Numerical simulation of the motion of a free rising air bubble

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Today the process of bubble's rising is not well described in terms of a quantitative analysis. This is not only a wealth of physical content of the problem, but also the characteristic sizes of the problem requires the using of very large computational resources. From the viewpoint of the experiment the investigation of this process requires the using of the modem, high-precision detecting devices and subsequent computer processing of the results.

There are works in which analytical models of rising bubble are proposed [1, 2]. Also, a large number of studies consider the numerical simulation of rising bubble. The most effective method for the numerical solution of this problem is the front-tracking method [5]. This method allows you to accurately describe the gas-liquid boundary and obtain an exact solution on limited computing resources.

We carried out a 3d numerical simulation of single bubble rising in the water with different diameters (1-10 mm). The regular grids with fixed nodes were used in the calculations. The free surface between the phases was determined by the CLSVOF (Coupled Level-Set VOF) method. This method is the most accurate for calculating two-phase flows on fixed grids. To account for the surface tension forces, the Continuum Surface Force Model was used. The dependence of the parameters of the trajectory on the diameter of the bubble is shown. Trajectories have a zigzag or spiral character.

The period and amplitude of the trajectories for all simulated bubble's sizes and the average speed of rising are calculated. These values are consistent with known experimental data [3,4] and with the results of numerical simulation. The problem of processing large output data was solved, by creating the original software tool with a graphical interface. This allowed to significantly reduce the time for data processing.

Bibliography

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