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Principal characteristics of a bubble formation on a horizontal downward facing surface

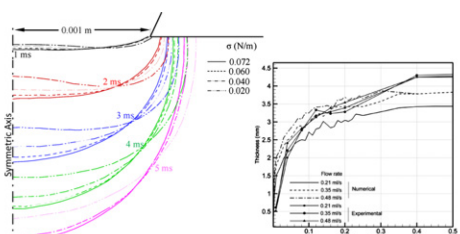
Subrat Das[a,*], Yos S. Morsi[a], Geoffrey Brooks[a], John J.J. Chen[b], William Yang[c]

[a] *Faculty of Engineering and Industrial Science, Swinburne University of Technology, Australia*
[b] *Department of Chem. and Materials Eng., University of Auckland, New Zealand*
[c] *CSIRO Process Science and Engineering, Clayton, Victoria, Australia*

HIGHLIGHTS

- ► Experimental and numerical model is developed to analyse bubble formation underneath a horizontal plane.
- ► The bubbles attain an equilibrium thickness and then start spreading over the surface.
- ► The effects of surface tension are significant during the initial growth of the bubble.
- ► The onset of the transition from spherical to non-spherical shape was analysed.

GRAPHICAL ABSTRACT



Effect of surface tension on bubble evolving on downward facing plate

Rate of growth during initial growth of the bubble.

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ABSTRACT

The formation of gas bubbles on downward facing surface and the variation in their shape due to buoyancy and surface tension forces are important fundamental phenomena that contribute significantly to the understanding of the hydrodynamics involve in many gas–liquid systems and particularly in Hall–Héroult aluminium cell.

In this paper a cold model and numerical simulation study was carried out to determine the effect of gas injection rates and orifice diameters on the formation of a single bubble arising from an orifice placed on a flat plate submerged horizontally in water and aqueous sodium dodecyl sulphate (SDS) respectively. In the experimental part of the study, high speed camera was used to record the bubble movements followed by a numerical analysis using the phase-field method.

The findings indicated that lower surface tension has an influence on equilibrium thickness of the bubble when it grows on a downward facing submerged horizontal plate. The thickness of the bubble can be decreased by 8–10% for a decrease in surface tension from water to aqueous SDS by 0.036 N/m. Moreover, the thickness of the bubble was found to be a function of the injection rate and the surface tension of the liquid, whereas the shape change of the bubble during the initial formation was found to be the main cause for the induced flow in the surrounding fluid. The predicted numerical results of the changes in the bubble thickness and its aspect ratios (AR) during initial bubble development were validated against our experimental results. The thickness of the bubble shows a good agreement with the predicted data while the aspect ratio shows similar trend during initial growth.

* Corresponding author at: Deakin University, Faculty of Science and Technology School of Engineering, Waurn Ponds, Geelong, Australia. Tel.: +61 3 52272387; fax: +61 3 52272028.
E-mail address: subrat.das@deakin.edu.au (S. Das).

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