Hygrothermal Modeling: A Numerical and Experimental Study on Drying and Water-Uptake Tests

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Abstract

The use of COMSOL Multiphysics® software in building-physics for hygrothermal modeling of materials and components is nowadays state of the art, as shown by numerous studies published in recent years e.g. [1, 2, 3, 4, 5, 6, 7]. However, the majority of considered cases refer to heat and moisture transfer in hygroscopic range (relative humidity below circa 98%) while it has been shown that modeling the material behavior in the super hygroscopic range (relative humidity up to 100%) may represent a numerical challenge [3]. This is due to the fact that the material functions (in particular the water storage function and the liquid water diffusivity) are in general highly nonlinear at saturation and the numerical errors may become important in that range.

This paper aims at handling this challenge, by considering drying and water-uptake tests performed on capillary active materials (calcium silicate and cellulose). Simulation results obtained through 3D modeling of laboratory experiments are compared with measured data. Moreover, considerations on the numerical quality of the solutions are made. Preliminary results are very promising for a further application of COMSOL also in the super hygroscopic range.

Reference

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Figures used in the abstract

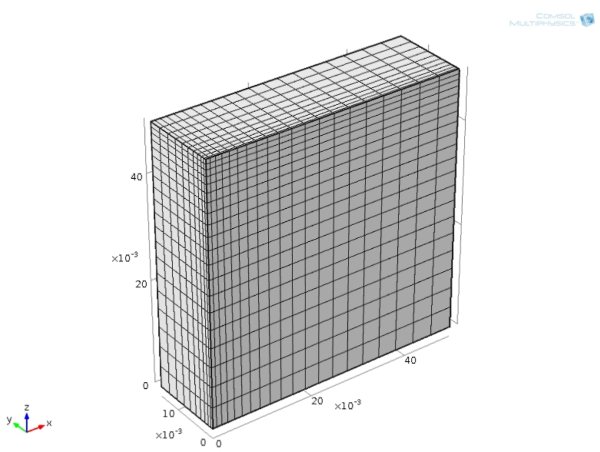

Figure 1: 3D mesh of the material sample employed for the drying and water-uptake tests.

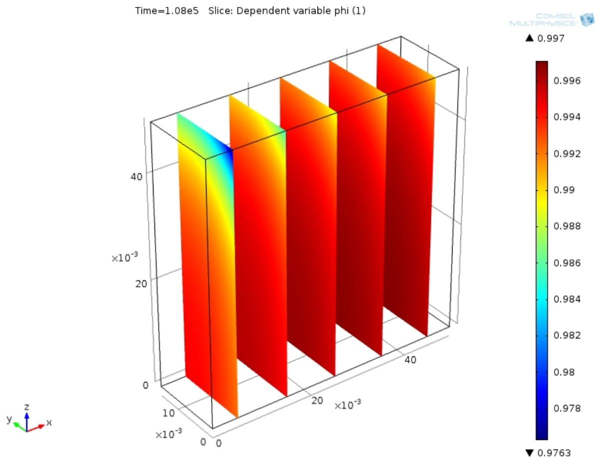

Figure 2: Relative humidity in the sample after 30 hours drying.

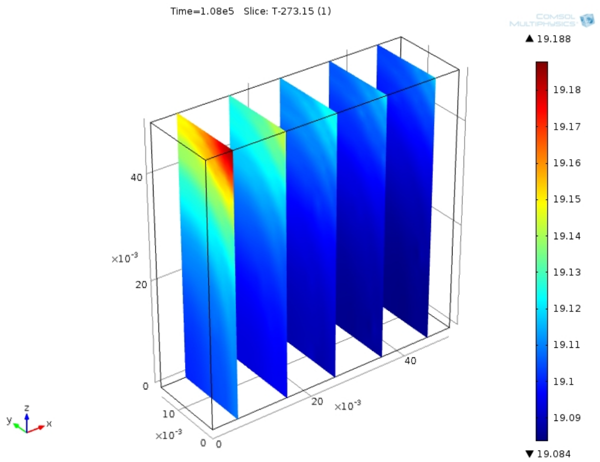

Figure 3: Temperature in the sample after 30 hours drying.