11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Numerical Investigation of Electrically Excited RTI Using ISPH Method

Amin Rahmat*, Nima Tofighi and Mehmet Yildiz

Faculty of Engineering and Natural Sciences, Sabanci University
Orhanli, Tuzla, 34956 Istanbul, Turkey
*arahmat@sabanciuniv.edu

Key Words: Multi-Phase Flow, Interfacial Flow, Rayleigh-Taylor Instability, Electrohydrodynamics, Smoothed Particle Hydrodynamics.

The influence of external electric field on the Rayleigh Taylor instability in a confined domain is numerically investigated using Smoothed Particle Hydrodynamics method. The leaky dielectric model is used for each of the flow phases having different electric permittivity and conductivities. The results are obtained for an Atwood number of 1/3 and gravitational Bond number of 100. It is shown that the electric force consists of two force components, namely the polarization force and electric field force. The polarization force acts in the direction of electric permittivity gradient of fluid phases at the vicinity of interface while the electric field force is influenced by the electric charge and electric field intensity. It is observed that exposing the two-phase system to the electric field when heavy fluid to light fluid ratio of electric permittivities is smaller than that of electric conductivities, the resulting force configuration on the interface promotes spike descent whereas a reverse configuration of the ratios will result in a faster ascent of the bubble, bearing dramatically different interfacial profiles. Figure 1 compares the resultant electric force with the surface tension force for two distinct cases corresponding to two aforementioned force configurations. The left subfigure shows the results for the case with the electric permittivity gradient from lighter to heavier fluid, in contrast to the right subfigure having a reverse scenario. In each subfigure, the left and right sub-columns present the resultant electric force and surface tension force, respectively.

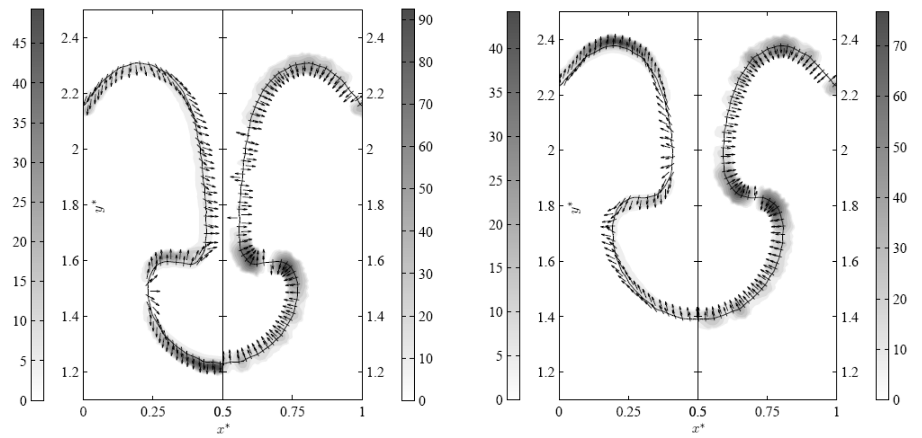

Figure 1 - Comparison of the resultant electric force and surface tension force; the left sub-column shows the resultant electric force while the right sub-column gives surface tension forces. The direction and magnitude of the forces are respectively indicated by arrows and filled contour levels.

The role of electric force on the instability will be tested by exposing it to various electric force values. The controlling parameter will be the electric permittivity magnitudes of both fluid phases by keeping their ratio constant. The results will be presented for two permittivity ratios similar to those which have already been discussed.