# Study of coalescence and breakage in bubble columns with fine pore spargers

**N.A. Kazakis, A.A. Mouza, S.V. Paras**

Department of Chemical Engineering
Aristotle University of Thessaloniki
Univ. Box 455, GR 54124 Thessaloniki, GREECE
*e-mail: paras@cheng.auth.gr*

## Abstract

Bubble columns are widely used in industrial gas-liquid operations because of their simple construction, low operating cost and high-energy efficiency. However, their design and scale up is still a difficult task and subject to errors due to the generally complex structure of the multiphase flow encountered in this type of equipment. Bubble size and gas holdup are the most important design parameters, which define the interfacial area available for mass transfer. These parameters depend extensively on column geometry, operating conditions, physical properties of the two phases and type of gas sparger. Amongst the common gas spargers used, fine porous plates seem to be advantageous since bubbles created by this type of gas distributor are numerous and far smaller offering a greater gas-liquid interfacial area for efficient mass and heat transfer. However, information related to the performance of this kind of sparger is limited.

In a previous work conducted in this Laboratory [1], the effect of liquid properties on bubble size distributions and gas holdup in a bubble column reactor with fine pore sparger was studied by acquiring new experimental data. More specifically, the data revealed that liquid viscosity and surface tension influence coalescence and breakage mechanisms, and thus affect the bubble size distribution in the column. It has also been proved that bubble sizes in columns equipped with fine porous spargers depend mostly on phenomena, which take place either directly onto or in the vicinity of the sparger surface.

This work is motivated by the need to develop reliable predictive tools for bubble column reactor design and is focused on the way that coalescence/breakage phenomena *onto* the sparger surface affect the bubble size distribution. The purpose of this study is to acquire data by performing experiments in a microscopic scale and to investigate how the operating conditions, the liquid phase properties and the diameter of the sparger pores influence the coalescence/breakage phenomena and the size of the bubbles formed.

Experiments are conducted in a small vertical rectangular Plexiglas® column (cell) with a square cross section (side length 4cm), where air is injected through a number (2-3) of small i.d. stainless steel tubes (60, 110 and 160 μm). This set-up is considered equivalent, though in a simplified manner, to a miniature segment of a porous sparger. In order to study the influence of liquid properties several liquids are used (i.e. water, aqueous glycerine and butanol solutions) covering a sufficiently broad range of viscosity (1.0-22.5 mPa.s) and of surface tension (48-72 mN/m). Visual observations based on fast video recordings are used to obtain an insight into the coalescence/breakage mechanisms occurring during bubble formation at the vicinity of the tube exit. Using appropriate software the bubble size can be obtained from the recorded images for the various liquids and flow conditions used.

This study will help to suggest rigorous criteria, in which will include the effect of the aforementioned parameters, for the coalescence and breakage of bubbles at the microscopic level. Correlations of general validity can be formulated and can be incorporated in CFD codes, which are considered a tool useful in bubble column design.

[1] Mouza, A.A., Dalakoglou, G.K. & Paras, S.V. 2005 Effect of liquid properties on the performance of bubble column reactors with fine pore spargers, *Chem. Eng. Sci.* **60**, 5, 1465-1475.