

Are single-phase flow numerical models sufficient to estimate pressure distribution in CO₂ sequestration projects?

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Abstract:

As CO₂ is injected into a deep saline aquifer, three regions develop: a “drying” region next to the well in which CO₂ injectate occupies 100% of the pore space, a brine region away from the injection well in which 100% of the pores are saturated with brine, and a two-phase region in which water and CO₂ coexist. Several papers describe the speeds at which those two fronts progress outward using the Buckley-Leverett fractional flow (BLFF) theory. Next to a CO₂ injection well and at early times, compositional flow theory must be implemented. It is also understood that far from the injection site, where only slight pressure elevation is felt, a single phase flow approach is sufficient because all the complexities of compositional flow could be neglected. However regulators may be wary of complex models and of the associated black box syndrome and rather may favor the simpler single-phase flow approach. This paper investigates using single-phase flow numerical models to describe compositional flow processes. Previous work already showed that results from the CMG-GEM and MODFLOW numerical codes are very similar away from the injection zone given some minor modifications in the input file of the single-phase flow code. We present a more thorough scoping analysis aiming at establishing the proposition that single-phase flow models (CMG-IMEX), given some simple treatment, can predict pressure increase as well as more complex compositional flow models (CMG-GEM).

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