Modelowanie i analiza procesów wymiany ciepła w oszkleniu wypełnionym materiałem fazowo zmiennym

2 ABSTRACT

This dissertation presents the results of a research conducted in the field of simulation of heat transfer and optical processes within a three-pane window, in which one of the chambers is filled with phase change material. For this purpose, a proprietary calculation algorithm based on the Control Volumes Method was developed, which uses the Net Radiation Method to simulate the propagation of solar radiation and for simulation of the phase change phenomenon the Mushy Volume Tracking Method was implemented. It is an innovative approach of simulating coupled heat transfer and optical processes including changing parameters of PCM. The algorithm was verified on the basis of exact solutions of the transient heat exchange, including the phase change phenomenon, and then validated basing on the results of experimental tests performed in a climatic chamber and on the partition installed in an external facade of the building. This proved the first of the thesis stated in the dissertation. The results were obtained through the experiments performed in cooperation with the team headed by dr hab. inż. Dariusz Heim, prof. Łódź University of Technology on Łódź University of Technology. Successful verification and validation allowed to use the algorithm in simulations of heat transfer during a full meteorological year. Their aim was to prove the second thesis treating about the possibility of designing the parameters of the tested partition in such a way that it would be justified to use it in Polish climatic conditions. Assessment included 32 variants, covering various material and geometric solutions, which were compared with the results of the simulation carried out for an analogous conventional window - a triple-glazed window with two chambers filled with gas. The aspects of energy, ecological and economic efficiency were considered, which made it possible to identify the variant that gives the best results in the heating and cooling season and throughout the whole year. Conclusions of the dissertation allowed for the determination of further directions of the researches that may contribute to the development of windows equipped with phase-changing materials in various climatic conditions. In addition, the developed computational algorithm, in the future can be implemented in any software for energy simulation of buildings.