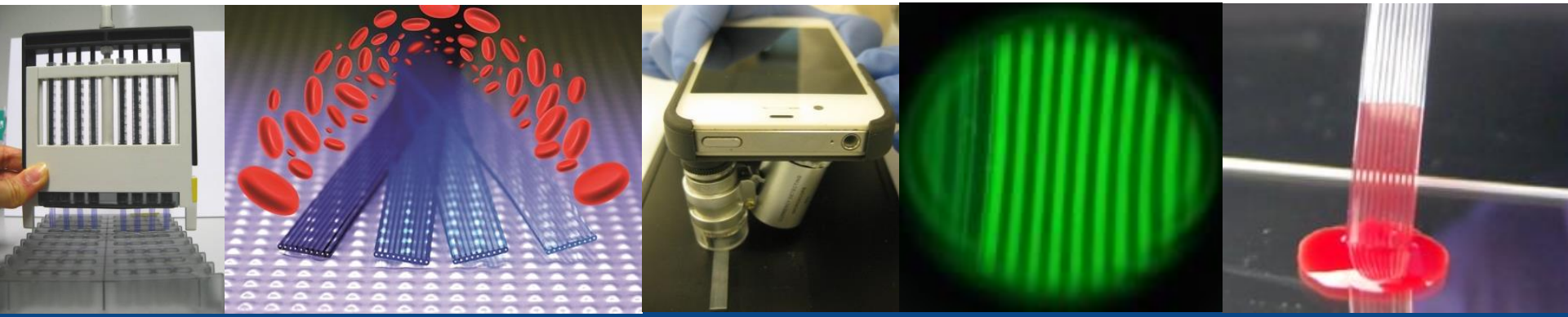

Modelling of bubble size distribution and mass transfer in steady and unsteady gas-liquid flows

Nuno M. Reis

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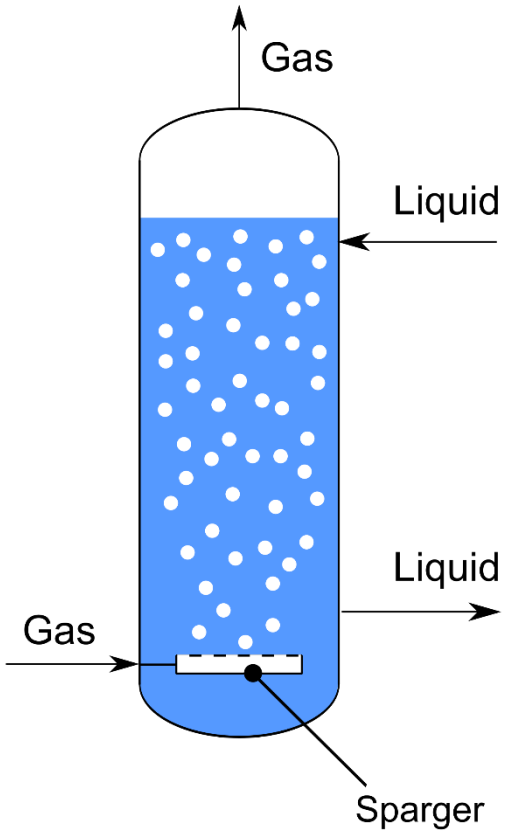
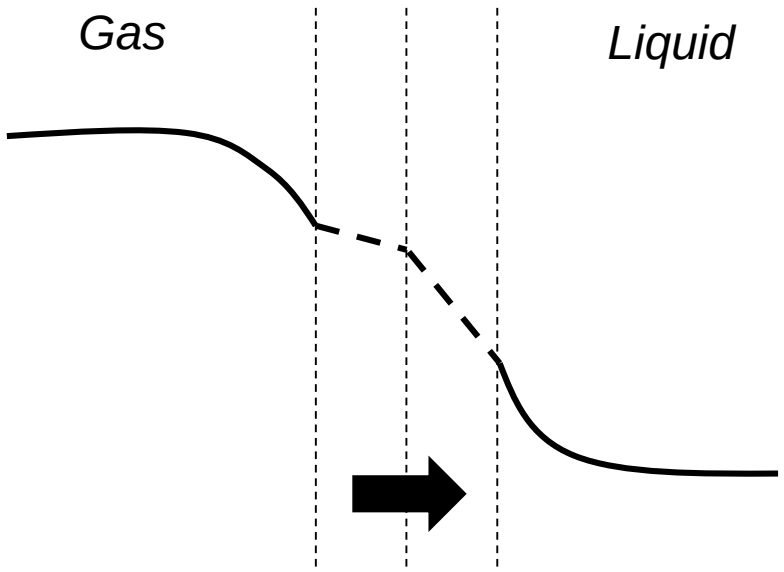
SAMBa ITT6, 5th February 2017

