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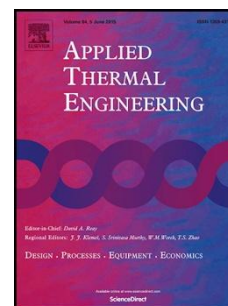
Title: Dynamic coupled thermal-and-electrical modelling of sheet-and-tube hybrid photovoltaic/thermal (PVT) collectors

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DYNAMIC COUPLED THERMAL-AND-ELECTRICAL MODELLING OF SHEET-AND-TUBE HYBRID PHOTOVOLTAIC/THERMAL (PVT) COLLECTORS

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Research Highlights

- A fully dynamic, 3-D numerical model of a PVT collector is presented.
- High-resolution weather data and hot-water demand data are used in the simulation.
- The use of PV cells with reduced emissivity for PVT applications is introduced.

Abstract

In this paper we present a dynamic model of a hybrid photovoltaic/thermal (PVT) collector with a sheet-and-tube thermal absorber. The model is used in order to evaluate the annual generation of electrical energy along with the provision of domestic hot-water (DHW) from the thermal energy output, by using real climate-data at high temporal resolution. The model considers the effect of a non-uniform temperature distribution on the surface of the solar cell on its electrical power output. An unsteady 3-dimensional numerical model is developed to estimate the performance of such a collector. The model allows key design parameters of the PVT collector to vary so that the influence of each parameter on the system performance can be studied at steady state and at varying operating and atmospheric conditions. A key parameter considered in this paper is the number of glass covers used in the PVT collector. The results show that while the thermal efficiency increases with the additional glazing, the electrical efficiency deteriorates due to the higher temperature of the fluid and increased optical losses, as expected. This paper also shows that the use of a dynamic model and of real climate-data at high resolution is of fundamental importance when evaluating the yearly performance of the system. The results of the dynamic simulation with 1-min input data show that the thermal output of the system is highly dependent on the choice of the control parameters (pump operation, differential thermostat controller, choice of flow rate etc.) in response to the varying weather conditions. The effect of the control parameters on the system's annual performance can be captured and understood only if a dynamic modelling approach is used. The paper also discusses the use of solar cells with modified optical properties (reduced absorptivity/emissivity) in the infrared spectrum, which would reduce the thermal losses of the PVT collector at the cost of only a small loss in electrical output, providing the electrical performance does not deteriorate when the selective coating is applied.

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