Characterization of the performance of an injector for the generation of controlled microbubbles

S. Arias [a], R. González-Cinca [a], L. Ramírez-Piscina [a,b], J. Casademunt [b, c] and X. Ruiz [b,d]

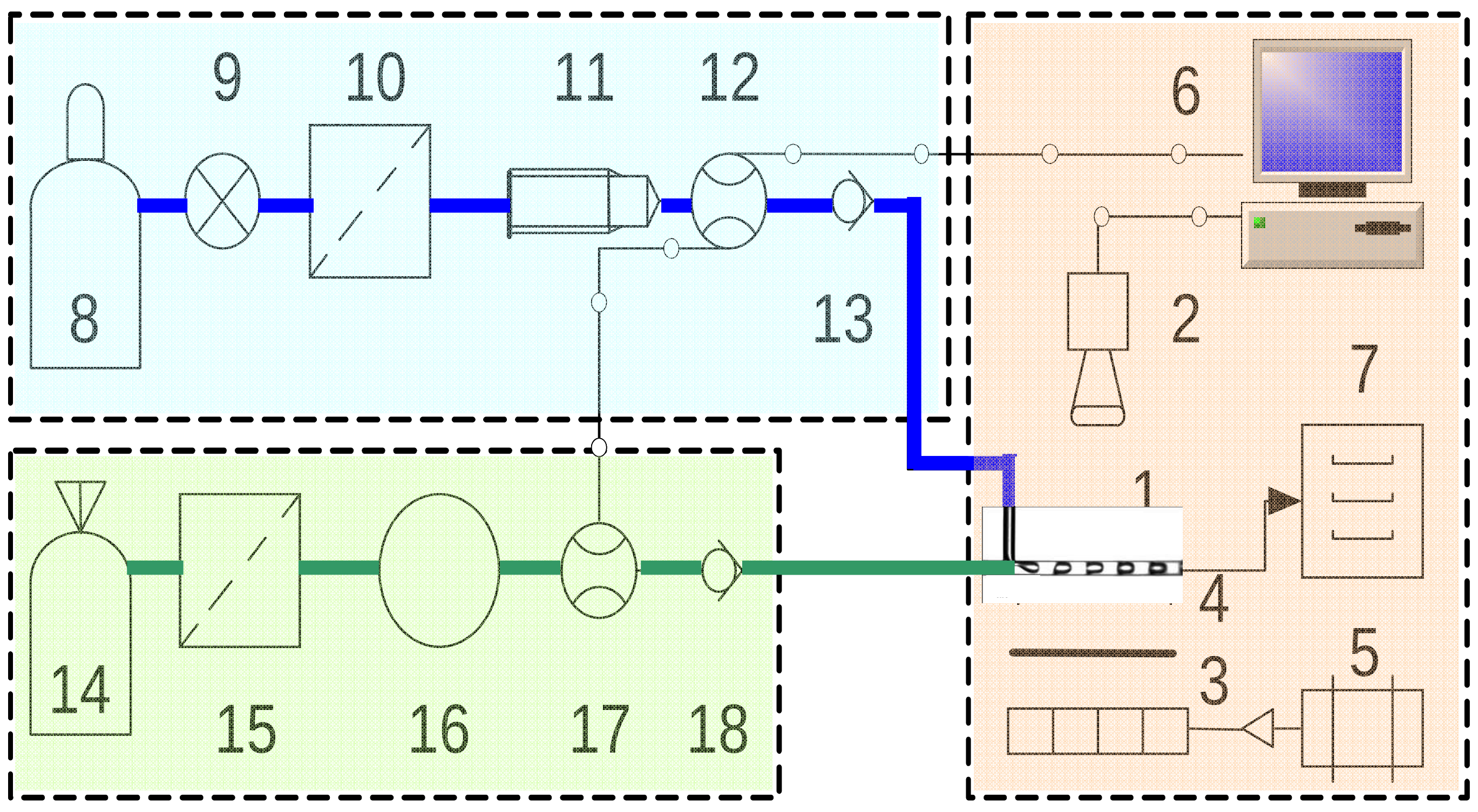
a) Universitat Politècnica de Catalunya, Barcelona (Spain); b) Institut d'Estudis Espacials de Catalunya (Spain)
c) Universitat de Barcelona, Barcelona (Spain); d) Universitat Rovira i Virgili, Tarragona (Spain)

