Electrohydrostatically driven flows in radial and vertical Hele-Shaw cells

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Viscous fluid flow control in confined geometries (at dimensions less than the capillary length) such as porous media are of interest to emerging fields, such as micro (MEMS) and nano-electromechanical systems (NEMS). If fluids in these devices are driven by pressure, and/or motor driven constant flow-rate pumping then they lack a certain degree of control that is desirable for high precision and robust experiments. Recently, researchers have been studying the possibility of driving precision motion of fluids in porous media by using electrically driven flow phenomenon to overcome some of the shortcomings of their flow-rate and/or pressure driven flow counterparts. Here, two problem involving such a flow is presented to drive the motion of a very viscous non-conducting fluid, such as oil, in a micron scale geometries, called a Hele-Shaw cell that is a model for flow in porous media. The first problem involves the radial flow and the second a vertically oriented Hele-Shaw cell. Experiments are performed using silicone and castor oil at gap spacing less than the capillary length. The experimental results for the interface displacement as a function of elapsed time are compared with the theoretical predictions for the average propagating front position as a function of time with knowledge of the needed physical parameters. No instabilities are observed in the radial Hele-Shaw cell problem of a viscous fluid penetrating a less viscous fluid which is predicted by theory. In the second problem, a convective instability is observed at large electrostatic Reynolds (□1) numbers, in plots of the interface position as a function of time. The propagating front also reveals an interfacial instability for large electrostatic Reynolds numbers coupled with large fluid displacements.

And, if time permits, I will discuss some novels flows in tilted rotating tanks that lead mixing of fluids and de-mixing of solids.

Bio: Born in Chicago, 1976. Graduated with an BS in Chemical Engineering and minor in Applied Math (high honors and cum laude) from University of Missouri - Rolla. MS in Chemical Engineering from Stanford University and PhD in Mechanical Engineering from UCSB. I am interested in studying all aspects of fluid mechanics with particular interest in microscale fluid flow which ranges from blood flow in arteries to the flow of oil in porous rocks. Another topic of interests are dynamical system studies of fluid systems from mixing of highly viscous fluids to studying the dynamics of squeezed thin films. I currently teach as an NSF-VIGRE adjunct professor in the department of Mathematics and sometime Lecturer in Mechanical and Aerospace Engineering at UCLA.