Multiscale unveil of moisture in buildings

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Abstract

In this lecture, we zoom at different scales unveiling different aspects of moisture in buildings. At atomistic scale, we unravel sorption hysteresis in wood. At pore scale, we analyze the impact of particle deposition on the drying process of a porous material. At material scale, we present a two-phase model for predicting the effective moisture transport properties of books. At building scale, we analyze the potential of desorption cooling.

Peer-review under the responsibility of the organizing committee of the ICMB21.

Keywords: Multiscale modelling, sorption hysteresis, drying, moisture buffering, sorption cooling

1. Introduction/Background

In this presentation, we first zoom on the water sorption process at microscale using molecular dynamics, with a focus on understanding of sorption hysteresis [1], [2]. As an example, we discuss the impact of sorption hysteresis of finishing materials on the fluctuations in relative humidity inside a room.

A second zoom is on the drying of porous materials at pore scale using Lattice Boltzmann modelling (LBM) and a hybrid method using pore network modelling and LBM [6]. As an example, we discuss the drying of pure water and water with suspended particles from a porous medium. Drying of water shows mainly a first drying regime, while the drying of the suspension shows a second drying phase with decrease in drying rate. We analyze the deposition pattern of the particles and possible clogging of the pore system [5].

A third zoom is on material scale, where we analyze the moisture buffering effect of papers, books and textiles [3], [4]. Book is considered as a periodic system of parallel paper sheets and air layers. Effective moisture transport properties are determined considering two diffusion paths, one normal to the paper edge and one via the air layer normal to the paper sheet. The impact on average and maximum relative humidity of books and textiles is presented.

A final zoom is on building scale. We analyze the potential of precooling and of water desorption from inside hygroscopic materials as passive cooling measure for indoor sleeping rooms during heat waves [7].

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