunnel dryers
- ❖ In- House dryer
- ❖ Table – like solar dryer, Tanzania
- ❖ Banana dryer,
- ❖ Mango dryer, Uganda
- ❖ Fruit & vegetable dryers in Senegal and Burkina Faso
- ❖ Coffee dryers (diff. types- small, medium & large scale) Kenya and Zimbabwe
- ❖ Chilly dryers
- ❖ Grain dryers
- ❖ Fish dryers
- ❖ Tobacco curing dryers
- ❖ Timber dryers etc.

V. CONCLUSION

This paper presents the importance of a solar dryer and the classification of solar dryers. And presented are the some specific solar dryer. The use of a photovoltaic solar fan has been suggested as an auxiliary port to provide forced air circulation in the dryer to achieve the highest dehydration rates. Obtain a better drying speed of the dryer and study the dryer using computational fluid dynamics.

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