Industrial gap #1: compact & efficient gas-liquid contacting system

- Current gas-liquid contacting systems are very inefficient: bubbles have very short residence time linked to large $\Delta\rho$, large diameter and coalescence, that cannot be controlled





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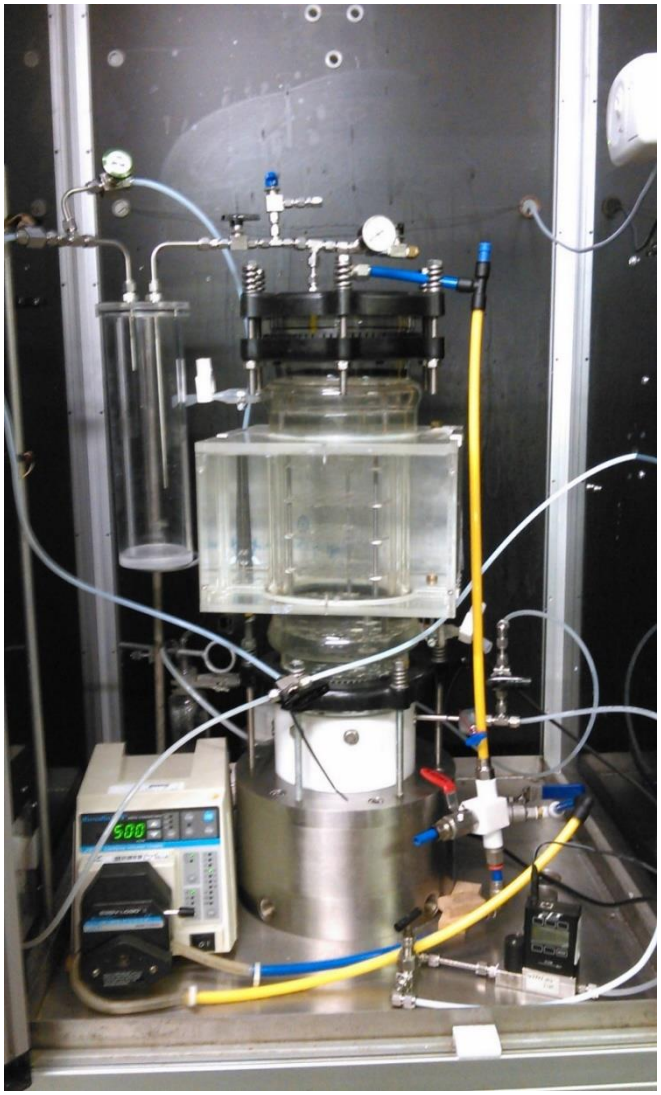
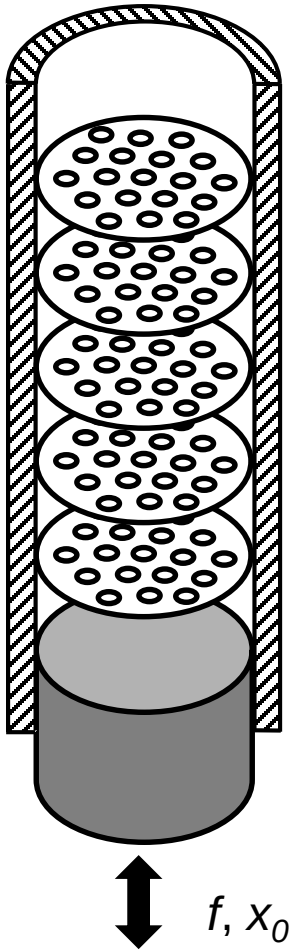
Our solution: pulsating flow – compact & efficient