Introduction

- **Exploration of the performance of a minibubble injector[1].**
- **Crossflow at the T-junction inside the injector.**
- $We \sim 1, 10$ **–> Capillary regime.**
- $Bo \sim 10^{-1}$ **–> Performance independent of the gravity level.**
- $Re \sim 10^{3}$ **–> Laminar regime.**
- **Characterization of the injector consists in the analysis of bubble frequency and size distribution.**
- **Design of PC control and data acquisition system.**

[1] S. Arias, X. Ruiz, J. Casademunt, L. Ramírez-Piscina and R. González-Cinca, *Experimental study of a microchannel bubble injector for microgravity applications*, accepted for publication in Microgravity Science and Technology (2008).

Experimental setup

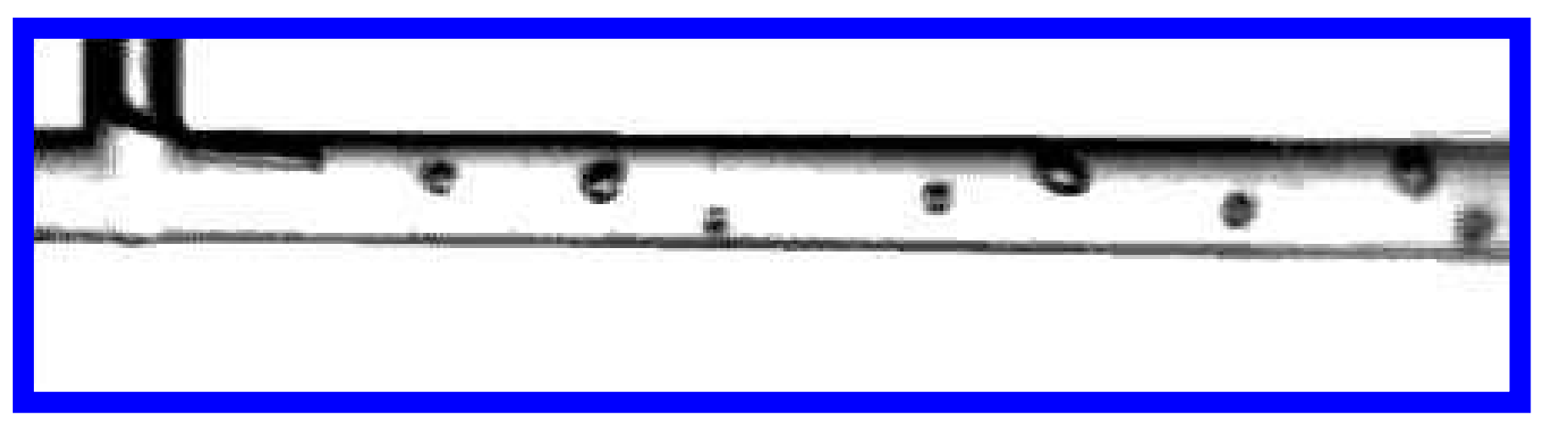


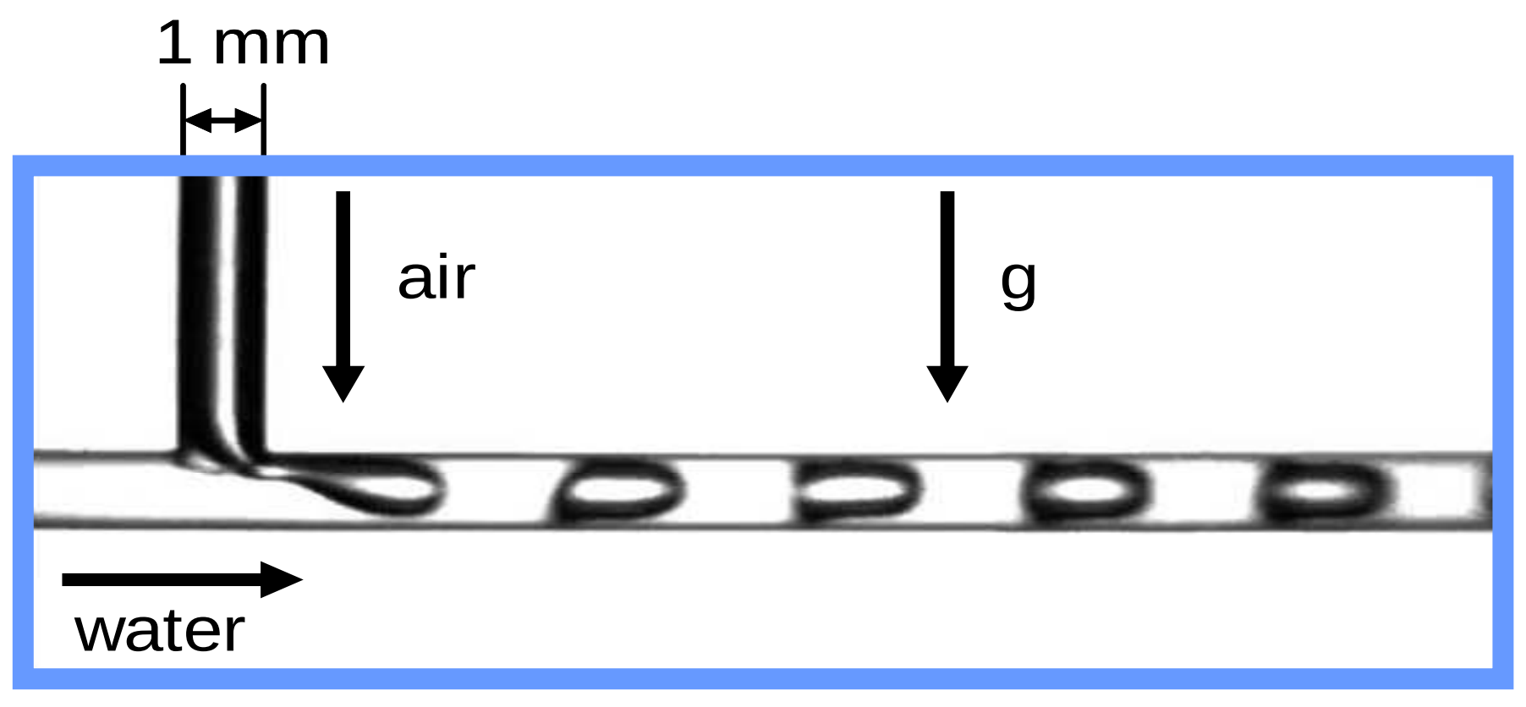
Test section (1: injector, 2: HS camera, 3: light source, 4: diffuser, 5: power supply, 6: computer, 7: residual tank)

Air supply system (8: air bottle, 9: manometer, 10: air filter, 11: chocked orifice, 12: air mass flow meter, 13: check valve)

