GENERALIZED SAFFMAN-TAYLOR FORMULA FOR MULTI-LAYER HELE-SHAW AND POROUS MEDIA FLOWS

PRABIR DARIPA
Department of Mathematics, Texas A&M University, USA

Abstract: Stability theory plays a major role from fundamental science to applied sciences. It is useful in the design of many processes and engineering instruments as well as in explaining many phenomena. In this talk, we review some of the author’s and his collaborators’ recent works on the extension of Saffman-Taylor instability which occurs at an interface between two immiscible fluids in porous media and Hele-Shaw cells when displacing fluid is less viscous than the displaced one. The growth rate of interfacial disturbances is given by a formula called Saffman-Taylor formula which plays a very important role in many areas including flows in porous media and oil recovery among several others. We summarize our results on generalization of this formula to many interfaces in multi-layer flows. The generalization is in the form of upper bounds on the growth rates of interfacial disturbances. This is discussed in cases of constant viscosity layers and variable viscosity layers. The upper bound provides a way to assess cumulative effects of many layers and many interfaces on the growth rates of unstable waves. As an application of the generalized Saffman-Taylor formula, we present necessary conditions for suppressing instability of two-layer flows by introducing arbitrary number of constant viscosity fluid layers in between. The important role that this condition plays in stabilization of hydrodynamic instabilities and enhanced oil recovery is discussed. Moreover, many other results relevant for stabilization of multi-layer Hele-Shaw flows are reviewed from our recent publications listed below.


