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Simulation of Isothermal Drying of Porous Media using Lattice Boltzmann Method

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Drying is a highly energy intensive unit operation in the process industry. Its high complexity due to the large number of interacting phenomena makes it very difficult to model. Thus far, modelling of drying was done using either continuum methods or pore network models, both of which have some limitations. In this work, the Lattice Boltzmann Method (LBM) is used to simulate the drying in porous media. The LBM is ideal for such simulations as it can incorporate complex effects in a simple and natural way. Four different types of porous media were used, differing in both node and throat geometries.

Due to the complex geometries present in porous media, capillary instabilities are often observed which leads to sudden jumps in drying rate. In this work, the effects of such instabilities on the liquid distribution is studied and an approximate range of such effects is identified. Further, we compare the drying of different types of porous media to identify the dependence of capillary instabilities on the pore structure. It was observed that the types of liquid interface motion could be classified into two types- type A, which constituted of slow invasion of pores by diffusion and type B, which involved fast invasion of voids due to capillary instabilities. It was observed that some types of porous media exhibited an abundance of type A invasion, while others showed a combination of type A and type B. Lastly, it was observed that the drying rate of nodes depend heavily on it structure. Nodes with sharp edges take considerably longer to invade due to liquid holdup at the edges. This work emphasizes the advantages of using the LBM for modelling drying of porous media.

References

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