Lattice Boltzmann simulation of a multicomponent viscous fingering instability at high Schmidt number

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Résumé

The simulation of the multicomponent viscous fingering instability in the case of miscible fluids at high schmidt number is presented. This instability, also called Saffman-Taylor instability in the case of immiscible fluids, occurs when a fluid of low viscosity moves into a fluid of higher viscosity. In this study, the dynamic of such a fluid mixture in the case of miscible components is simulated within a Lattice Boltzmann framework. The considered multicomponent lattice Boltzmann model is based on a split collision model derived from kinetic theory proposed by Sirovich [4] and further adopted by Luo & Girimaji [1] or more recently by Tong et al.[5]. This approach leads to two or more collision terms which represent the self-collisions among one species and the cross collisions among one component and the others. These kind of models are known to recover the Maxwell-Stefan equations in the continuum limit which take into account non ideal diffusion behaviors (osmotic diffusion, reverse diffusion and, diffusion barrier). For this study the multicomponent collision process is associated to the central moments collision framework introduced by De Rosis [3]. This formulation shows good properties in terms of accuracy, convergence and better stability than the BGK approach and is compared to the local and adaptive filtering techniques recently introduced by [2].

Références

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