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Dispersion in porous media gravity currents experiencing drainage

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We developed a theoretical and numerical model to study dispersion effects in two-dimensional porous media gravity currents experiencing drainage along their bottom boundary. The need for including dispersion comes from experimental observations of miscible gravity currents experiencing either local or dispersed drainage. In either case, it is found that significant dispersion may arise leading to the appearance of distinct bulk and dispersed phases. For the case of local drainage, we derive an analytical model starting from mass- and buoyancy-balance in both bulk and dispersed phases. The dispersion severity is characterized by quantifying the amount of fluid that appears in the dispersed phase or, equivalently, the spatial separation of leading fronts of the bulk and dispersed phases. Results for gravity currents with local drainage show that the severity of the dispersion depends on flow conditions upstream of the (local) fissure, as well as the fissure dimension and permeability. The extension of our results to the case of distributed drainage shall also be discussed.
The theoretical model is corroborated with reference to complementary COMSOL numerical simulations. COMSOL results are used to specify, in the theoretical model, the value of entrainment parameters that characterize mass transport across the bulk and dispersed phase interfaces. The COMSOL simulations are performed for various source and drainage conditions. Generally, a good agreement between theory and numerics is found.
Finally, the implications of our work to real geological flows in energy sectors i.e. H_2 storage in depleted gas reservoirs are briefly highlighted.

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Participation

In-Person

References

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