Reply to "Comment on 'Free surface Hele-Shaw flows around an obstacle: A random walk simulation' "

Vladislav A. Bogoyavlenskiy* and Eric J. Cotts
Physics Department, State University of New York at Binghamton, Binghamton, New York 13902-6016, USA
(Received 10 May 2007; published 5 September 2007)

As pointed out by Vasconcelos in his Comment, our computer simulations of Hele-Shaw flows around series of wedges differ from analytical solutions existing for this problem. We attribute the discrepancy to the notion that these analytical solutions correspond to ideal, steady-state flow regimes which are hardly applicable when a rigid obstacle interacts with a moving liquid-gas interface.

DOI: 10.1103/PhysRevE.76.038302 PACS number(s): 47.15.G−, 47.11.−j, 68.03.−g, 83.50.−v

In his Comment [1], Vasconcelos argues on the problem of a Hele-Shaw flow around a wedge that we have computed by Monte Carlo simulations [2], pointing out that our numerical solutions differ from analytical solutions existing for this problem. In this Reply, we intend to explain this discrepancy which stems, in our view, from inapplicability of the steady-state approach used to derive the analytical solutions for cases when the Hele-Shaw flow meets a rigid obstacle.

The conformal mapping technique applied in Ref. [1] and similar works cited assumes a steady-state regime of the Hele-Shaw flow, resulting in self-similar solutions [Eqs. (11) and (12) of the Comment]. This constitutes, among other premises, that (i) the Hele-Shaw flow somehow possesses *a priori* knowledge about the obstacle even before a liquid-gas interface reaches it and (ii) there are no transients of the flow as the liquid-gas interface moves around the obstacle. We believe both these premises break the physics of the problem. Originally, the conformal mapping method has been applied and succeeded for Hele-Show flows without external obstacles (the Saffman-Taylor problem being a classic example). The applicability of this method to complex conditions of rigid obstacles should be investigated and proved separately and, in the majority of cases, the steady-state approach would not be suitable for apparent reasons. Our numerical simulations have reported significant flow transients as a result of the interface-obstacle interaction which should never be neglected (specific details of this interaction for step- and ellipse-shaped obstacles can be found in Ref. [2]). We note that this interface-obstacle interaction leading to flow transients and, subsequently, pushing the Hele-Shaw flow out of the steady-state regime, is the main reason of the discrepancy between the self-similar analytical solutions and our numerical solutions for the wedge-shaped obstacles that have been discussed in the Comment [1].

*vbogoyav@binghamton.edu

[1] G. L. Vasconcelos, preceding Comment, Phys. Rev. E **76**, 038301 (2007).

[2] V. A. Bogoyavlenskiy and E. J. Cotts, Phys. Rev. E **69**, 016310 (2004).

