Microbubble injector: an experimental quantitative characterization

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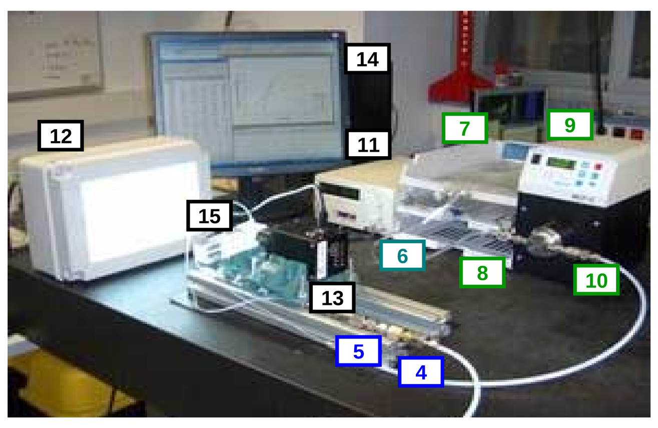
Introduction

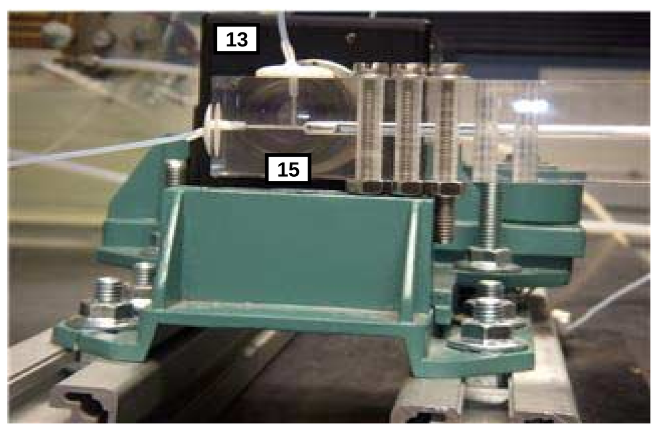
- A new method to generate bubbles[1],[2] is characterized.
- Slug flow is generated in the T-junction of a microbubble injector.
- Capillary regime –>Performance independent of the microgravity level .
- Characterization of the injector consists in the analysis of bubble frequency and size distribution.
- PC control and data acquisition system have been designed.

[1] J. Carrera, X. Ruiz, L. Ramírez-Piscina, J. Casademunt, M. Dreyer, *Generation of a Monodisperse Microbubble Jet in Microgravity*, submitted to AIAA Journal (2007)

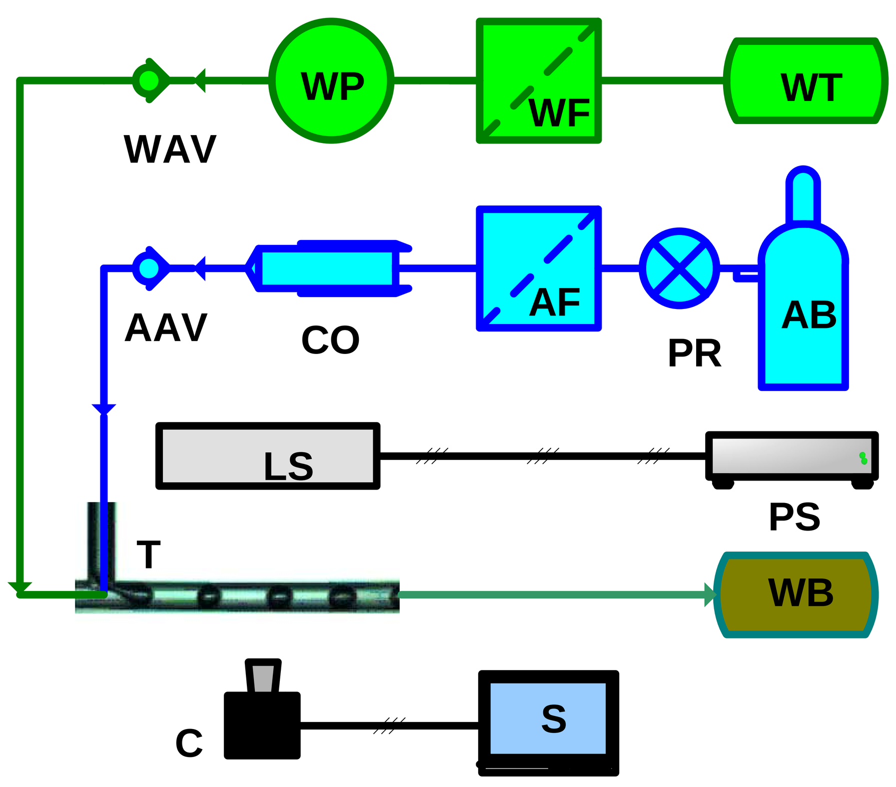
[2] S. Arias, X. Ruiz, J. Casademunt, L. Ramírez-Piscina and R. González-Cinca, *Experimental study of a microchannel bubble injector for microgravity applications*, preprint (2007)

