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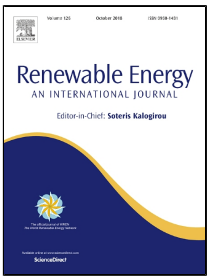

Computational drying model for solar kiln with latent heat energy storage: Case studies of thermal application

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PII:	S0960-1481(18)30742-0
DOI:	10.1016/j.renene.2018.06.090
Reference:	RENE 10246
To appear in:	*Renewable Energy*
Received Date:	30 October 2017
Accepted Date:	21 June 2018

Please cite this article as: A. Khouya, A. Draoui, Computational drying model for solar kiln with latent heat energy storage: Case studies of thermal application, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.06.090

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Computational drying model for solar kiln with latent heat energy storage: Case studies of thermal application.

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Abstract:

The use of solar energy in wood drying systems can reduce the often-heavy energy bill that manufacturers in this promising sector complain about. In this context, the study of solar kilns has received increasing attention and the work presented in this paper is a contribution for developing theoretical investigation during drying process of wood using solar energy. The system of drying consists of four units, solar air collector, cylindrical parabolic solar collector, drying and thermal storage unit. Two mathematical models of storage and drying are developed. The governing equations are solved by Newton Raphson's method for storage and finite difference techniques for the drying model. The results show that the size of the latent storage unit increases when the temperature level is raised. The integration of thermal storage unit into the solar kiln has the effect of reducing the drying time up to about 26.5 %. The recovered heat process is efficient to improve markedly the amount of the energy supplied to the drying unit and reduce drying time up to about 47 %. The effect of choosing the phase change material on the thermal storage unit is significantly important in terms of increasing the evaporation capacity and drying efficiency.

Keywords: Solar kilns; Thermal storage; Drying time; Recovered heat; Drying efficiency.

1. INTRODUCTION

The issue of energy efficiency is one of the main axes of the strategic vision of Morocco to reduce its energy dependence and constitutes the roadmap of the development model that Morocco wishes to set up to make the transition to a green economy. In the context of sustainable development, the national concern is the reduction of energy consumption and the improvement of the performance of energy production systems. In fact, the National Energy Strategy adopted in 2009 considers energy efficiency as a national priority aiming to achieve 12% energy savings by 2020 and 15% by 2030 [1]. Moreover, if we analyze for example an energy-intensive sector such as processes in the wood drying industry, it is generally considered that drying operations represent about 15 % of the total energy consumed by the industrial sector in developed countries [2]. This is an important part and it is necessary to find solutions to optimize the process of drying wood in an economic and ecological approach. The efficient use of renewables energies appears to be an ecological necessity but also to guarantee attractive prices in the regional and international energy markets.

Solar drying, as a means of preserving wet products, has been considered the most widely used system of solar energy [3]. The wood drying industry is one of high energy consumers during processing. From an economic point of view, this activity leads to a reduction in transport costs and an increase in the sales value of the dry product. Traditionally, there are several techniques for drying wood, among the most used we can mention: conventional drying, microwave drying, vacuum drying and outdoor drying. Conventional dryers with a very high heating power are useful, however their energy consumption remains too high [4]. Drying in the open air is characterized by long drying periods and the use of large areas of land. However, constraints related to large scale supply and demand limit the use of normal outdoor drying of the sun. Solar drying techniques can alleviate the disadvantages of open drying and improve the quality of dried wood species.

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