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Two-step diffusion in cellular hygroscopic (vascular plant-like) materials

Wednesday, 1 June 2022 16:00 (15 minutes)

Vascular plants, a vast group including conifers, flowering plants, etc, are made of a cellular hygroscopic structure containing water in the form of either free (i.e. in a standard liquid state) or bound (i.e. absorbed in the cell-walls) water, which makes water transport processes in such materials rather complex [1-2]. From NMR (Nuclear Magnetic Resonance) relaxometry and MRI (Magnetic Resonance Imaging) we are able to distinguish the details of bound water and free water transport in a typical material with such a structure (softwood) under convective drying. Thus, we show that water extraction relies on two mechanisms of diffusion depending on whether the material still contains free water or only contains bound water [3]. For a sufficiently weak (dry) air flux the free water is extracted homogeneously from the sample by absorption in the cell walls; then it is transported as bound water towards the free surface, which results in a constant drying rate. For a sufficiently strong air flux a region without free water grows from the sample free surface while water diffuses through both regions, and the drying rate continuously decreases. Remarkably, as a result of this process, in this case the drying rate is limited by the diffusion of bound water so that further increasing the air flux intensity does not change it. Thus, we demonstrate that when subjected to dry air flux, such natural systems control and limit the rate of extraction of free water. This constitutes a general reversible self-protective system which makes it possible to prolong free water storage despite dry external conditions, but can be fed back by diffusion under humid conditions. This full description and characterization of the internal processes opens the way to a simple physical description of drying, and provides key elements for a general understanding of water transport in various hygroscopic porous systems.

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[3] M. Cocusse, M. Rosales, B. Maillet, R. Sidi-Boulenouar, E. Julien, S. Caré, P. Coussot, Two-step diffusion in cellular hygroscopic (vascular plant-like) materials, submitted (2021)

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

In person

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