CHARACTERIZATION OF BUBBLES IN A BUBBLE COLUMN BY IMAGE ANALYSIS

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Summary

The aim of this work was to study the influence of airflow rate, the distributing plate orifice diameter and the presence of a coalescence inhibitor on the size and shape of bubbles in a rectangular bubble column.

INTRODUCTION

In recent years there has been considerable interest in the use of pneumatic reactors for biological reactions. Bubble columns are characterized by the fact that the gas is dispersed in the continuous liquid phase in bubble form. Hence, bubble size, rising velocity and distribution are important parameters that influence the performance of the reactor and, consequently have to be calculated.

Bubble characteristics are determined by the operation conditions of the reactor and parameters as the distributing plate and the properties of the liquid phase are determinant.

Several methods for particle size measurement are available. They are generally divided into two categories, depending upon whether or not a sample is removed. The most simple characterization method is the photographic technique that, however, demands for photographs analyses. With the exponential increase of the processing capabilities of computers, as well as their price reduction, image analyses has become a very important tool, being a routine in cellular biology studies.

Several parameters can be used to statistically describe the diameter of a bubble. The most commonly used parameter to describe the diameter of a particle is the equivalent diameter, based on the projected area of the bubbles.

MATERIAL AND METHODS

Three-phase system

Gas-phase: Air

Liquid-phase: Water and aqueous solution of 10g/l ethanol

Experimental conditions

Airflow rate: 100, 125, 150, 175 and 200 l/hr

Distributing plate orifice diameter: 0.5 mm, 1.0 mm and 1.6 mm

Fig. 1 - Rectangular bubble column

Bubble size and shape characterizations was done by recording images, at 30 cm from the distributor plate, with a video camera .

After digitalisation, images were analysed using an image analysis system based on a MATLAB developed software.

RESULTS AND DISCUSSION

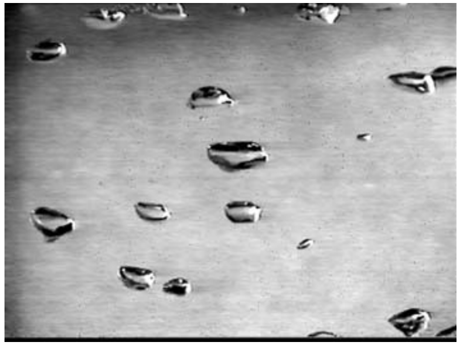


Fig. 2 - Image of bubbles obtained by digitalization of video camera recordings

Fig. 3 - Image of bubbles obtained by image analysis treatment of Fig. 2

Equivalent diameter of bubbles was obtained from the calculated values of the projected area.
By the determination of the lengths of the perpendicular axes, the superficial area and the volume of each bubble were calculated.
The shape of the bubbles was obtained by comparison of the ratio between its superficial area and volume with the one of a sphere.

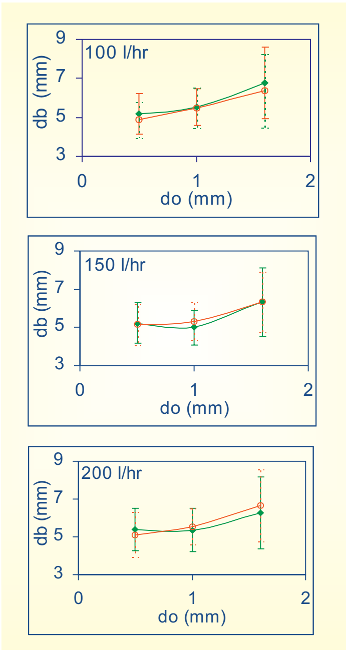


Fig. 4 - Mean diameter of bubbles and standard deviation vs. the orifice diameter of the distributing plate, for different airflow rates (◆ - water; ○ -ethanol solution)

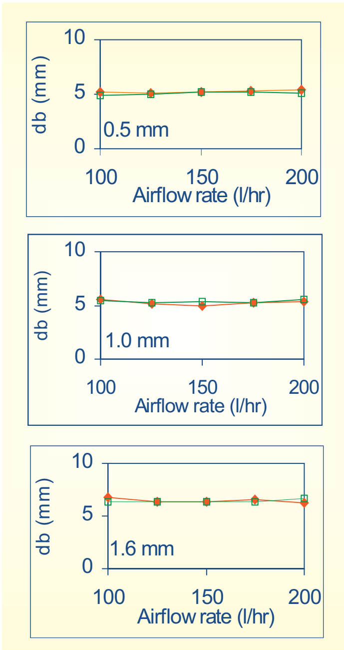
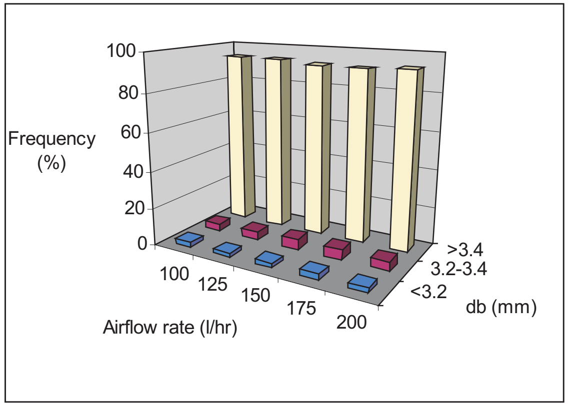


Fig. 5 - Mean diameter of bubbles vs. the airflow rate, for three orifice diameters of the distributing plate (◆ - water; □ - ethanol solution)



SHAPE FACTOR:

(A*r/V)>3.4	bubble is an ellipsoid
3.2<(A*r/V)<3.4	bubble is an intermediate
(A*r/V)<3.2	bubble is a sphere

Fig. 6 - Bubble shape distribution based on shape factor (A*r/V)

CONCLUSIONS

- In the range of the studied airflow rates, bubble diameter slightly increased.
- An increase of bubble size was also observed with the increase of the distributing plate orifice diameter, being this variation more pronounced when the orifice diameter increased from 1.0 mm to 1.6 mm.
- The presence of ethanol did not lead to any significant change on bubble diameter.
- Comparison of the ratio between the superficial area and the volume with the one of a sphere, showed that ellipsoidal bubbles are predominant.

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