Contribution ID: **375** Type: **Oral 20 Minutes**

Pore scale study of drying in porous media

Thursday, 17 May 2018 08:32 (15 minutes)

Drying in porous media is of interest to many research and engineering fields, such as recovery of volatile hydrocarbons from underground oil reservoirs, remediation of contaminant soils by vapor extraction, and water management in gas diffusion layers (GDLs) of proton exchange membrane fuel cells (PEMFCs).
The drying process in a porous material is dependent on the structure and wettability of this porous material. In a porous material, the void spaces are composed of pores of various sizes. At the interface between a small and a larger pore, there exists a sudden geometrical expansion. Such sudden geometrical expansion increases the resistance to the menisci movement, and therefore is called the capillary valve effect. Because of this capillary valve effect, two types of pore invasion are revealed, i.e. bursting and merging invasion. We found that if the capillary valve effect is considered in the pore network model for drying of porous media, the modelling results will have a better agreement with the experimental data obtained from drying of a micromodel pore network.
For slow drying of a hydrophobic porous material where liquid flow is controlled by capillary forces and no liquid films exists, drying induced gas invasion in the porous material is a random process if bursting invasion dominates but shows a stable process when merging invasion dominates. For slow drying of a hydrophilic porous material, liquid films can form in the corners of pores. We will show there are two types of corner films. One is the continuous corner film, and the other is the discontinuous corner film. How the continuous and discontinuous corner films influence the drying process will be investigated in detail.

References

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Primary author: WU, Rui (Shanghai Jiao Tong University)

Presenter: WU, Rui (Shanghai Jiao Tong University)

Session Classification: Parallel 9-F

Track Classification: MS 1.05: Drying of porous media from pore to macro scale