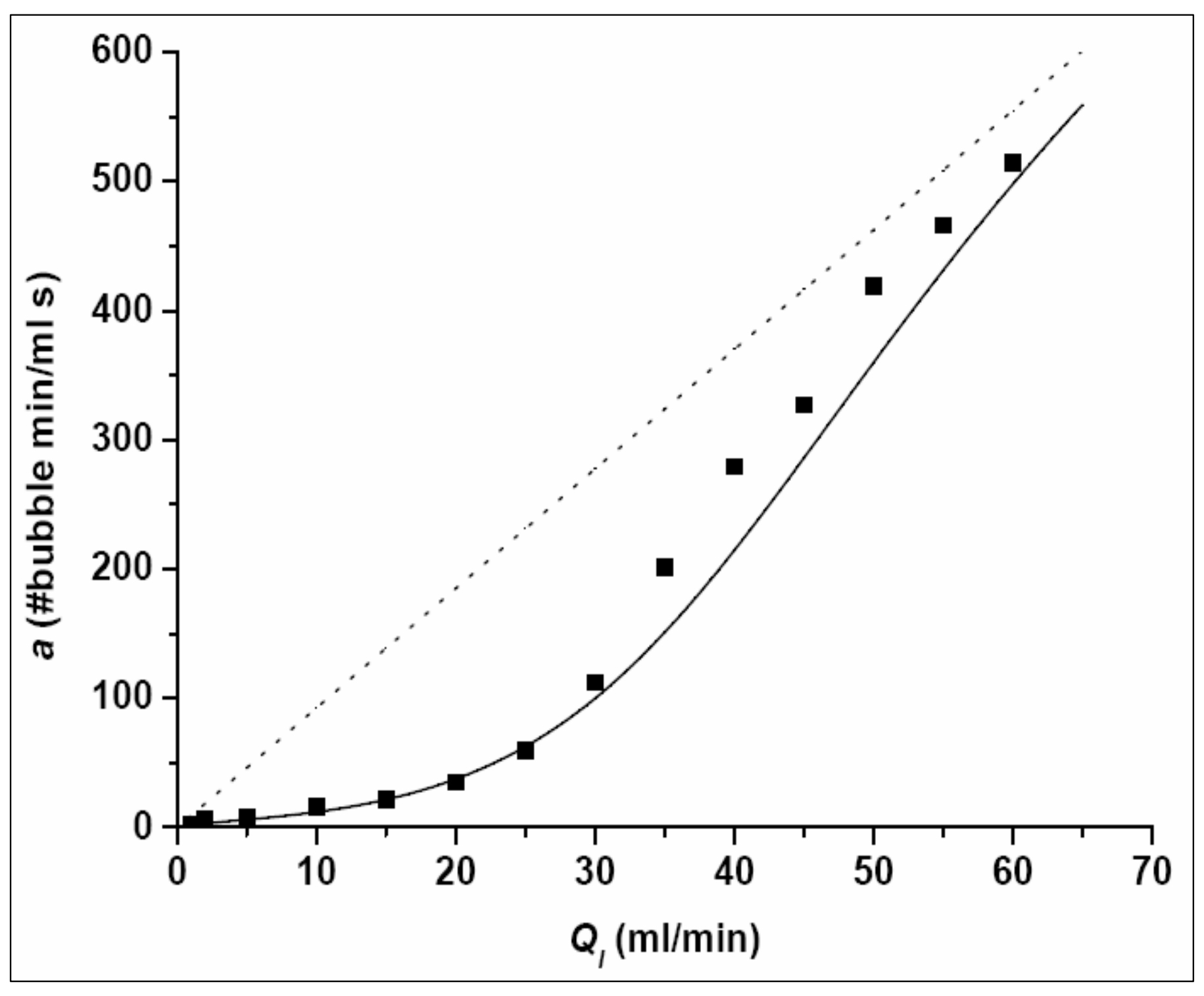
Water supply system (14: water tank, 15: filter, 16: pump, 17: water mass flow meter, 18: check valve).

