TRIF MBR - Anaerobic membrane reactor technology for biodegradable waste stabilisation

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Start year	2005	
Finish year	2008	
Funding body	Defra Technology Innovation Research Fund	

• 4-litre reactors for laboratory studies

Introduction

Anaerobic digestion has enormous potential for the stabilisation of biodegradable solid waste streams, allowing for energy recovery as well as diversion from landfill. Effective digestion results in a substantial reduction in mass and a product with low biodegradation potential, allowing for disposal as an inert waste if the markets are not developed for this high-value soil additive and fertiliser product.

Design

Anaerobic digestion of high solids wastes has until now relied on classical CSTR designs. There is significant room for improvement, however, as the low loadings and long retention times required because of low rates of hydrolysis lead to large reactor volumes and high capital and operating costs (e.g. heating/mixing and effluent disposal). These problems can be overcome by introducing a first phase hydrolysis reactor in which the solids and liquids retention times are uncoupled. Methane is then recovered in a second phase high-rate reactor that degrades the volatile fatty acids produced in the first phase, allowing the treated water to be recycled to induce a 'hydraulic flush'. The major problem with this technology has been developing a practical method for uncoupling the solids and liquids retention times. Membrane bioreactors are already used in aerobic treatment on a large

scale, and their use in anaerobic treatment is currently being developed. The aim of this project was to look at the use of membranes both for the retention of partially hydrolysed substrate in the first phase, and for the retention of biomass in the second phase, in order to achieve a step-change in process efficiency and economics.

• Prototype design for first stage of MBR

Outputs

Work was carried out at laboratory scale (3 - 20 litre reactors) in Southampton and at Imperial College, London. It used residual municipal solid waste (MSW) to evaluate: process-relevant characteristics of the material; effect of temperature on rates of solid hydrolysis; which membrane types are suitable for use in each reactor; optimum retention times for both reactors; composition of permeate and optimum recycle ratios; and changes in microbial ecology. The fundamental scientific data collected in the project will allow scale-up to pilot or demonstration scale plants.

Collaborators:

Imperial College

Publications:

Walker, Mark, Banks, Charles J. and Heaven, Sonia (2009) Use of a hydraulic flush reactor in a single and two-stage anaerobic digestion process for biodegradable municipal waste. Environmental Engineering Science, 26, (11), 1599-1606. (doi:10.1089/ees.2009.0021).

Walker, M., Banks, C.J. and Heaven, S. (2009) Two-Stage anaerobic digestion of biodegradable municipal solid waste using a rotating drum mesh filter bioreactor and anaerobic filter. Bioresource Technology, 100, (18), 4121-4126. (doi:10.1016/j.biortech.2009.03.066).

Salter, A. and Banks, C.J. (2009) Establishing an energy balance for crop-based digestion. Water Science and Technology, 59, (6), 1053-1060. (doi:10.2166/wst.2009.048).

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