Experimental set-up

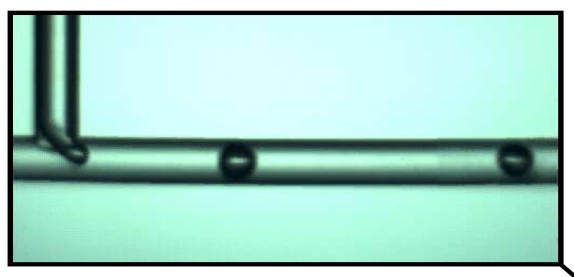


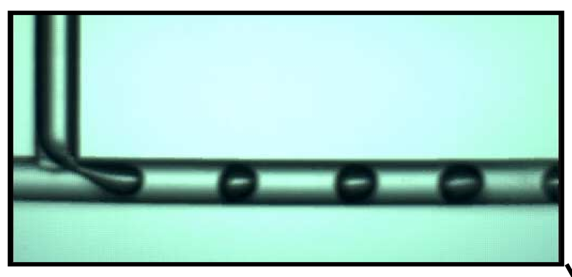


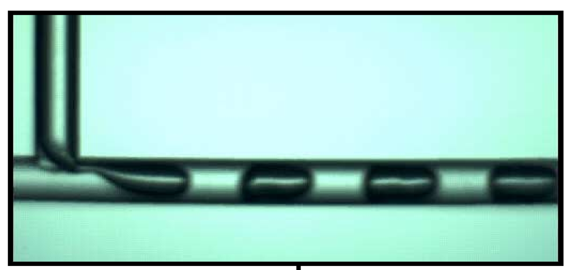
1.	Air bottle	[AB]
2.	2 Stage pressure reducer	[PR]
3.	Air filter	[AF]
4.	Choked orifice	[CO]
5.	Air anti-return valve	[AAV]
6.	Waste bag (air + water)	[WB]
7.	Water tank	[WT]
8.	Water filter	[WF]
9.	Water pump	[WP]
10.	Water anti-return valve	[WAV]
11.	DC supply	[DC]
12.	Light source	[LS]
13.	High speed camera (2000fps)	[C]
14.	Server	[S]
15.	Methacrylate T-Junction	[T]