Results

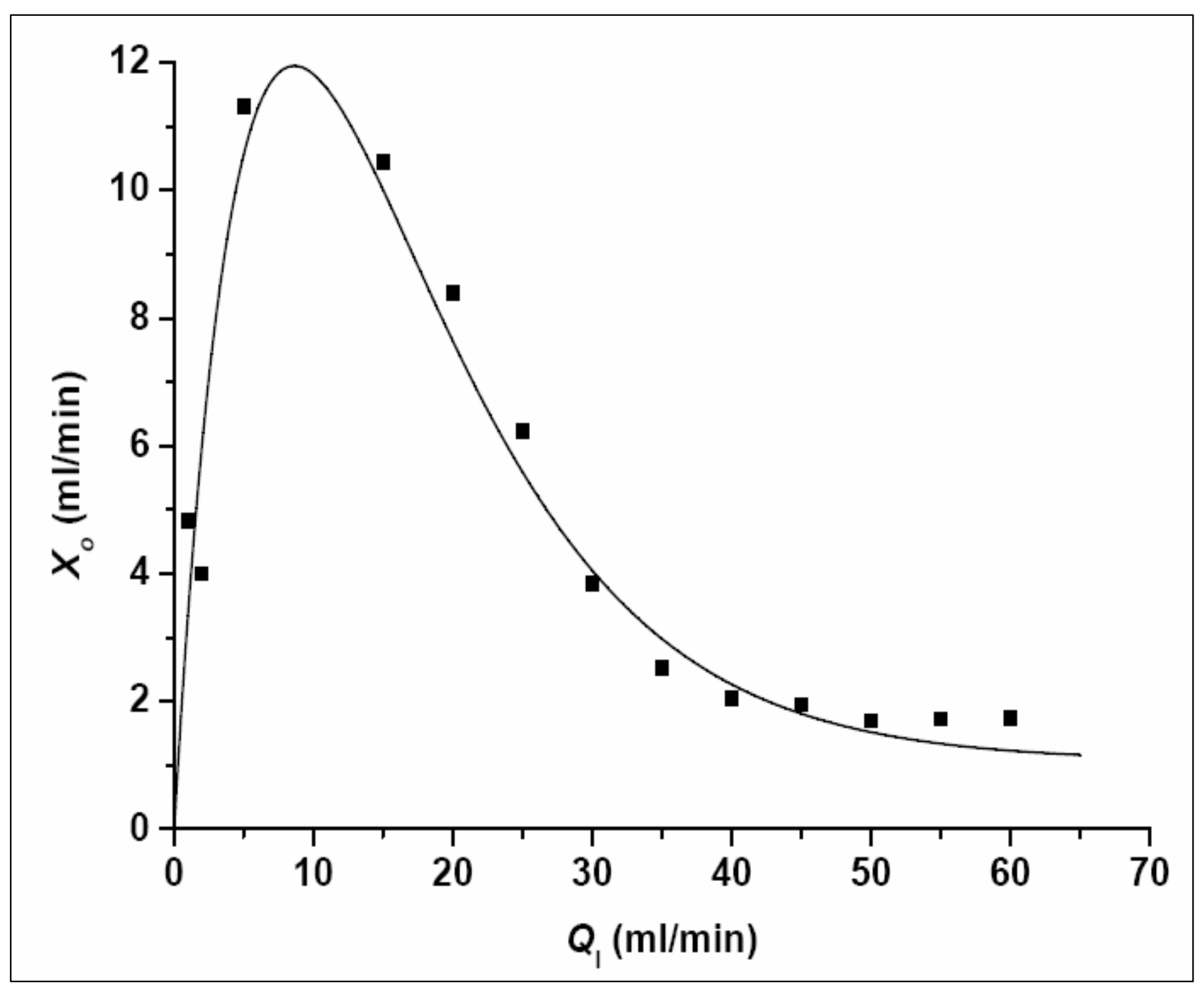




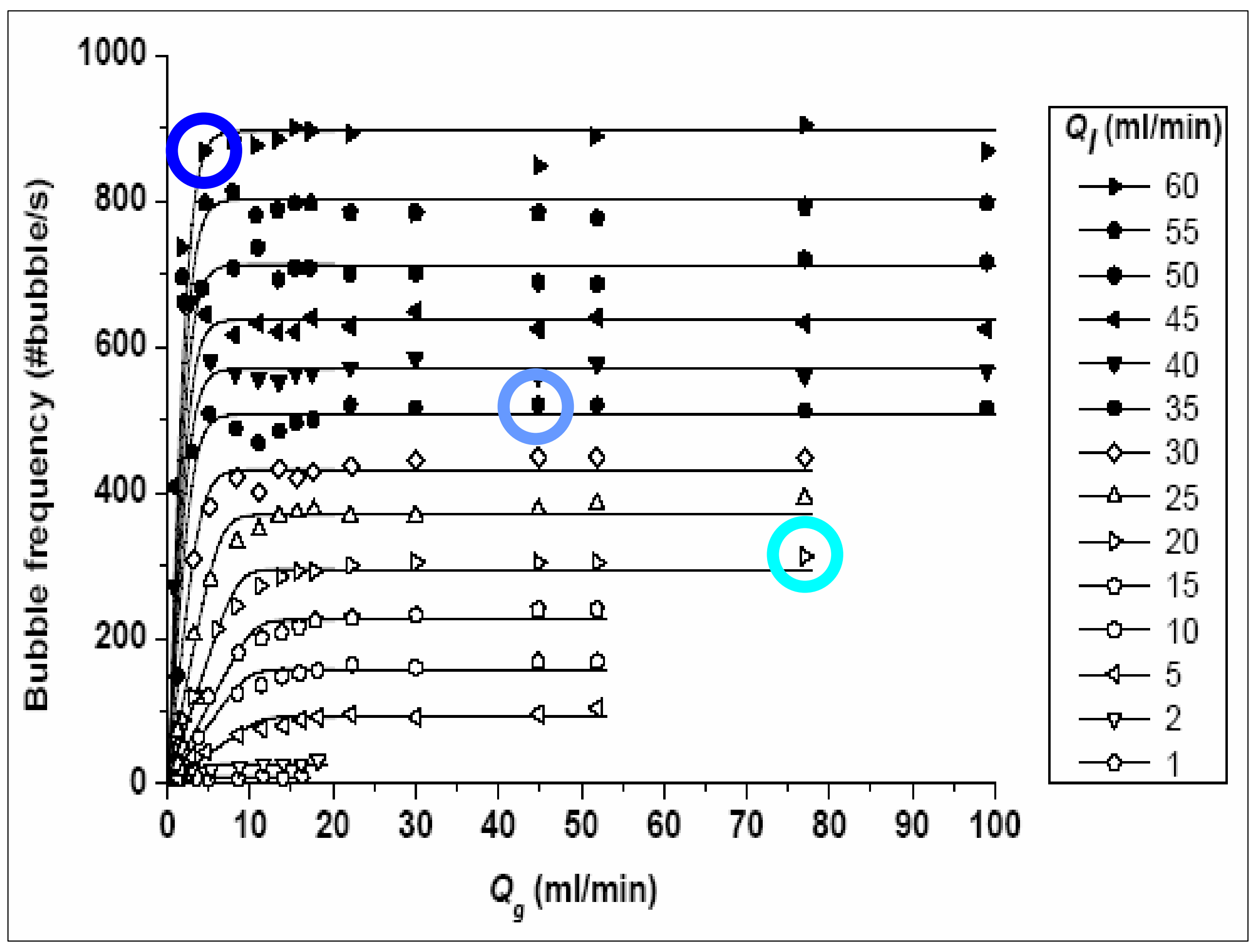
Linear regime



