Comparing Different Approaches for Moisture Transfer Inside Constructions with Air Gaps

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Abstract

In constructions with embedded wooden beam in the external wall, the analysis of the moisture risk is of paramount importance, since water condensation can lead to structural damage to the wood. If an internal insulation is applied, as in case of historical buildings for which an external insulation is not always possible, the risk of structural damage could arise. Moreover, the presence of air gaps can significantly influence the moisture distribution. In such a situation a high quality energy retrofit must be studied, in order to guarantee a long term preservation of the building.
A model for the conjugate simulation of heat and moisture transfer inside porous materials and fluid domains is presented. The equations describing transfer and storage mechanisms inside the porous domain are implemented according to models available in the literature [1], [2].
The convective and diffusive transfer inside the fluid domain is modeled according to [3].
In this study a two-dimensional fully developed laminar channel flow is investigated. The flow is forced and considered to be incompressible. At the boundaries of the channel a porous domain exchanges water vapor and energy with the flow.
The results of this conjugated model are compared with those obtained through a simplified approach. The line source approach is a method to couple the transfer mechanisms which occur inside a porous domain with those that occur in a free fluid flow. The fluid flow is considered to be one-dimensional, and its effects on the porous domain are taken into account through convective transfer coefficients, that are taken as inputs for the model. This approach does not enable to compute the temperature and humidity distribution inside the fluid phase, but only the bulk quantities along the channel axis.
On the one hand the conjugate method is able to predict better results from a physical point of view, since it calculates the velocity field inside the air cavities through computational fluid dynamics; on the other hand, including fluid dynamics in long period hygrotermal simulation increase numerical effort and computational time. Even in the case of laminar non-turbulent forced flow, the differences in term of computational time between the two approaches are significant.
In this study the results of the two models are compared with another simulation program and validated against measured data from the literature. It can be demonstrated that the line source approach can be employed in numerous building-physics applications with good accuracy.

Reference

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