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Interfacial Instability of Hele-Shaw/Porous Medium Flows by Diffuse Interface Approaches

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Fingering instabilities a Hele-Shaw cell (or 2-dimenional porous medium) are highly relevant to practical applications, e.g. enhanced oil recovery process, pollutants contaminations and material processes. In this work we numerically revisit the immiscible and miscible displacement problems in a radial Hele-Shaw geometry. The simulations are based on a diffuse-interface approach of the so-called Hele-Shaw-Cahn-Hilliard equations [1,2]. A robust theoretical formulation will first be presented, which is capable to deal with both immiscible and miscible interfaces by properly choosing profiles of interfacial free energy. Taking advantages of this robust formulation, highly accurate simulations to different mixing conditions, e.g. (a) fully miscible and (b) fully immiscible, are performed.

REFERENCES

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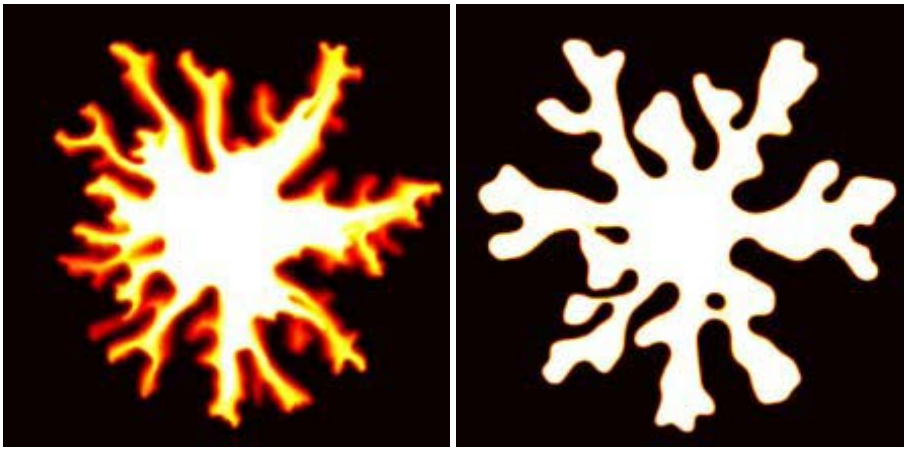

Fig. 1 Typical fingering patterns for miscible (left) and immiscible (right) interfaces in a 2-D porous medium with heterogeneous permeability.

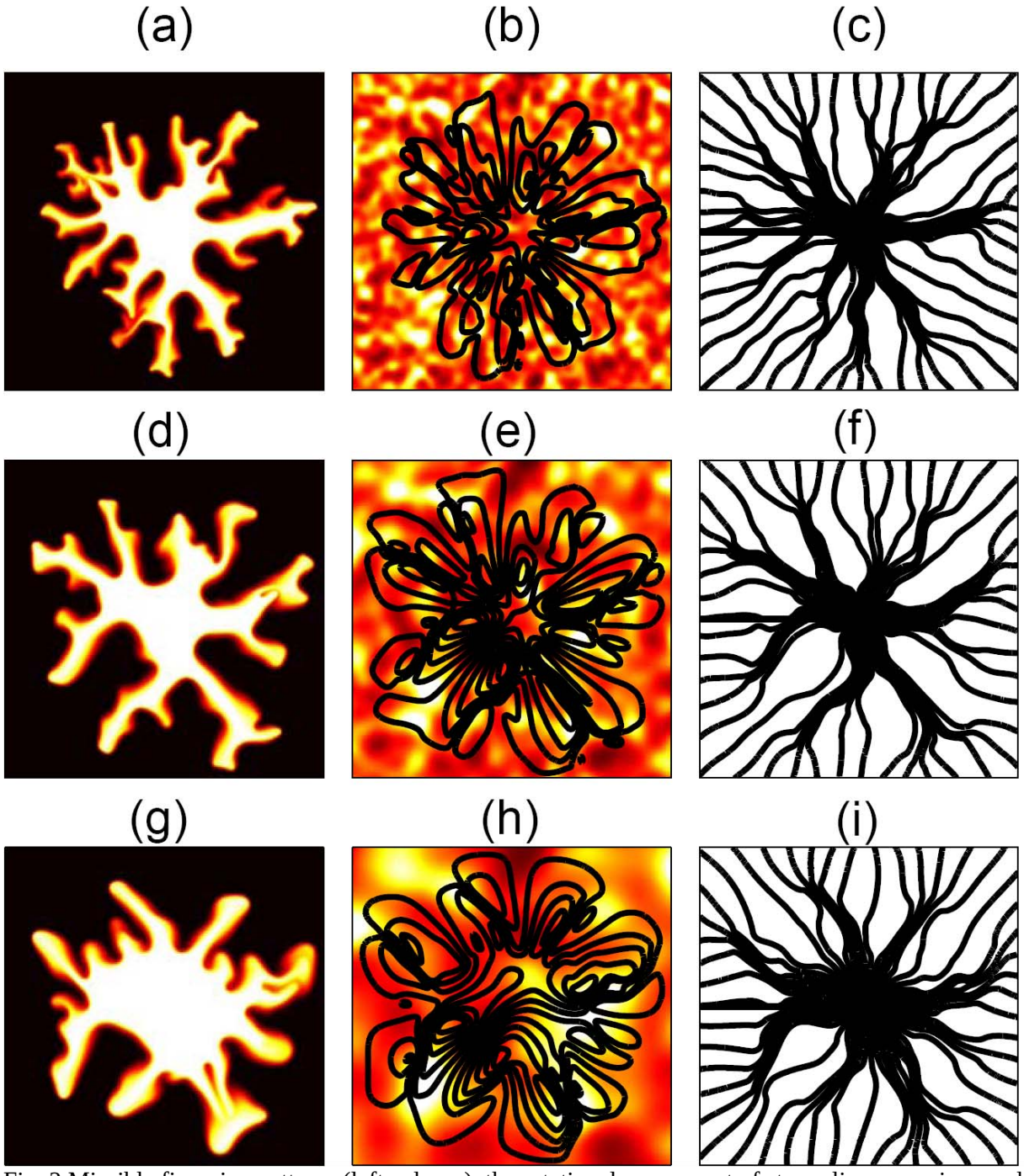

Fig. 2 Miscible fingering patterns (left column), the rotational component of streamlines superimposed on the correspondent permeability distribution (middle column) and total streamlines (right column) for different correlation length (l) of the permeability distribution: l =0.05 (top row), l =0.1 (middle row) and l=0.2 (bottom row).