ABSTRACT

COMPUTATIONAL INVESTIGATION OF THERMOCAPILLARY MIGRATION OF BUBBLES AND DROPS IN ZERO GRAVITY

by

Selman Nas

Chairperson: Associate Professor Grétar Tryggvason

The thermocapillary migration of many bubbles and drops in zero gravity is studied numerically in two and three dimensions. The full Navier-Stokes equations and the energy equation for the temperature, are solved for the fluid inside and outside of the bubbles and drops by a front tracking/finite difference method. The method is verified by comparison with analytical solution in the limit of zero Reynolds, Marangoni and Capillary numbers and good accuracy is found. It is found that two bubbles, initially oriented arbitrarily with respect to the temperature gradient, tend to line up, side by side, perpendicular to the temperature gradient in both two and three dimensions. The interaction between two drops, on the other hand, is different. Only in the low Re and Ma number region drops do behave like the bubbles, but when both the Re and the Ma are high, they tend to line up in tandem. Drops also deform more than bubbles, along the direction of the temperature gradient.

Numerical simulations of a large mono-dispersed bubble system show that the bubbles form horizontal layers. As soon as the bubbles form one layer that fills the channel horizontally, the rest of the bubbles form another layer. Although these layers sometimes break up by instability waves, the layers are eventually regenerated. Three-dimensional simulations confirm this tendency to form layers while simulations of bubbles in polydisperse systems show the same behavior. In contrast to the two dimensional simulations of polydisperse systems, where bubbles of different size form a horizontal layer, a three dimensional simulation of a polydispersed system shows that different sizes of bubbles form different layers.