Investigation of physiological heterogenity in membrane-aerated biofilms

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Introduction: The membrane aerated biofilm reactor (MABR) can be expected to find widespread application for high-rate aerobic wastewater treatment. It's principal advantage is ability to deliver high oxidation rates while maintaining a high conversion efficiencies.

Aims: The aim of this recently initiated research project is to use a scale-down methodology as part of a wider objective to develop the potential of the MABR as a viable bioprocess. It is expected that an improved understanding of underlying reaction-diffusion mechanisms in membrane-aerated biofilms will contribute to a rational scale-up strategy for the bioreactor. In this project, particular emphasis will be placed investigating the effect of nutrient gradients on spatial physiological heterogeneity in the biofilms.

Methods: Laboratory scale bioreactors have been designed to tightly control process conditions combined with the ability to conduct a range of in situ measurements. A combined experimental and mathematical modelling approach is employed to investigate reaction-diffusion mechanisms.

Non invasive analytical techniques include: effective diffusivity (tracer method), oxygen transfer rate (pressure dynamics method), biofilm thickness (optical projection technique). Spatial solute gradients will be determined using confocal scanning laser microscopy and micro-sensors for dissolved oxygen.

Results: Preliminary experiments have focussed on:
(a) Abiotic mass transfer studies in the scale-down bioreactors.
(b) Development of analytical techniques for biofilm analysis including application of PreSens Microx microsensors to determination of oxygen profiles.
(c) Suspended-cell characterisation of a Vibrio natriegens culture
(d) Optimisation of start-up conditions in the MABR utilising Vibrio natriegens as a test organism. Initial results show rapid biofilm growth (Figure 4) and also high oxygen uptake rates.

References: