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Electric field driven formation of particle concentration fronts in suspensions BORIS KHUSID, New Jersey Institute of Technology, University Heights, NJ 07102, ANIL KUMAR, ANDREAS ACRIVOS, The Levich Institute, The City College of New York, NY 10031, DAVID JACQMIN, NASA Glenn Research Center, Cleveland, Ohio 44135 — A distinct front, separating regions enriched with and depleted of particles, was recently observed in suspensions subjected to high-gradient ac electric fields and a set of equations for the field-driven suspension flow, containing no fitting parameters, were developed [Kumar et. al. 2004, Phys. Rev. E 69, 021402-1-10; Bennett et. al. 2003, Appl. Phys. Lett. 83, 4866-4668]. Although the numerical solutions of these equations were found to be quantitatively consistent with the experimental observations, they did not provide sufficient information for elucidating the mechanism of the front formation due to the complexity of the equations. Here, we examine analytically the dynamics of the concentration front formation and propagation by considering these equations for the special case in which they can be simplified and then reduced, via a similarity transformation, to ordinary differential equations. We establish the existence of shock solutions to these equations and determine the location of the concentration front as well as the dependence of the front velocity on the bulk particle concentration of the suspension. In particular, we demonstrate that the appearance of the front is caused by the rapid local growth of the suspension viscosity due to the field-driven particle accumulation in a certain area of the domain.

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