Information sheet

PERLEMAX

## Aims

To develop and commercialise the use of novel microbubble technology (Fluidic Oscillation) for the Waste Water Treatment Industry.

In conjunction with all stakeholders to develop the application of the Microbubble Technology to create sustainable operation with energy efficiency

To promote gas exchange by tuning dosing and capturing off gases for the integration of biological treatment units for CO2 emissions neutrality and bioenergy production.

# Microbubbles in Wastewater Aeration

### Wastewater aeration economics overview

Estimated Total UK Market Size to 2020: £37.5M @ 20% energy reduction (with only change to introduce fluidic oscillators) to £150M @ 80% expected energy reduction (changing operating conditions to take advantage of greater aeration rates.)

Pilot plant facility for wastewater aeration (Yorkshire Water)

Of 9351 UK Water Treatment Works (WWTW) a significant proportion are small scale works which are unlikely to use aeration technology.

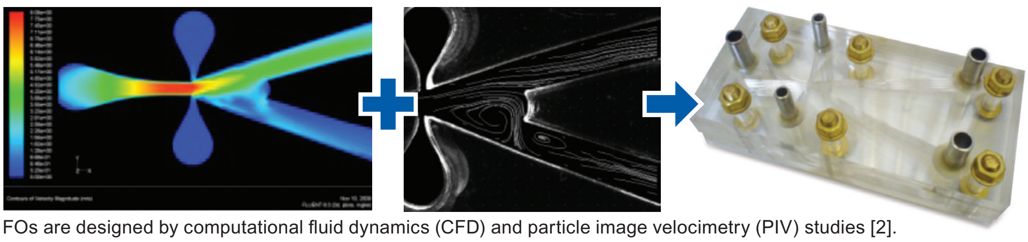
To estimate the market size the following has been assumed.

- 66% of all plants serve small populations on average 2,500 p.e. and do not use aeration technologies:total of 15M p.e.
- 100 very large plants serve populations on average 150,000 p.e. and all use aeration technologies:total of 15M p.e.
- Approximately 3000 plants serve mid size populations on average 10,000 p.e. with 50% of these plants using aeration technology.
- Capital investment in WWTW means a further 5% of UK p.e. will be served by aerated plants over the next 2 AMP periods to 2020.

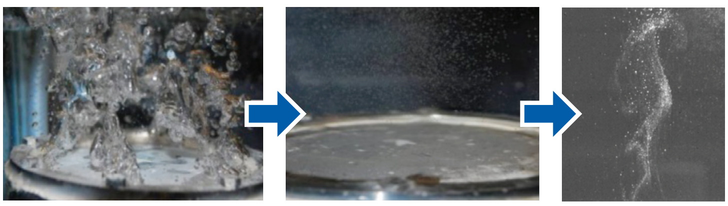
This suggests that in total 33M p.e. will be served by aerated WWTW by 2020. An estimation of total energy consumption for this p.e. has been made using the blower figures for a works of 10,000 p.e.

## Microbubble Technology

The key device for microbubble generation is the fluidic oscillator (FO). The fluidic oscillator has no moving parts and does not require any external energy input for its operation. It works by limiting the growth of bubbles produced in percolation by restricting growth time to one half of the oscillation period. Compared to larger bubbles that have the same volume, smaller bubbles have a much larger surface area, hence significantly improved mass transfer rates.



FOs are designed by computational fluid dynamics (CFD) and particle image velocimetry (PIV) studies [2].



(a) dia. approx. 5-10 mm

(b) dia. approx 80 - 100 μm

(c) dia. approx. 20 - 30 μm

Bubbles produced

a) Without FO

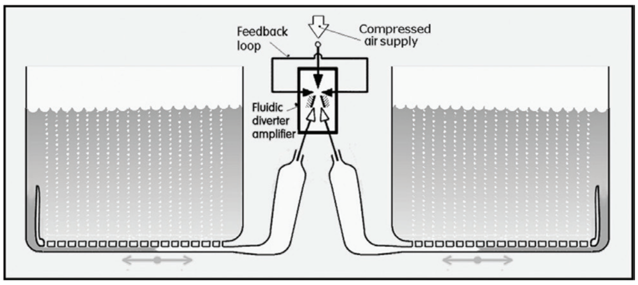
b) With FO

c) With FO and optimized conditions

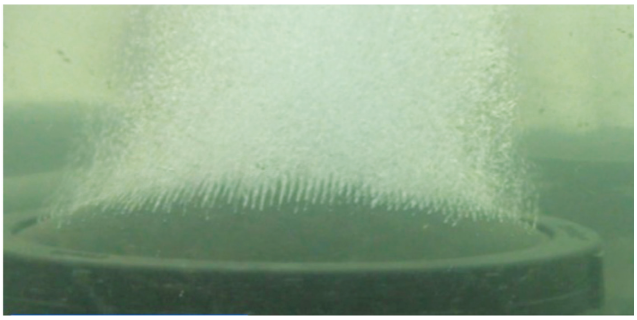
Perlemax • 40 Leavygreave Road • Sheffield S3 7RD • United Kingdom
tel. +(44) 114 222 7517 • email. info@perlemax.com • www.perlemax.com

# Aeration in Wastewater Treatment: Pilot trials

Wastewater aeration plants operate typically with a dissolved oxygen level of 1-3mg/L.




Fine bubble membrane slit disk diffusers are the current low capital cost solution for 2mm average bubble diameters (below right).



Introduction of the fluidic oscillator into the air blowing ducts and arranging the piping for nearly equal hydraulic resistance allows the retrofit of existing disk diffusers.

Oscillation causes the slits to open and close more rapidly, cutting the average bubble size 3-4 fold.

Low capital cost and immediate electricity savings.

Provides hydrodynamic stabilisation that avoids bubble coalescence giving 3-4 fold better aeration rates with ~300-500 micron bubbles, up to 50 fold larger with 20 micron sized bubbles. Microbubbles monodisperse & uniformly spaced as they rise.

Microbubbles formed by fluidic oscillation draw 18% less electricity than the same flow rate of steady state flow forming larger bubbles.

Design and construction of fluidic oscillation generator requires no moving parts.

Example 20 micron sized pores – tuned to deliver 300 micron bubbles @ 80 litres/min from 24cmx 24cm diffuser @ 0.5 bar air pressure.

Microbubbles will strip the $CO_2$ from the wastewater as well – more viable bioculture and a second metabolic boost.

## Acknowledgements

Yorshire Water (Martin Tillotson, R&D Manager) for support of the pilot scale aeration study. The 2010 Royal Society Innovation Award - (Brian Mercer fund). IChemE Moulton Medal (2009). Czech Academy of Science research plan AV0Z20760514.

## References

1) Zimmerman W.B., Hewakandamby B. N., Tesař V., Bandulasena H.C.H., Omotowa O.A.:"On the design and simulation of an airlift loop bioreactor with microbubble generation by fluidic oscillation", Food and Bioproducts Processing, Vol. 97, Issue 3, 2009, p. 215, 2009

2) Tesař V., Bandalusena H. "Bistable diverter valve in microfluidics", Experiments in Fluids, in Press, DOI 10.1007/s00348-010-0983-0

## More information

http://eyrie.shef.ac.uk/steelCO2/awards.html - particularly the Royal Society video!