Lucas et al. (2014), Chemical Engineering Journal 296: 335–339

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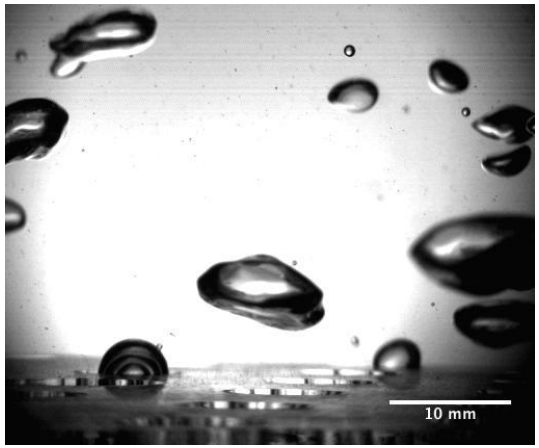
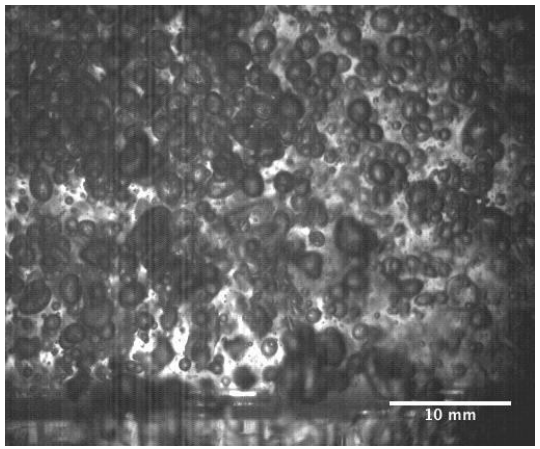
BC


MOBC

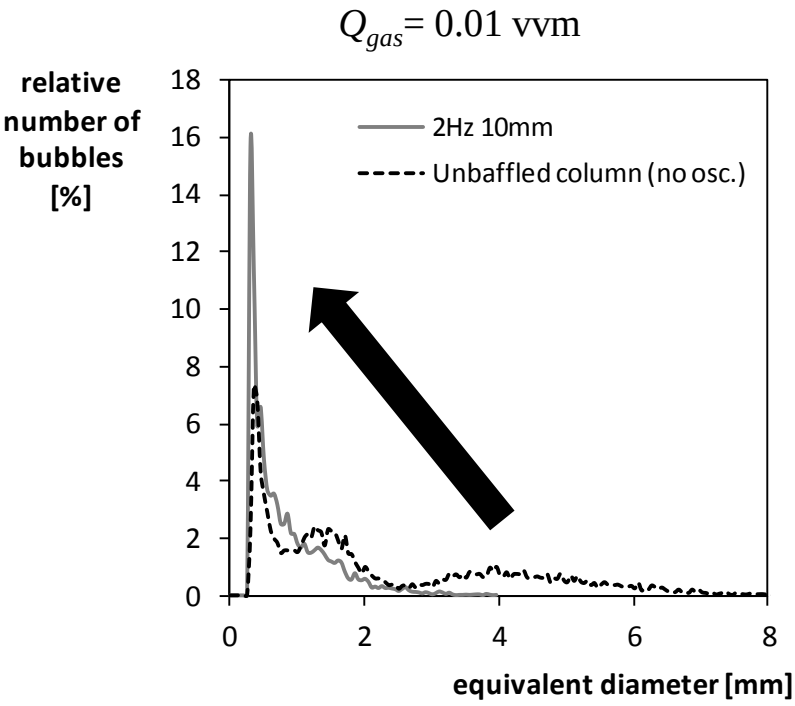
Challenge #1: prediction size distribution microbubbles



Bubble column (BC)



Multi-orifice Oscillatory Baffled Column (MOBC)