$$a\left(Q_l\right) = 9.25\,Q_l - 8.7$$

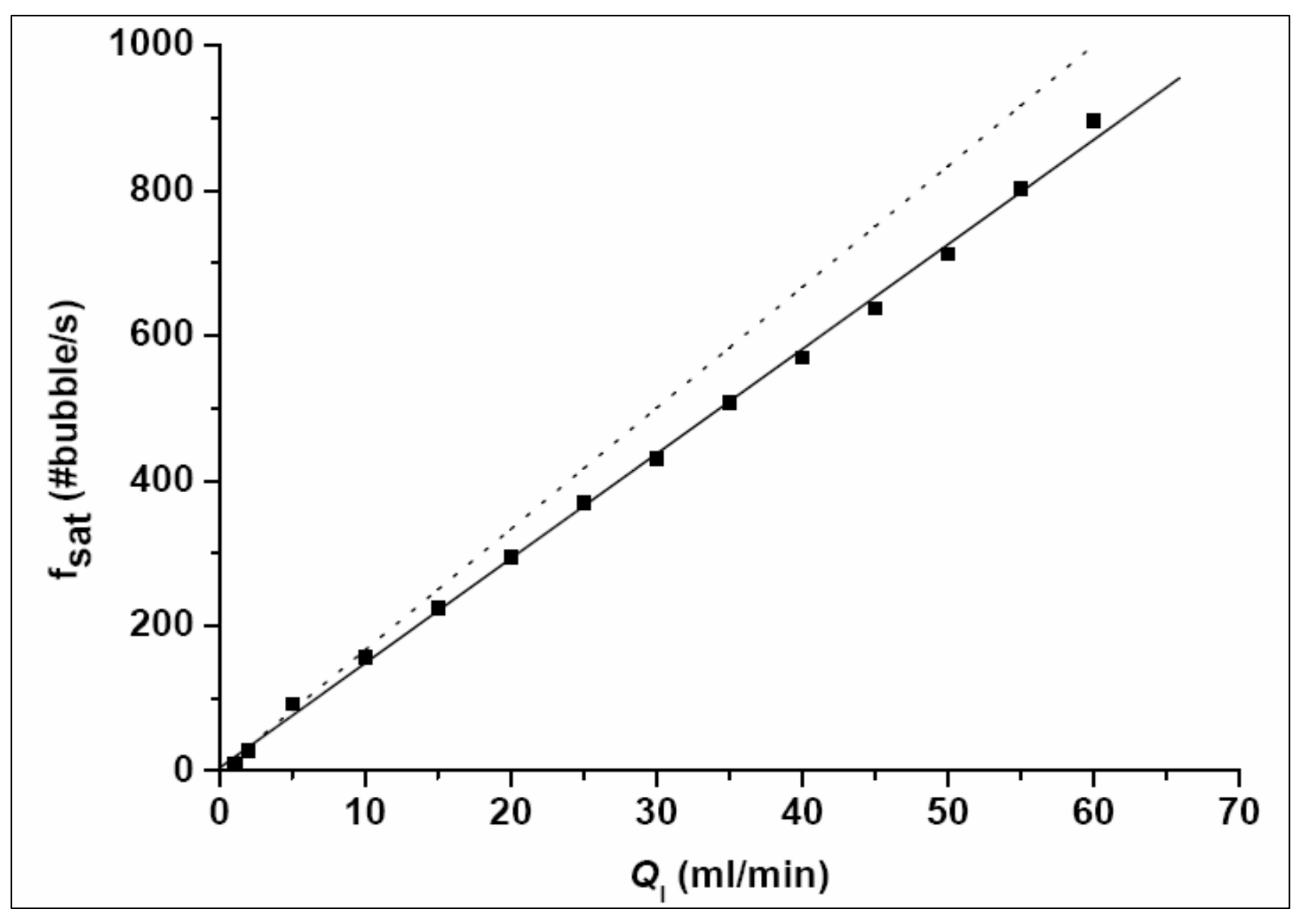


$$x_o\left(Q_l\right) = d\left(b + \frac{Q_l - b}{e^{c\left(Q_L - b\right)}}\right)$$



$$f\left(Q_g\right) = f_{sat} - a\log\left(1 + e^{-\left(Qg - x_o\right)}\right)$$

