Effect of surfactant additives on holdup in bubble columns equipped with fine pore sparger

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This work is motivated by the need to develop reliable predictive tools for the design of bubble columns, a type of equipment widely used as gas–liquid contactor in a variety of industrial processes (e.g. absorption, bio-reactions, biomedical applications etc.). Among the most important design parameters is the gas holdup, which, in conjunction with the bubble size distribution, defines the interfacial area available for mass transfer. Gas holdup is affected by the column dimensions, the liquid properties as well as the type of the gas distributor. Although the fine pore sparger employed in the present study is a common gas distributor, information regarding its performance is quite limited.

Depending on the gas flow rate, two main flow regimes are observed in bubble columns, namely the homogeneous and the heterogeneous regime. The former offers a larger contact area and it is preferable for applications involving sensitive materials, i.e., bioreactors, blood oxygenators (Olmos et al., 2001; Joshi et al., 2002). In previous works conducted in this Laboratory (Mouza et al., 2005; Kazakis et al., 2007 & 2008) the effect of liquid properties and sparger characteristics on bubble size distribution and gas holdup in the ***homogenous*** regime was experimentally studied in a bubble column equipped with a fine pore sparger. The data confirm that the liquid viscosity and surface tension as well as the pore size of the sparger affect the holdup in the column. A correlation based on dimensionless groups for the prediction of gas holdup was proposed and found to be in good agreement with the limited available data.

It is widely accepted that the presence of small amounts of surfactant additives largely affects a wide range of phenomena in a bubble column (i.e., production of more numerous bubbles, inhibition of coalescence) leading to higher gas holdup values. However, most studies deal with salt solutions, while little has been reported about the effect of organic surfactants on bubble column operation. The ***scope*** of this work is to examine the effect of the surfactant concentration and type (i.e., anionic, cationic or non-ionic) on gas holdup in a bubble column equipped with porous sparger.

To accomplish this, experiments are conducted for various common organic surfactants (e.g. *Tween-80®*, *SDS*, *Triton X-100®*) in a range of concentrations under and over the critical micelle concentration (*CMC*). The experimental set-up (***Figure 1***) consists of a cylindrical (ID=9 cm) Plexiglas® column 1.5 m height, equipped with the appropriate rotameters for the gas phase flow measurement. For the injection of the gas phase, a 4.48 cm in diameter porous sparger (316L SS from *Mott Corp.*), with nominal pore size 40 μm, is installed at the centre of the column bottom,. The gas phase is atmospheric air for all runs. The experiments are conducted at ambient pressure and temperature conditions with no liquid throughput. The average gas holdup is estimated by

measuring the bed expansion method, which is accomplished by means of a digital video camera (*Redlake MotionScope PCI® 1000S*). The uncertainty of the measurements is estimated to be less than 20%.

The new experimental data are used to validate a previously proposed holdup prediction correlation, which, is adjusted to account for the new data (***Figure 2***).

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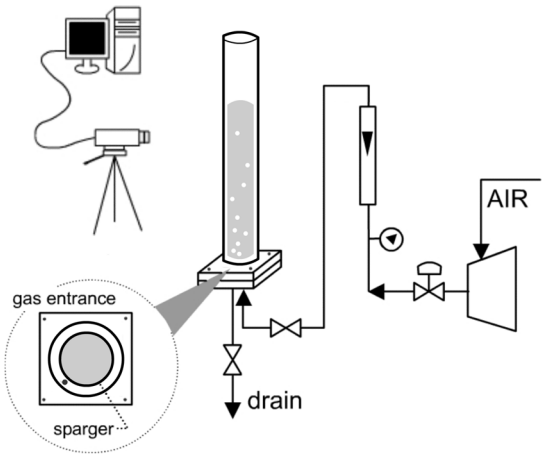

Figure 1. Experimental set-up.

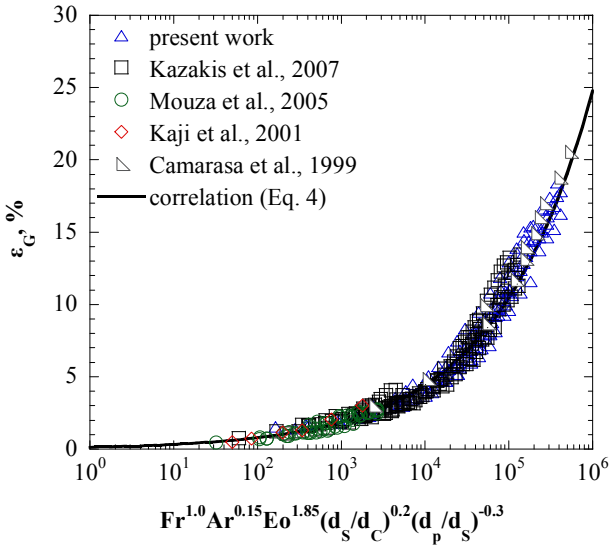

Figure 2. Gas holdup correlation for the homogeneous regime.