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Conception of a Solar Air Collector for an Indirect Solar Dryer. Pear Drying Test.

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Abstract

This paper presents a new conception of the absorber of a solar air collector for an indirect solar dryer. This absorber consists of two corrugated aluminium plates. The two corrugated plates are fixed to form parallel cylinders allowing air to circulate along the collector. Experimental tests for pear drying were carried out at Solar Energy and Environment laboratory, Faculty of Sciences of Rabat. The results thus obtained, reveal that after 24 hours of drying, the mass of samples was reduced from 997.3 g to 135.13g. The average thermal efficiency of the drying chamber was observed to be 11.11 %.

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Keywords: Solar drying; Indirect solar dryer; Collector; Pear.

1. Introduction

Solar drying of crops, fruits and vegetables, has been practiced around the world for centuries in the open air under the rays of the Sun. This traditional method of drying suffers from several problems, among which uncertainty of drying time, high labor cost, the need for large areas, infection by insects and other foreign bodies. Also, dried products are poor quality due to the unavoidable presence of rain, wind, moisture and dust. To use freely, renewable and clean energy as a primary source provided by the Sun, the introduction of solar dryers in developing countries can reduce losses of crops and improve the quality of the dried product compared to traditional drying methods. In recent years, many studies have been done to develop the solar drying mainly to preserve agricultural products [1, 2, and 3]. Therefore, the main objective of this study was to study the thermal performance of an indirect Solar dryer under natural convection for the drying of the pear.

Nomenclature

A_c area of collector (m^2)

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h_l	latent heat vaporization of water (KJ/Kg)
I	solar radiation (W/m^2)
m_w	amount of water (Kg)
t	time (h)
η_d	efficiency of dryer (%)

2. Introduction

2.1. Description of the solar dryer

The solar dryer consists of a solar air collector for heating the air, a drying chamber containing wet product to dry, and a chimney for exhaust air. The absorber of 1 m^2 area was composed of two corrugated aluminum sheets painted in matt black paint. The two corrugated plates were fixed to form parallel cylinders allowing air to circulate along the collector. A 6 mm thick glazing has been used as cover. A 5 cm thick Cork plate has been added to minimize heat loss at the bottom of the solar air collector. Air heated cross the channels of the absorber to reach the drying chamber by natural convection.

The drying chamber was fabricated from trespa wooden sheet, was insulated from all sides with glass wool of 5 mm thick. The back of the drying chamber was equipped with a double-swing door of dimensions 95.5 cm 48.2 cm, for easy loading and unloading of foods to dry. Four rectangular trays were made of galvanized iron wire of dimensions 95.5 cm by 26.2 cm. The first tray was fixed at 32 cm from the bottom of the drying chamber and the last at 13.5 cm from the top. The upper part of the drying chamber was equipped with a vertical chimney made of aluminum of 70 cm height. The whole is supported by a metal frame located at 86 cm above the ground.

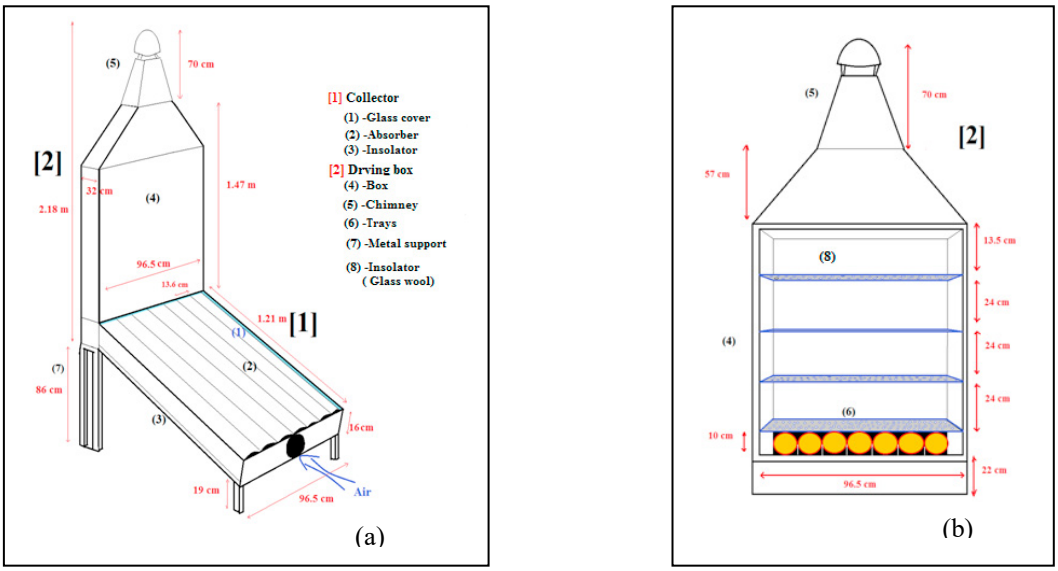

Fig.1. (a) Schematic description of the drying system; (b) drying chamber

In order to dry the pear, a measurement campaign was carried out during the months of April, May 2016. Temperature measurements at different locations in the dryer were performed using T-type thermocouples. These measurements were collected and stored at the end of each hour using an acquisition system.

On the other hand, the solar air collector was placed facing south, inclined at an angle of 34° corresponding to the latitude of Rabat.

2.2. Pre-treatment of product

For drying of pear using indirect solar dryer the following steps are performed [4]:

- Wash with clean water.
- Pear peeling.
- Cutting the pear into rings of the same thickness (5mm).
- The rings of pear were dipped into some lemon juice to avoid their oxidation.