Abstract

Observing the growing need for an innovative solutions in the field of solar energy was the motivation to undertake the research topic of heat exchange intensification in the solar air heater. The dynamically developing field of renewable energy source utilisation requires searching for ways to increase the thermal efficiency of energy conversion devices.

The literature on the subject shows that research area concerning the use and optimization of free convection phenomenon in solar air heater has not been exhausted. Despite numerous reports on methods of heat transfer intensification, presented in the chapter 2, few of them are used in collectors operating in natural convection conditions. There is a knowledge gap about the practical use of the so-called ćhimney drafteffect, that can be obtained in solar air heater by proper separation of walls within its design.

Based on the conclusions drawn from the literature review, research hypotheses were formulated in the chapter 3. In order to verify them, research goals were set consisting of searching, by means of experimental and numerical means, for new design solutions of a passive air solar collector, which would be characterized by higher thermal efficiency. The objectives of the thesis are presented in the chapter 4.

The chapter 5 presents planned research activities aimed at achieving the objectives of the thesis. Experimental tests were carried out in laboratory conditions on three prototype designs of a solar air heater. The description of prototypes, design of the experiment and research results are presented in the chapter 6. The experimental work was supplemented by CFD computer simulations (*Computational Fluid Dynamics*). Their aim was to determine the influence of the absorber shape and the geometric and material parameters of the collector structure on the thermal and flow variables determining its efficiency. The chapter 7 presents a detailed description of the computer models used and the results of the CFD simulation.

On the basis of the obtained test results, it was determined how the selected parameters of the solar air heater influence its thermal efficiency. The proposed design solutions were compared and the characteristics of their operation in the conditions of free convection were determined. The knowledge in the field is expanded by the proposed correlations for the Nusselt number depending on the Rayleigh number for different collector designs. They illustrate the influence of the characteristic parameters of free convection on the intensity of heat transfer. The chapter 8 presents a summary of the research results, indicates their practical aspect and proposes further research.

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