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Research Article

Building Thermal, Lighting, and Acoustics Modeling

Assessment of temperature gradient effects on moisture transfer through thermogradient coefficient

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Abstract

The objective of this paper is to describe moisture transfer through porous material due to temperature gradient. For that purpose, an experimental device was set up to assess moisture flux under isothermal and non-isothermal conditions. This involves placing samples between two compartments with controlled air conditions and monitoring relative humidity and temperature profiles inside the samples over the time. To interpret these results, we proposed to express the mass flux in terms of two driving potentials: water vapor content gradient and temperature gradient. Accordingly, thermogradient coefficient was calculated and discussed. It represents the difference between the moisture fluxes under isothermal and non-isothermal conditions. The impact of temperature gradient on the moisture buffer value (MBV) was also considered through a numerical experiment taking into account thermogradient coefficient. Results show that temperature gradient implies a relative variation of the MBV for about 14%. Thus, it would be better to consider non-isothermal conditions for its assessment.

Keywords

non-isothermal transfer,
thermogradient coefficient,
experimental,
MBV,
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1 Introduction

Non-isothermal moisture transfer in porous building materials and envelopes is a process that occurs frequently in many building engineering applications (ANNEX41 2007). It involves complex interactions of different heat and moisture transport mechanisms. In the past decades, many researchers have devoted by using phenomenological macroscopic models, introducing heuristic laws relating thermodynamic forces to fluxes through moisture and temperature dependent transport coefficient. In this way, the most used and accepted macroscopic models that used the temperature and moisture content as driving potential are carried out by Philip and DeVeries (1957), Luikov (1966), Qin and Belarbi (2005).

Till now, a lot of models and methods were developed for predicting the heat and moisture transfer in porous materials. Each of them has its own aim and scale. At the same time, there are still lacks in the knowledge that defines the problem well. The main difficulties can be summarized by the following points:

- The complex structure of the most building envelopes as they are porous medium that may contain variable proportion of water and a mixture of vapor and dry air. This moisture (water and vapor) comes from several sources: rainwater pouring on the walls, water vapor presented in the surrounding air of the material. It can be absorbed by the porous building envelopes according to their equilibrium sorption moisture content. In turn, the equilibrium sorption relation depends on the characteristics of the porous system, such as the porosity and the pore size distribution.
- The multi-component process presented by the moisture transport inside the porous medium; the flow of moisture and heat is dependent on each. It is explained by the fact that the heat transfer in the micro-capillaries occurs mainly by molecular conduction through the framework of the body and the material bound within the pores. The

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