Pereira et al. (2014), Ind. Eng. Chem. Res., 53, 17303−17316

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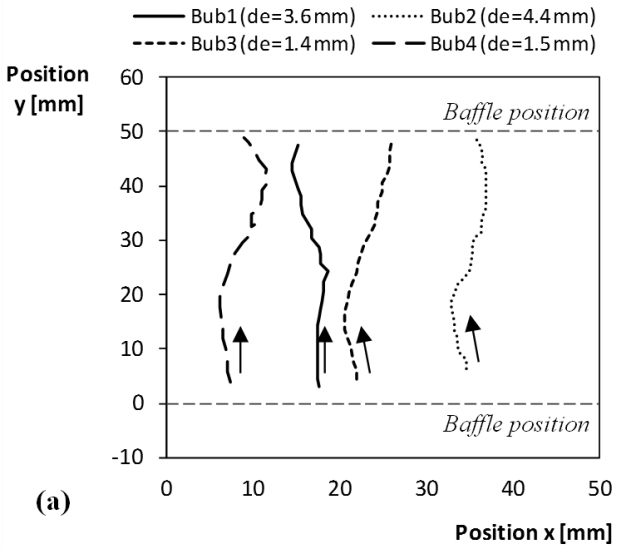
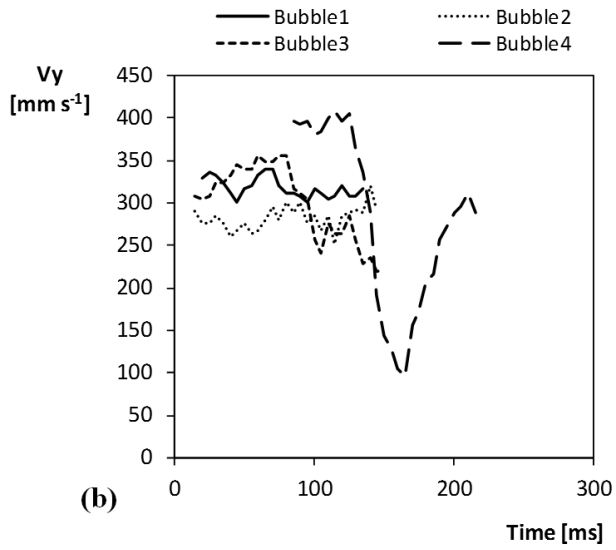
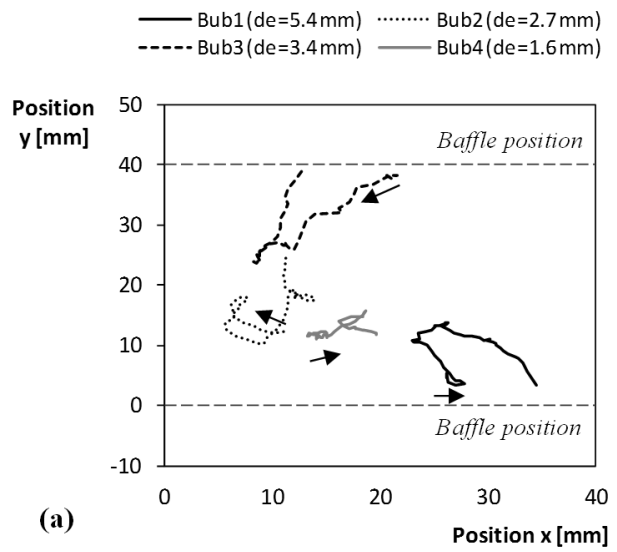
Challenge #2: prediction residence time of bubbles

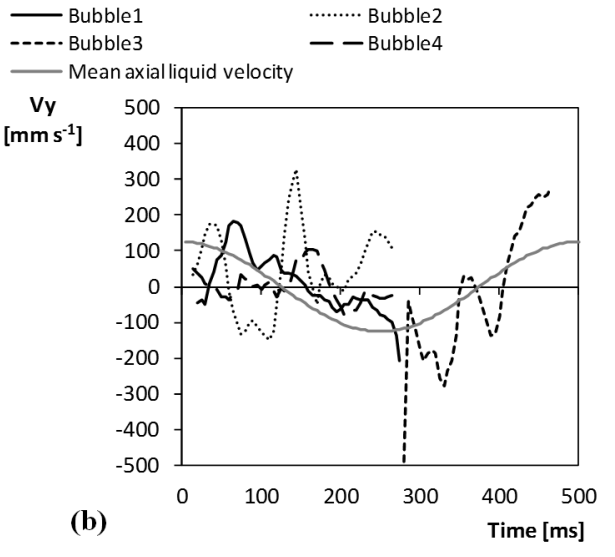
***Bubble column**: bubble rising velocities of up to 350 mm/s*





