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

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Introduction

- Exploration of the performance of a minibubble injector[^1].
- Crossflow at the T-junction inside the injector.
- \( \text{We} \approx 1 \text{ to } 10 \Rightarrow \) Capillary regime.
- \( \text{Re} \approx 10^3 \Rightarrow \) Performance independent of the gravity level.
- \( \text{Re} \approx 10^5 \Rightarrow \) Laminar regime.
- Characterization of the injector consists in the analysis of bubble frequency and size distribution.
- Design of PC control and data acquisition system.


Experimental setup

- Water supply system
- 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: choked 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

- Saturation regime

\[ f(Q) = f_{sat} - a \log \left( 1 + e^{-\left( Q_{sat} - a \right)} \right) \]

\[ Q_{sat} = \frac{Q}{\phi^2} \]

\[ x_{sat}(Q) = \left( b + \frac{Q - b}{e^{(Q/b - 3)}} \right) \]

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 \( Q \) and \( Q_{sat} \).
- 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.