Poster 1 Demianov, Inogamov & Oparin

Bubble motion in inclined pipes

A.Yu.Demianov[1], N.A.Inogamov[2] & A.M.Oparin[3]

1. Moscow Institute of Physics and Technology,
Dolgoprudny, Moscow region, Russia
sn@co.ru

2. Landau Institute for Theoretical Physics,
Chernogolovka, Moscow region, Russia
nail@landau.ac.ru

3. Institute for Computer Aided Design,
Moscow, Russia
a.oparin@icad.org.ru

We analyze strongly nonlinear fluid motion with free surface in vertical, inclined, and horizontal pipes. The problem concerning rise of buoyant bubbles in vertical pipes is closely connected to a problem of Rayleigh–Taylor instability. Inclined pipes are intensively investigated in connection with problems of transportation of gas-liquid or liquid-liquid flows.

We develop new approach to the problem of motion of large bubbles in wide pipes (large and wide mean that capillary scale is small). As against the previous approaches based for inclined case on semiempirical methods, in the given work the analytical methods concerning to the theory of potential are used.

We have calculated velocity of rise for plane and circular inclined pipes. We have carried out the comparative analysis of vertical bubbles with round (2D, 3D), wedge type (2D, $\theta = 120^0$) and conic (3D, $\theta \approx 114.8^0$) tops, where θ is the angle at top point of bubble. For the first time velocity of rise of conical bubble and its angle θ have been obtained. We present better estimate for rise velocity of 2D bubble with wedge type top than was previously known.

We do careful comparison of obtained solutions for two and three-dimensional spaces. It is shown, that not always increase of dimension leads to an increase in velocity of rise of bubbles (as it is usually supposed).

For the first time direct numerical simulation (DNS) is applied for studies of flows with free boundary in inclined pipes. Direct numerical simulations allow us, first, to check up accuracy of our analytical models and, second, to receive general picture of motion.

This work has been supported by RBRF (grants 02–02–17499, 03–01–00700) and scientific schools (NSh–2045.2003.2, NSh–70.2003.1).