***MOBC**: bubbles trapped by eddy vortices*





SuperOzonation

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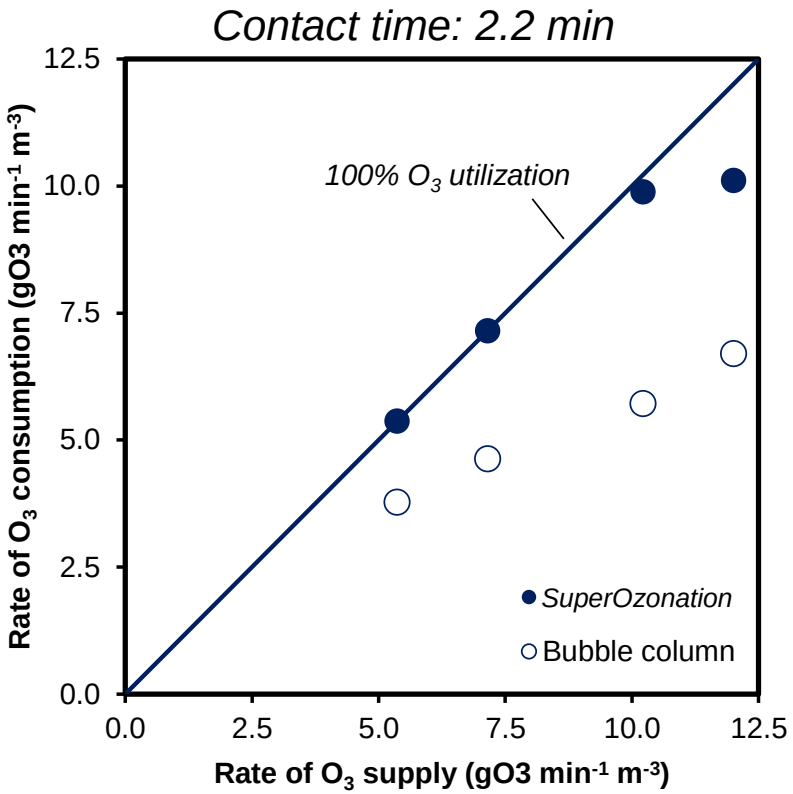
Challenge #3: prediction mass transfer rates & efficiency

- Experimental data so far includes removal emergent contaminants with ozone & syngas bioconversion to biofuels



Reis and Li Puma, GB patent application 1412749.2

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Relevant publications

I&EC research
Industrial & Engineering Chemistry Research

Article

pubs.acs.org/IECR

CO_2 Dissolution and Design Aspects of a Multiorifice Oscillatory Baffled Column

Filipa M. Pereira,[†] Diana Z. Sousa,[†] M. Madalena Alves,[†] Malcolm R. Mackley,[‡] and Nuno M. Reis*[,‡,§]

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[‡]Department of Chemical Engineering and Biotechnology, University of Cambridge, New Museum Site, Pembroke Street, CB2 3RA Cambridge, U.K.

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1. (WO2016009177) OSCILLATORY BAFFLED REACTOR AND GAS-LIQUID REACTION PROCESS

PCT Biblio. Data | Description | Claims | National Phase | Notices | Drawings | Documents

