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Lattice Boltzmann modeling of contact angle hysteresis in liquid drying in porous media

Tuesday, 1 June 2021 15:40 (15 minutes)

Drying in porous media is a complicated multi-physical process including liquid/vapor multiphase flow, phase change and heat and vapor transport, occurring with the complex geometry of porous media. Contact angle hysteresis induced by surface roughness is shown to influence drying of liquid or colloidal droplet, resulting in a stick-slip drying mode and the formation of coffee ring after drying in constant contact radius mode. However, the influence of contact angle hysteresis on liquid drying in porous media still lacks exploration, either experimentally or numerically.

Lattice Boltzmann model (LBM) is an advanced numerical approach that can model phase change problems such as evaporation and boiling. In this paper, utilizing a geometric formulation scheme to prescribe contact angle, we present a contact angle hysteresis model within the framework of a two-phase pseudopotential LBM. First, we simulate droplets sitting on flat and curved surfaces, to validate the capability and accuracy of prescribing and automatically measuring contact angles over a large range. The proposed contact angle hysteresis model is further validated by modeling droplet drying on flat and curved surfaces. It is found that by considering contact angle hysteresis a stick-slip mode on both surfaces can be captured. Drying of two connected capillary tubes is studied, considering the influence of different contact angle hysteresis ranges on the evolution of liquid-vapor interface. The model is finally applied to study drying of a dual-porosity porous medium with/without considering contact angle hysteresis, where liquid configuration and drying rate are compared showing important differences. The proposed model is shown to be capable of dealing with different contact angle hysteresis ranges accurately, and of capturing the physical mechanisms during drying in different porous media.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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