Numerical Comparison of Selected Methods for Modelling Phase Change in Heat Transfer Problems

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The study concerns numerical modelling of transient heat transfer in a multilayer system containing a phase change material (PCM) layer. Particular attention is devoted to the analysis of selected methods for modelling the phase change process. The governing equation is solved using the finite difference method. The mathematical model is based on the one-dimensional heat conduction equation

$$c\rho\frac{\partial T(x,t)}{\partial t}=\frac{\partial}{\partial x}\left(\lambda\frac{\partial T(x,t)}{\partial x}\right). \tag{1}$$

In the case of the PCM layer, thermophysical parameters are temperature-dependent, and the phase change process is taken into account. The phase change is described using two approaches: the effective heat capacity method and the enthalpy method [1, 2]. In the enthalpy approach, the enthalpy is defined for the PCM and includes latent heat effects.

Calculations are carried out for a multilayer roof system containing a PCM panel. The influence of the applied modelling approach on the temperature distribution in the system is analysed. The comparison is performed under identical boundary and initial conditions.

The numerical results are compared with experimental data reported in the literature [1]. The obtained agreement confirms the correctness of the model and the suitability of the applied approaches. The differences between the considered methods are particularly visible in the phase change interval, where the distribution of latent heat affects the temperature evolution.

The results indicate that both approaches enable effective modelling of the phase change process. The enthalpy method provides a continuous representation of thermophysical properties, while the effective heat capacity approach offers a simpler and computationally efficient formulation. The comparison allows for the assessment of accuracy and computational efficiency of the considered methods.

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