Latest bibliographic data on file with the International Bureau

PermaLin

Pub. No.: WO/2016/009177 **International Application No.:** PCT/GB2015/051975
Publication Date: 21.01.2016 **International Filing Date:** 08.07.2015
IPC: ***C02F 1/68*** (2006.01), ***B01J 19/00*** (2006.01), ***B01F 11/00*** (2006.01), ***B01J 19/24*** (2006.01), ***B01F 15/00*** (2006.01), ***C02F 1/78*** (2006.01), ***C02F 3/28*** (2006.01)
Applicants: **LOUGHBOROUGH UNIVERSITY** [GB/GB]; Ashby Road Loughborough Leicestershire LE11 3TU (GB)
Inventors: **REIS, Nuno**; (GB).
LI PUMA, Gianluca; (GB)
Agent: **OXLEY, Rachel**; (GB)
Priority Data: 1412749.2 17.07.2014 GB
Title **(EN)** OSCILLATORY BAFFLED REACTOR AND GAS-LIQUID REACTION PROCESS
(FR) RÉACTEUR À DÉFLECTEUR OSCILLATOIRE ET PROCÉDÉ DE RÉACTION GAZ/LIQUIDE

Chemical Engineering Journal 296 (2016) 335–339

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Short communication

Intensification of ozonation processes in a novel, compact, multi-orifice oscillatory baffled column

Marco S. Lucas, Nuno M. Reis *, Gianluca Li Puma *

Environmental Nanocatalysis and Photoreaction Engineering, Department of Chemical Engineering, Loughborough University, Loughborough LE11 3TU, United Kingdom

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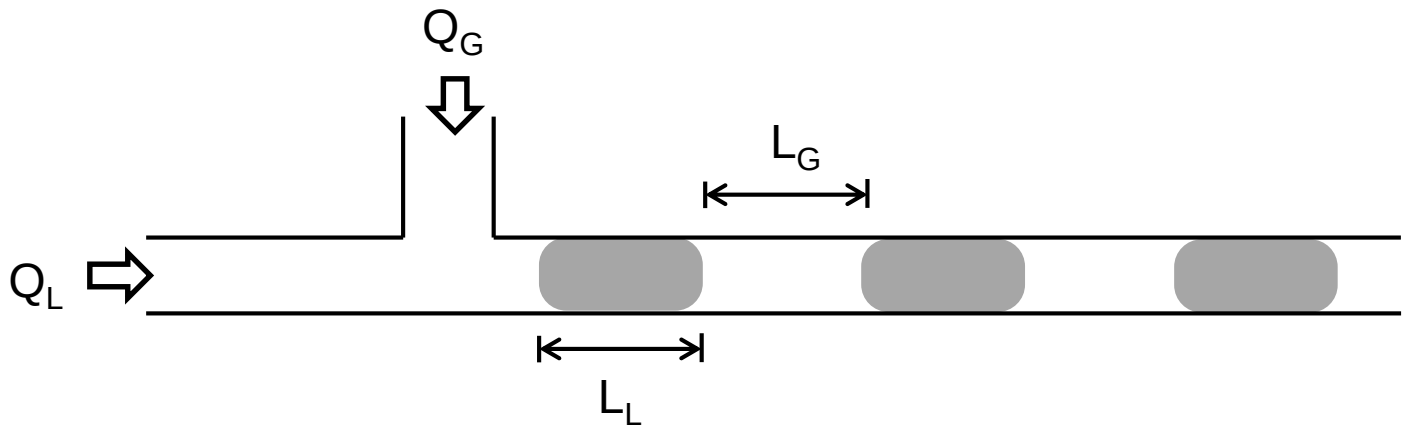
Industrial need #2: modelling gas-liquid flow in microchannels

- There are a number of analytical and processing situations where gas-liquid flow is utilised in miniaturised devices, benefiting from the enhanced mass transfer.
- Microfluidics market growing double figures, and estimated to reach $6Bn by 2020



