Review of: "A macroscopic Washburn approach of liquid imbibition in wood derived from X-ray tomography observations"

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Liquid transport in capillaries is frequently observed in our daily life, therefore unraveling the liquid transport kinetics in complex capillary system like vascular system of trees is important to understand the mechanisms of trees' growth and death. In this work (https://doi.org/10.1038/s41598-022-05508-0), the authors attempted to explore the imbibition processes of water and silicone oil in the vascular system of two wood samples with aid of in-situ X-ray computed tomography (XCT). XCT is a powerful tool to nondestructively measure the structure of a material and to quantitatively access the volume of different phases. Depending on the attenuations when X-rays penetrate a phase, images with different gray values can be recorded. With the processes of threshold, segmentation and reconstruction, structural information of a material including spatial and size distributions of pores or skeletons can be obtained (https://doi.org/10.1016/j.matchar.2019.02.014). More importantly, XCT can provide visual information, while the other microstructure testing methods (e.g., mercury porosimetry, gas sorption, and X-ray diffractions) cannot. As to liquid transport in porous media, XCT tests allow us to visually trace the paths and fronts of liquid uptake in the wood samples (Figs. 4, 6 and 7). The spatial information of liquid imbibition in porous samples with complex pore structures is important, as most macroscopic tests only collect the mass gains or height rises. According to the experiments of mass gain by the authors, 1D longitudinal Washburn model failed to capture the spectrum of water imbibition (Fig. 9) because, in microscopic scale, water did transport in one direction (Fig. 7). Therefore, the authors extended the 1D Washburn model to 2D. The extended 2D model enabled better simulation of water imbibition in the Spruce sample.

While this work presented a 2D Washburn model to capture the liquid uptake in wood samples, the model as well as the characteristic parameters may be only suitable for the materials with well-structured anatomical features. For other porous materials with different structures, for instance, shale rocks , cement pastes and concretes, other rigorous models should be developed for specific modeling.

It should be also noticed that using XCT to track the liquid imbibition fronts and paths may be not as easy as in this work. The reason is that the X-ray attenuations of water may not significant if water is confined in thin pores of dense matrix. So X-ray attenuation enhancing agent may be needed to improve the contrast of XCT images. We have shown that XCT tests without X-ray attenuation enhancing agent cannot distinguish between the pores with and without water in cement concrete samples (https://doi.org/10.1016/j.measurement.2021.109141). So, when one want to use XCT to track liquid imbibtion in porous materials with relatively dense compactness, proper experimental designs are recommended to consider both the properties of the liquid and porous medium.