Transformation Mapping of Bubbles' 2-D Circular Shape to an Elliptical Shape Under Influence of a Magnetic Field in Pool Boiling in Microgravity Conditions.

Thilanka Munasinghe,
West Virginia University,Morgantown, USA.
thilanka.munasinghe@mail.wvu.edu

In order to study the characteristic behavior of bubbles under influence of a magnetic field in pool boiling of a paramagnetic liquid was conducted in two identical tanks under microgravity conditions. Parabolic path of an aircraft was used to create microgravity conditions for increments of 20-30 seconds. Two cylindrical tanks were used for the boiling process. One tank had a permanent magnet attached at the bottom and the other was kept as a reference to allow the comparison analysis of bubble motion with and without a magnetic field. $MnCl_2$ was dissolved in distilled water to create a paramagnetic liquid, which was then used in the boiling process. The boiling process was captured on video simultaneously from three different angles to study the characteristics of bubble motion during the microgravity conditions. Frame by frame analysis occurring every half a second of the video clips was used to carry out image processing techniques to determine the characteristic data of the images. "*MatLab Image Processing Toolbox*" was used to analyze the image data of each frame that was captured from videos.

In addition, in order to study the bubbles' characteristics, a series of parameters were studied including, the center of the bubble, shape of the bubble (maximum radius and minimum radius in vertical and horizontal direction), rate of change of radius, vertical and horizontal displacement of the center of a bubble and rate of change of the bubble's coordinate position. Using the bubbles' characteristics and implementing the "*Jakouski*" mathematical transformation mapping on bubbles' 2-D circular shape to an elliptical shape under the influence of a magnetic field in microgravity conditions was mapped. Transformation mapping explained the deformation phenomenon of the bubble and mathematical explanation of the expansion of the area of the bubble relevant to its position.

Furthermore, the mathematical modeling of 2-D vector fields of the bubbles' path in microgravity condition was graphed to visualize the path of the center of the bubble rising through the tank. The vertical component of bubbles' velocity was also studied in order to create a velocity vector map of the bubbles with respect to the frame numbers in both microgravity conditions and magnetic field influence. As the strength of the magnetic field reduces, the influence of the magnetic field on bubbles was weakened along the vertical axis and that phenomenon was explained by comparing the radius of a bubble in the bottom, middle and the top of the tank.