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29

H Index

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Research Article

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Models for New Corrugated and Porous Solar Air Collectors under Transient Operation

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Abstract: Mathematical models have been developed to evaluate the dynamic behavior of two solar air collectors: the first one is equipped with a V-porous absorber and the second one with a U-corrugated absorber. The collectors have the same geometry, cross-section surface area and are built from the same materials, the only difference between them being the absorbers. V-corrugated absorbers have been treated in literature but the V-porous absorbers modeled here have not been very often considered. The models are based on first-order differential equations which describe the heat exchange between the main components of the two types of solar air heaters. Both collectors were exposed to the sun in the same meteorological conditions, at identical tilt angle and they operated at the same air mass flow rate. The tests were carried out in the climatic conditions of Bucharest (Romania, South Eastern Europe). There is good agreement between the theoretical results and experiments. The average bias error was about 7.75 % and 10.55 % for the solar air collector with "V"-porous absorber and with "U"-corrugated absorber, respectively. The collector based on V-porous absorber has higher efficiency than the collector with U-corrugated absorber around the noon of clear days. Around sunrise and sunset, the collector with U-corrugated absorber is more effective.

Keywords: solar air collector, porous absorber, corrugated absorber, mathematical model, dynamic operation

1 Introduction

Solar air heaters are solar collectors which utilize air as working fluid. Widespread applications include space heating and drying processes. Among their advantages are simple maintenance and manufacturing, the fact that they do not freeze and are less prone to corrosion compared with solar water collectors. Solar air collectors can be glazed or unglazed, and their absorbers usually consist of materials having high solar absorbance and low emittance, i. e. selective characteristics.

Many researchers focused on the improvement of the thermal performance of solar air collectors. In order to enhance the heat transfer by convection from the absorber to the flowing air, several design solutions have been tested, such as corrugated absorber plate [1, 2], roughness geometry [3, 4] or fins welded over and under the absorber plate [5, 6]. The performance of a single-pass solar air heater with baffles was studied in [7]. The results show that increasing the number of fins and increasing the baffle

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