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Impact of dynamic pore structure on local macroscopic parameters

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In continuum models for drying, macroscopic parameters are integral, relying on the microstructure of porous media. These parameters are determined through the volume averaging of state variables, often derived from simulations using fixed pore network models (PNM). While fixed PNM is a prevalent computational method, it typically assumes a static microstructure throughout the drying process, neglecting the dynamic changes inherent in drying deformable porous media. These changes significantly alter both the structural and transport properties of the porous medium. This study introduces an adaptive pore network model developed to capture the dynamic microstructure and mass transport kinetics of a model capillary porous medium under slow drying conditions. Through adaptive PNM simulations, key parameters, including local relative humidity and moisture transport coefficient, are derived. The findings reveal that, particularly in the later stages of drying, the non-local equilibrium effect becomes pronounced, evidenced by the deviation of local vapor pressure from equilibrium vapor pressure. Moreover, the moisture transport coefficient is primarily influenced by the liquid phase, leading to an extended transport region where the process dynamics are mainly governed by the presence and movement of liquid. This adaptive approach provides a detailed view of how microstructural changes interact with local macroscopic parameters during the drying of deformable porous media.
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