Abstract ID: 19381

Interfacial Dynamics in Stokes flow via an Efficient, Fully-Implicit, Time Integration Algorithm: Droplets and Membranes

Jingtao Wang, Yechun Wang, Walter R. Dodson and Panagiotis Dimitrakopoulos

Department of Chemical Engineering
University of Maryland
College Park, MD 20742-2111

Prepared for Presentation at the AIChE 2005 Annual Meeting, Cincinnati, OH.

Abstract

The deformation of droplets/bubbles and membranes (e.g. artificial capsules or biological cells) in micro-geometries is usually implemented through explicit time integration schemes. While these schemes are rather easy and straightforward to employ, they require that the time step is sufficiently small to ensure stability.

Methodology

To avoid the associated penalty of a large number of time steps required to monitor the deformation of the fluid interface, an implicit time integration algorithm may be used. The commonly used implicit time schemes based on the numerical calculation of the associated Jacobian matrix allow for large time steps but their implementation to realistic problems are prohibited due to the large cost of determining the expensive Jacobian matrix. To overcome this difficulty, we have developed an efficient, fully implicit, Jacobian-free time integration algorithm for interfacial dynamics in Stokes flow. Our method is based on a Jacobian-free integration of the kinematic condition at the interface by employing boundary perturbations between the known interface at some time and the unknown interface at the next time instance.

Conclusions

Due to the utilization of much larger time steps, the implicit scheme is much more efficient than the commonly used explicit algorithms and can be used in a wide array of different problems. In the present talk, we will discuss the dynamics of droplets/bubbles near the critical condition as well as the membrane deformation of artificial capsules and biological cells.