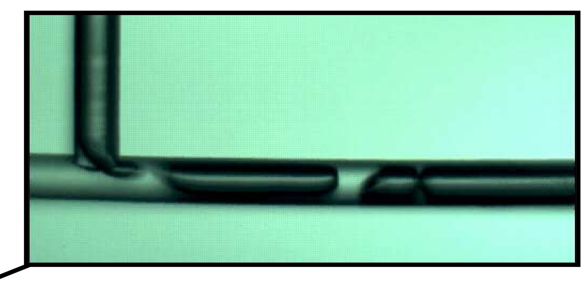


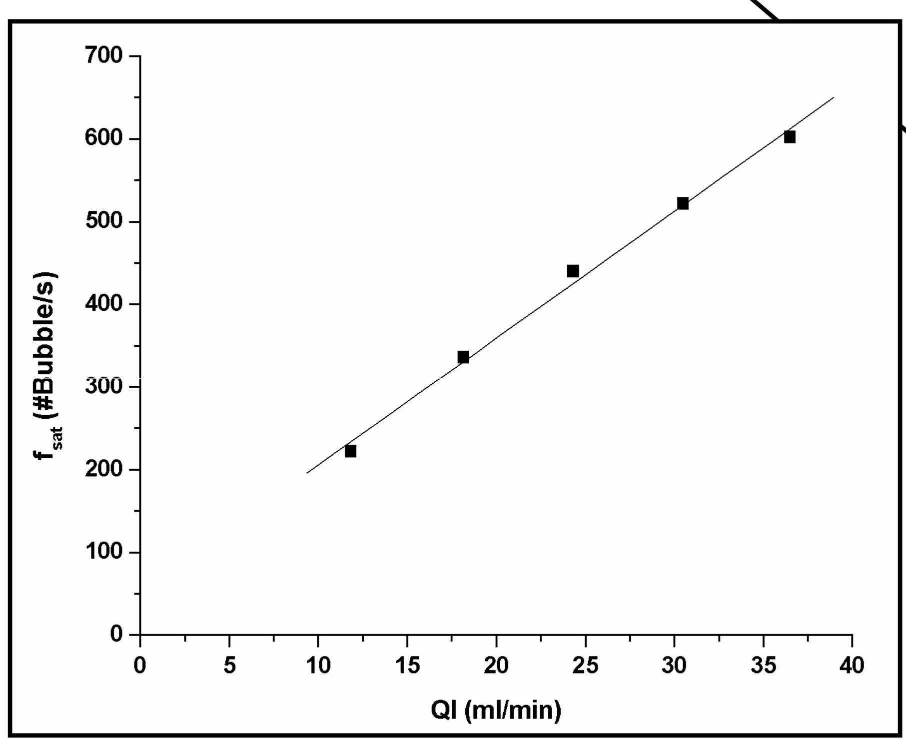
Results



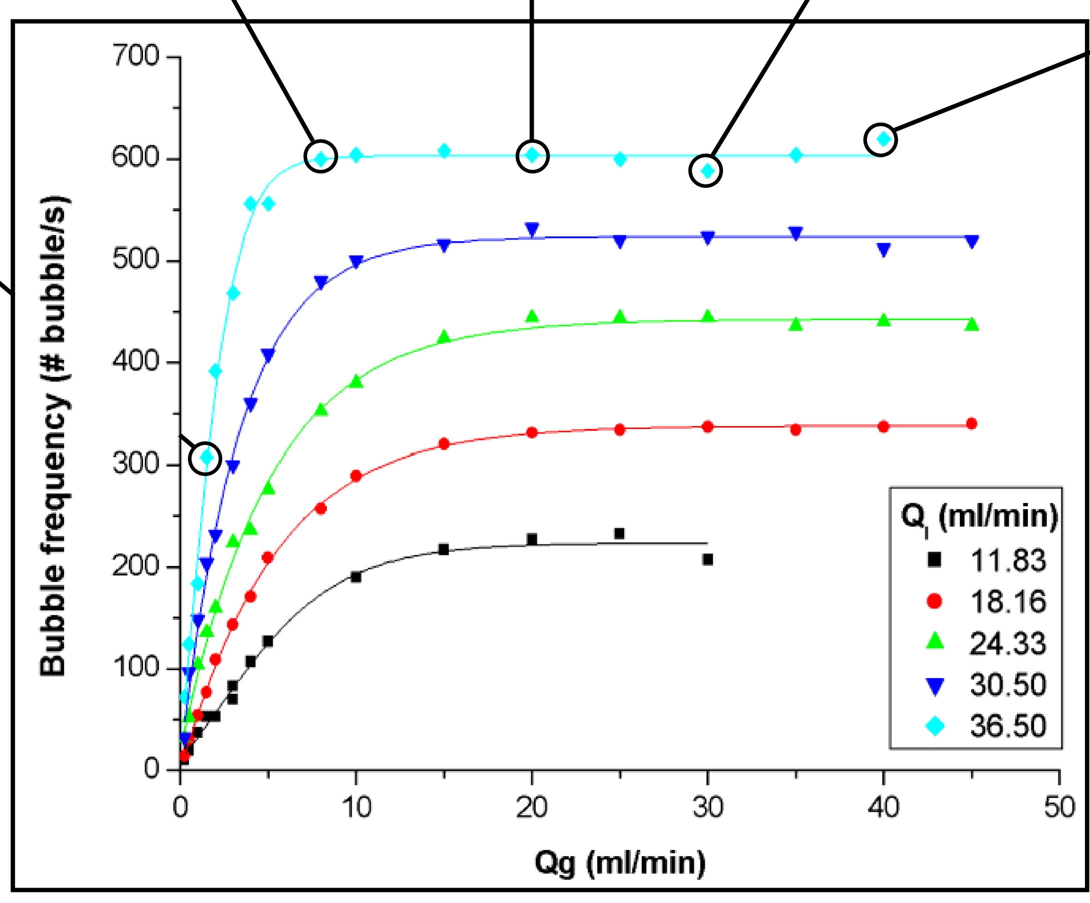








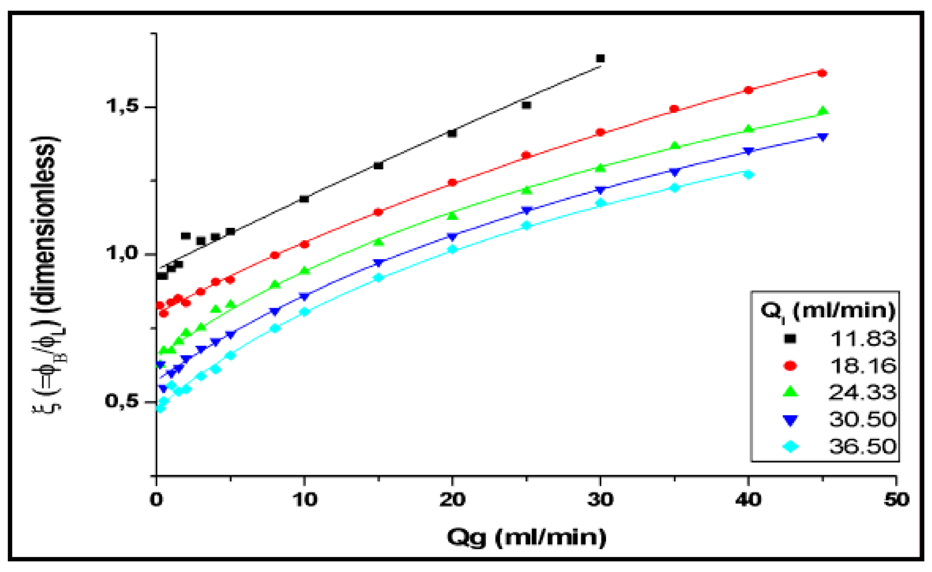
$$f_{sat} = Q_l / \phi^3$$



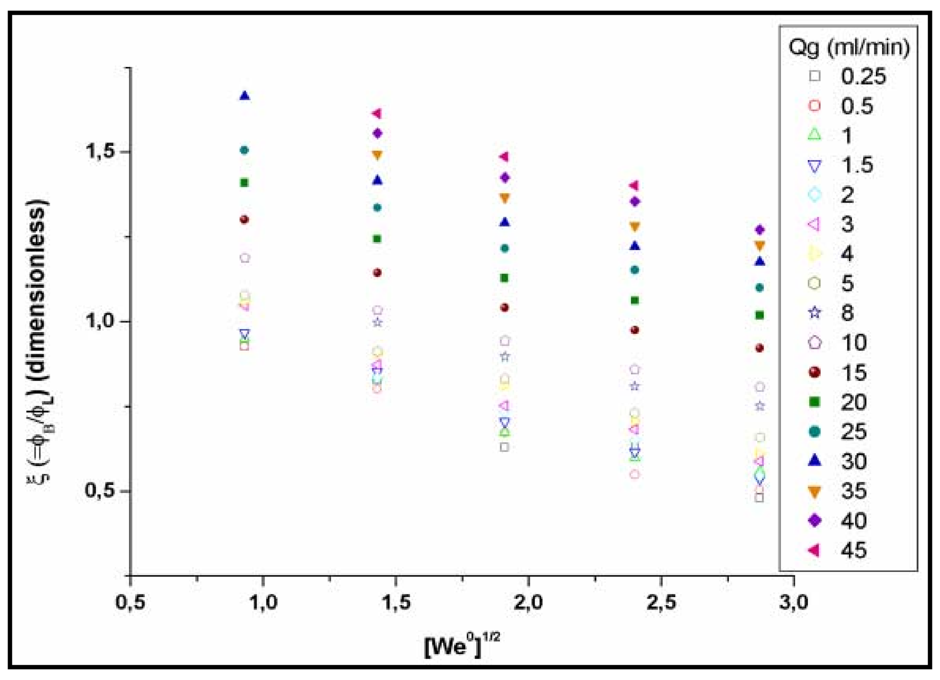
$$\phi_B = \left(\frac{6}{\pi} \frac{Q_g}{f} \right)^{1/3}$$

NOMENCLATURE

Q_l	water flow rate [10 to 30 ml/min]
Q_g	air flow rate [8 to 45 ml/min]
Φ_B	bubble diameter
Φ_L , Φ_g	liquid/gas injector diameters
f	bubble frequency
f_{sat}	saturation frequency
u_L	water mean velocity
σ	water surface tension
We^0	nominal Weber number
	$We^0 = (\rho_L \cdot u_L^2 \cdot \Phi_L)/\sigma$



$$\phi_B = \phi_l \left(\frac{1}{\alpha} - \frac{1}{2\alpha^2} \left(\frac{\phi_l}{\phi_g} \frac{We^0}{We^c} \right)^{1/2} \right) + o(We^o)$$



Conclusions

- A novel microbubble injector has been characterized.
- Information obtained is relevant for operation in microgravity conditions.
- Slug and transition flow have been observed.
- Performance under different working regimes has been analyzed.
- Bubble generation frequency saturates for high gas injection flow.
- Saturation frequency follows a simple linear scaling with the liquid injection flow.
- Slope of ξ vs. Qg appears to be independent of Ql.
- Scaled bubble diameter decreases linearly with nominal $(We^0)^{1/2}$.