Saturation regime

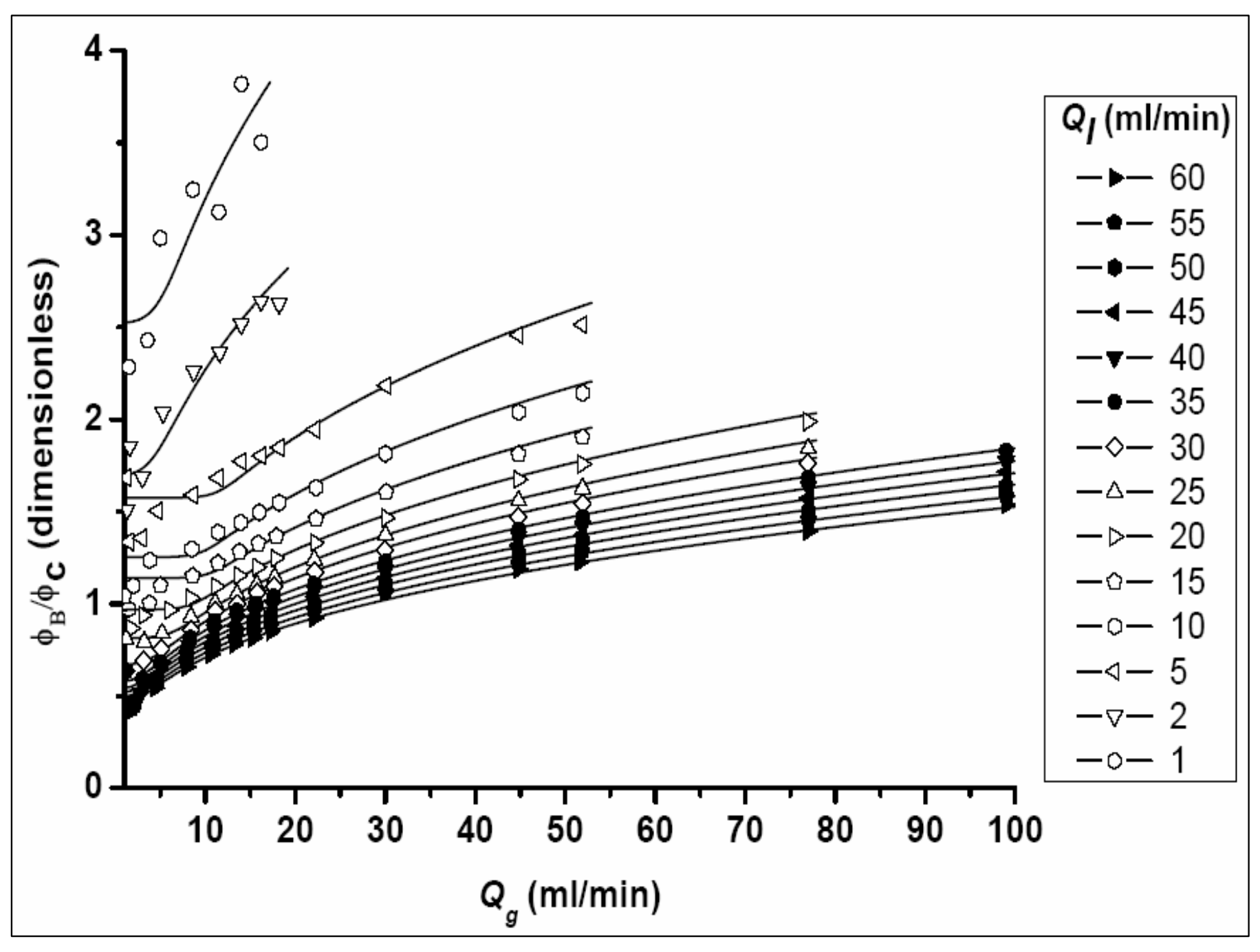


$$f_{sat}\left(Q_l\right) = Q_l / \phi_c^3$$

Conclusions

- **Relevant information obtained for operation in microgravity conditions.**
- **Bubbly, slug and annular flow regimes observed.**
- **Regular bubble generation and small dispersion in bubble size in the slug regime. High bubble generation frequencies can be achieved.**
- **Bubble generation frequency saturates for high gas flow rate.**
- **New proposed expression for the prediction of the bubble generation frequency for given values of *Ql* and *Qg*.**
- **Saturation frequency follows a linear scaling with the liquid flow rate.**
- **New proposed expression for the prediction of the crossover point.**
- **Linear asymptotic tendency in the variation of the slope of the linear regime with the liquid flow rate.**

Bubble size



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

NOMENCLATURE

Ql	**water flow rate [10 to 60 ml/min]**
Qg	**air flow rate [0.25 to 99 ml/min]**
ϕ_B	**bubble diameter**
ϕ_c	**capillary diameter**
f	**bubble frequency**
f_{sat}	**saturation frequency**
a	**linear regimen slope**
xo	**crossover point**