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Viscous fingering and nonlinear waves in a Langmuir adsorbed solute

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Waves in chromatography are well known to the practitioners. Characteristics of these waves are strongly correlated to the nature of the adsorption isotherm. We model the displacement of a finite slice containing an adsorbed solute by a carrier liquid flow. We examine the nonlinear dynamics that emerge from the interactions of rarefaction, shock layer and/or viscous fingers (VF) in the finite solute slice that adsorbs on a porous matrix according to a Langmuir isotherm. The differences between a linear and a Langmuir isotherm are discussed. In the absence of VF, a shock layer (rarefaction) wave appears at the frontal (rear) interface of the solute. VF at a viscously unstable rarefaction interface propagates through the finite sample to preempt the shock layer. However, no such incident is observed when the shock layer front features VF. Various quantities (e.g., the onset of VF, shock layer thickness, etc.) are calculated as a function of the saturation rate and the results a re supported by mathematical analysis.

References

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