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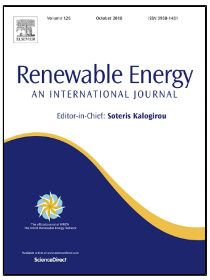

Mathematical and Experimental Analysis on Solar Thermal Energy Harvesting Performance of the Textile-based Solar Thermal Energy Collector

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PII:	S0960-1481(18)30622-0
DOI:	10.1016/j.renene.2018.05.097
Reference:	RENE 10149
To appear in:	*Renewable Energy*
Received Date:	06 December 2017
Accepted Date:	29 May 2018

Please cite this article as: Hao Jia, Xiaomei Cheng, Jingjing Zhu, Zhaoling Li, Jiansheng Guo, Mathematical and Experimental Analysis on Solar Thermal Energy Harvesting Performance of the Textile-based Solar Thermal Energy Collector, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.05.097

Mathematical and Experimental Analysis on Solar Thermal Energy Harvesting Performance of the Textile-based Solar Thermal Energy Collector

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Abstract: Textile-based solar thermal energy collectors (TSTECs) are one kind of novel flexible solar thermal harvesting products, which can be widely applied in the fields of building roofs and facades. In this paper, a proposed numerical model was developed to calculate the solar energy harvesting performance of textile-based solar thermal energy collectors with different layers of textile composites. Also, the outdoor tests were performed to confirm the effectiveness of the designed system and to validate the simulation results. It is found out that the numerical results showed a good agreement with the experimental results. As a consequence, the developed numerical model serves as a useful tool to predict and design the most promising and optimal performance of TSTEC with high efficiency. This research brings some progress in the field of textile-based solar thermal energy harvesting products and they can potentially extend to be widely used in an industrial application that needs heating supply in low-to-medium temperature level.

Keywords: Spacer fabric composites, transparent insulation materials, solar energy harvesting, thermal insulation properties

Introduction

Benefiting from the daylight, solar thermal energy is an essential category of renewable energy and has already been extensively explored and exploited in recent years [1-4]. The solar thermal collectors at medium temperature levels have potentially large applications in food and textile industries, as well as in solar drying, sterilizing, washing, cleaning, distillation and desalination fields [5, 6]. Moreover, solar heating and air conditioning systems of residential buildings are very interesting applications that require heating supply within a temperature range of 70–120 ℃ [7].

Recently, textile-based solar thermal energy collectors (TSTECs) have gained increasing attention, especially for the structurally flexible and diverse solar thermal energy collecting applications [8-11]. Compared with traditional solar thermal energy collection products, which are commercially manufactured by heavy and rigid materials, TSTECs exhibit compelling advantages of light-weight, better aesthetical decoration, and low cost [12]. As facade or roof elements in winter, these solar thermal collecting materials are expected to generate heat for the rooms by absorbing sunlight and at the same time reducing the heat loss of the building. In summer, this collected solar thermal energy also can be converted into other various kinds of energy by specific devices and then be utilized in the residential buildings.

In order to achieve a high performance, considerable efforts have been committed to optimizing the device structures and improving their photo-thermal conversion efficiencies.