Abstract for Dynamics Days Crete 2006
Topic: Turbulence and Fluid Dynamics

Oscillatory solute convection around bubbles in a plane rectangular channel

A.L. Zuev[1*], R.V. Birikh[1], K.G. Kostarev[1], R.N. Rudakov[1], A. Viviani[2]

[1] Institute of Continuous Media Mechanics UB RAS, Acad. Korolev Str. 1, 614013 Perm, Russia
[2] Seconda Universita di Napoli, via Roma 29, I-81031 Aversa, Italy
[*] Electronic Address: zal@icmm.ru

Earlier experiments [1-2] revealed an interesting oscillatory regime of the concentration convection around the stationary air bubble in an aqueous solution of surfactant with vertically stratified concentration. In our new experiments the bubble is placed into a horizontal rectangular channel. A convective motion in the channel develops due to the action of the solutocapillary Marangoni forces at the lateral bubble free surface. Due to a small channel thickness (1.2 mm) the arising convective flow and distribution of the surfactant concentration are nearly two-dimensional which makes it possible to investigate their structure and evolution using interferometric technique and to compare the experimental results with numerical calculations made for two-dimensional rectangular area. The development of self-oscillatory modes is caused by the interaction between the solutocapillary and solutogravitational mechanisms of motion. The time dependences of the oscillations period are analyzed in relation to the average concentration of the solution, the concentration gradient and the diffusion Marangoni and Grashoff numbers.

The observed phenomena are simulated numerically for the convection model with diffusion transfer of the surfactant to the bubble surface (without formation of the surface phase) at large values of the Schmidt numbers. Simulation is made for a rectangular zone stretched in a horizontal direction with its vertical boundary modeling the bubble surface. The solution is assumed to have vertical or horizontal initial gradients of the surfactant concentration. A non-stationary distribution of the surfactant concentration and the field of the flow function is calculated for large Marangoni numbers and long diffusion time by the finite-difference method. In the case of vertical concentration gradient the transient mode changes to a two-vortex flow with a separate localization of the gravitational and capillary convection. In a horizontal initial gradient a relatively slow gravitational convection carrying the surfactant to the bubble surface serves as a background for periodically initiated intensive solutocapillary flows. The lifetime of intensive convection is about 1/10 of the oscillation period.

The work was supported by Russian Foundation for Basic Research (RFBR) Grant 06-01-00221.

[1] K.G. Kostarev et. al., *Comptes Rendus Mecanique* **332**, 1 (2004).

[2] K.G. Kostarev et. al., *ASME J. Applied Mech.* **73**, 66 (2006).