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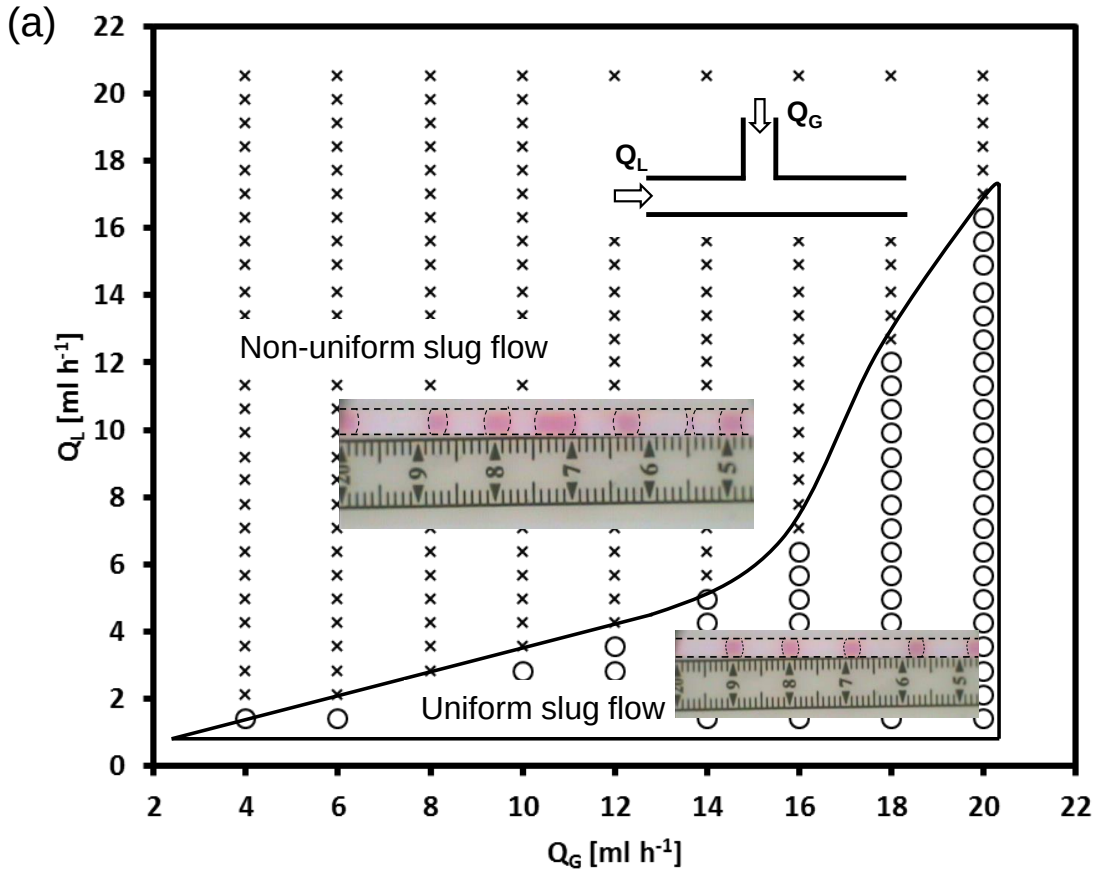
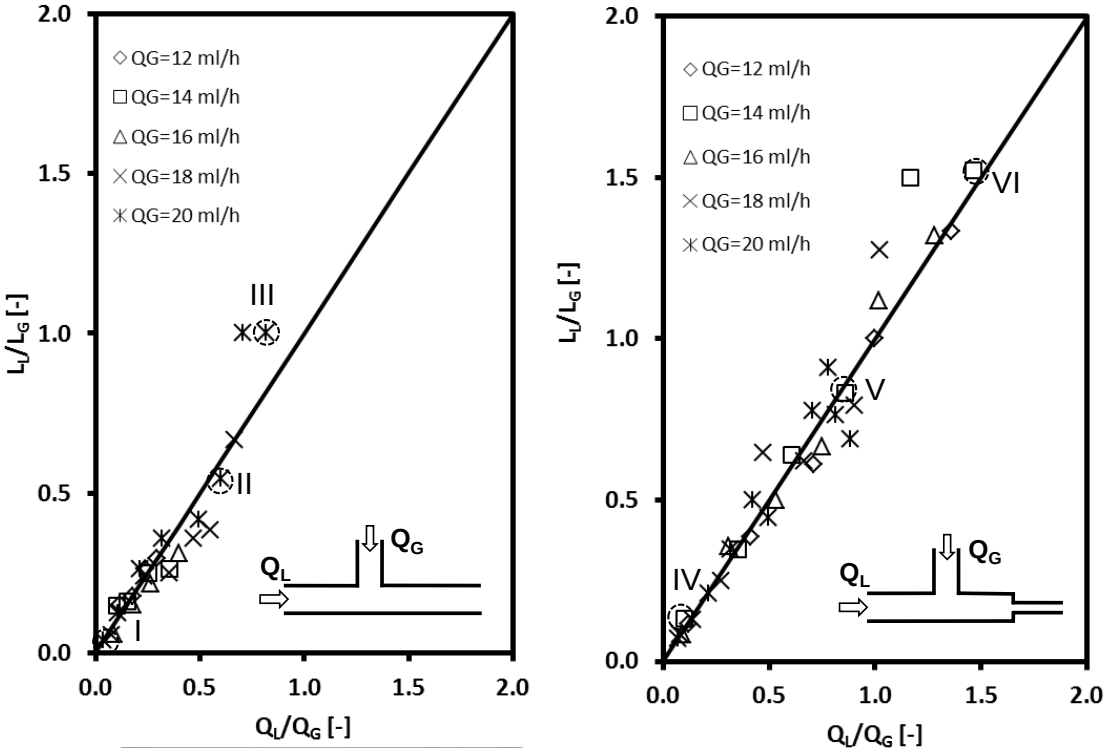
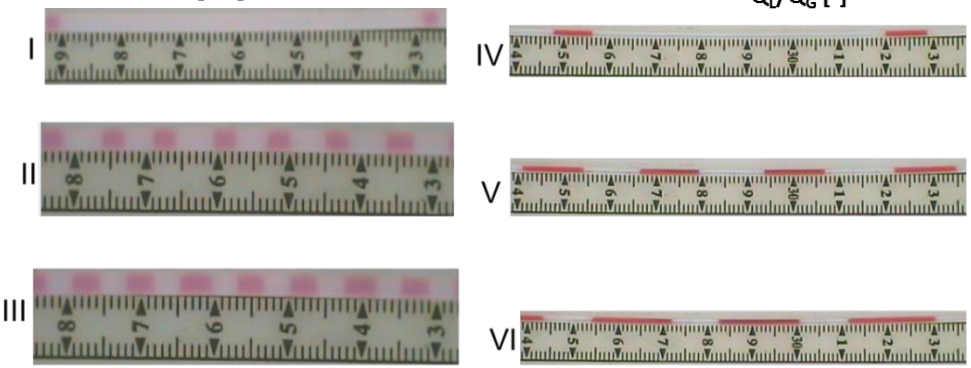


