Theoretical analysis of moisture transport in wood as an open porous hygroscopic material

Moisture transport in an open porous hygroscopic material such as wood is a complex system of coupled processes. For seasoned wood in natural climate three fully coupled processes active in the moisture transport are readily identified: (1) diffusion of vapor in pores; (2) phase change from one state to another, also called moisture sorption; and (3) diffusion of bound water in wood tissue (in the cell wall). A mathematical model for predicting moisture transport in wood for a given condition must at least consider the dominating active processes simultaneously to be considered accurate. In this study, a theoretical investigation is conducted on the influence of the model parameters on the model response to a known step change of ambient vapor pressure. The objective is twofold. First, to investigate if model simplification can be conducted in a transparent and stringent manner, not compromising required model accuracy and precision. Second, to show model characteristics that could enable tailored experimental studies to verify or discard variations of this type of transport model. The model sensitivity analyses clearly showed that there are large differences on the degree of influence of the three processes on the outcome of the coupled model. Least significant is the bound water diffusion. Based on the results from the sensitivity analyses, a simplified model for moisture transport in wood is proposed.

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