

Gas bubble formation examined for technological process of the foaming materials



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Abstract

An experiment was made to find dependence of air bubble diameter & velocity on nozzle diameter, flow rate, water for the purpose of industrial applications like Heat exchangers and Aluminum foam walls of buildings and construction structures.



Metal foam in wall construction

Introduction

The word foam has been used in many different connotations, thus there is a need to define it. Foam is the product of gas bubbles locked inside a liquid by the force of surface tension of that liquid.

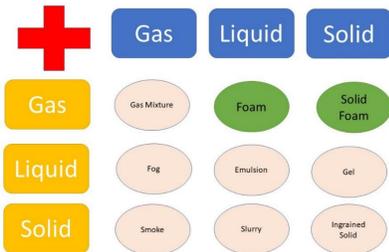


Fig1. multiphase mixtures naming.

In this paper formation of gas bubbles for the purpose of creating foam shall be examined and its relation to several influencing factors, also volume flow rate and its contribution to the bubble shape, the visualization are initially created by the usage of a High-Speed camera.

Methodology

From the illustrated figure 3, a water tank is filled with water while an air pump is connected by tubes inside the water.

A speed camera with a separate light source has been used, different acquisitions were taken for different FPS, the camera could take as many as 1200FPS, yet 130FPS to 180FPS were sufficient to trace different shapes of gas bubbles.



Fig2. speed-camera used.

Experiment Set-up

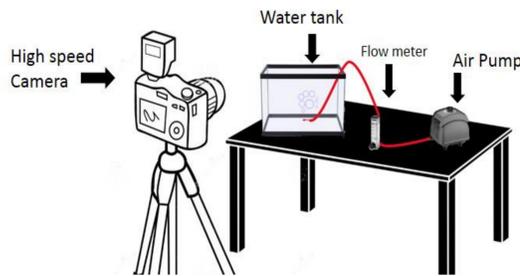


Fig3. Experiment set up.

A variable flow air compressor was used, the range was chosen to serve for the experiment purpose of studying different flow rates for air, and the shape of the gas bubble. With the use of 3D printing, it was possible to model through CAD software and 3D print different shapes of air nozzles, varying from 1 mm to 5 mm diameter.

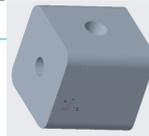


Fig4. 3D printed nozzle.

In order to calculate bubble size, velocity and distance traveled it was required to use image processing software, which can process RAW format images. Open-source, Java based software was used, in which it is required to define a horizontal and vertical Pixel to unit ratio, in which the software can measure a number of pixels, calibrated to a length or area

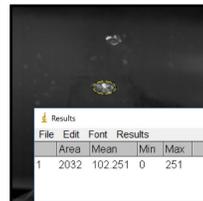


Fig5. Image processing

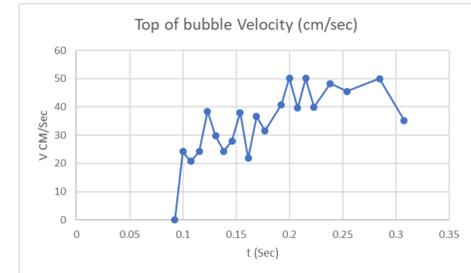
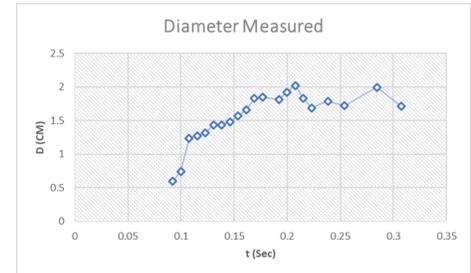
Results

Nozzle Diameter of 5 mm & volume flow rate of 130 Liter/Hr



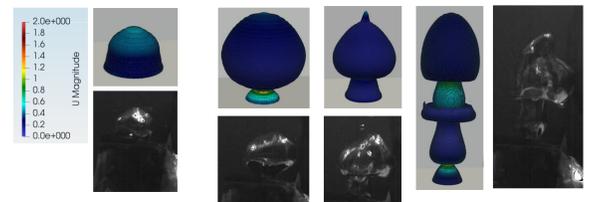
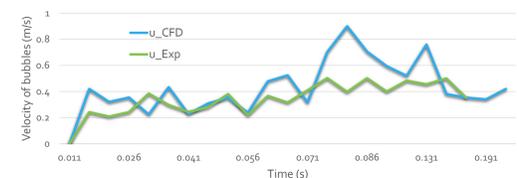
t = 0.138 sec t = 0.154 sec t = 0.177 sec

When observing the acquisitions taken for 130 Liter/hour, first thing that is noted that the nozzle would let out a bubble that would decrease in velocity once it gets out, but soon after the nozzle shoots another bubble into the first bubble which would lead to a sudden increase of the radius due to air mass increase. Which afterwards seem to cause a turbulence in the shape of the bubble as it rise to the surface with mass almost unchanged.



in the results obtained through the image processing software, in the above graphs where it depicts an turbulent increase in the velocity, due to the ongoing merging of several air bubbles, while the radius increase isn't as unstable as the curve of the velocity, it is noticed that the general trend of the diameter is an increase with a changing rate.

Bubble dynamics – numeric versus experiments



The first aluminum foam produced at the Technical University of Liberec



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