Challenge #1: prediction slug/droplet sizes





Reis and Nemeba (unpublished) - CONFIDENTIAL

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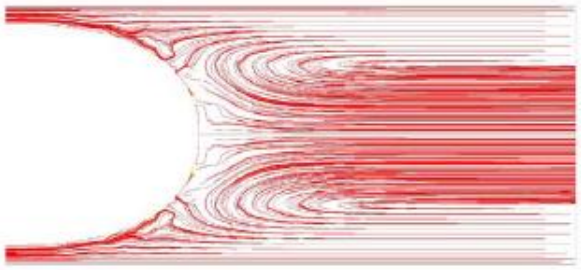
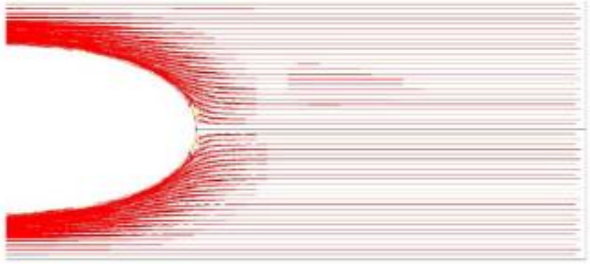
Challenge #2: can we predict recirculation & mass transfer within liquid slugs?

e.g. Recirculation inside the liquid slug (Taha and Cui, 2004)



$Ca = 0.03$



$Ca = 1.34$

Capillary number

$$Ca = U\mu/\sigma$$

U: flow mean velocity

μ: liquid viscosity

σ: interfacial tension

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References

- Unpublished experimental data is available (slug sizes and mass transfer) to help validating the numerical model

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