University of Birmingham

Dr Cynthia Carliell-Marquet BSc(Hons), MScEng, PhD

Senior Lecturer in Water and Environmental Engineering
Deputy Undergraduate Admission Tutor

School of Civil Engineering (/schools/civil-engineering/index.aspx)

Contact details

Telephone +44 (0) 121 414 5140 (tel:+44 121 414 5140)

Email c.m.carliell@bham.ac.uk (mailto:c.m.carliell@bham.ac.uk)

School of Civil Engineering
University of Birmingham
Edgbaston
Birmingham
B15 2TT
UK

About

Dr Cynthia Carliell-Marquet, a Senior Lecturer in Water and Environmental Engineering at the University of Birmingham, is a leading researcher in resource recovery from anaerobic digestion of biomass wastes. Dr Carliell-Marquet has been doing research in the field of anaerobic digestion for 20 years. Her experience spans industrial anaerobic treatment, co-digestion, behaviour of metals and phosphorus in anaerobic digesters, physical mixing of digesters and smaller-scale, decentralised anaerobic digestion facilities.

She has published twenty-eight papers that have been cited more than four hundred times and was awarded the Institution of Civil Engineers Robert Alfred Carr prize in 2011 for her paper “Inorganic Profiles of Chemical Phosphorus Removal Sludge”. Dr Carliell-Marquet has been successful in winning research funding from the EPSRC and the UK Water Industry and is currently working on international projects with researchers in India, Switzerland, South Africa, and Australia.

Qualifications

Lecturer in Water and Environmental Engineering:

- Postgraduate Certificate in Learning and Teaching in Higher Education, University of Birmingham, 2002
- PhD in Civil Engineering, Loughborough University, 2001
- MScEng in Chemical Engineering, University of Natal, South Africa, 1994
- BSc Hons in Microbiology and Plant Pathology, University of Natal,South Africa, 1992
- BSc in Biochemistry and Microbiology, University of Natal, South Africa, 1990

Biography

Dr Cynthia Carliell-Marquet trained as a microbiologist and biochemist at the University of Natal (South Africa), then went on to do a postgraduate Research MSc in Chemical Engineering (University of Natal) where she applied her microbiological background to industrial wastewater treatment by developing an anaerobic biological system for removing colour from textile dye wastewaters. This was followed by a move to the UK and a PhD in Civil Engineering (Loughborough University, UK), this time focussing on metal and phosphorus chemistry in anaerobic digesters. Cynthia joined Civil Engineering at Birmingham as a lecturer in Water and Environmental Engineering, in 1999.

Dr Carliell-Marquet’s research activity is best described as resource recovery from wastewater and, in particular, from the anaerobic digestion process. Within this, primary interests are biological methane production from biomass wastes and the biochemical and physical factors that increase or hamper methane production rates, together with recovery of mineral resources (phosphorus, nitrogen) from digested biomass wastes.

She has recently won three EPSRC CASE award grants related to biomass AD and phosphorus recovery from wastewater, the first of which (trace element supplementation to boost biogas from digesters) has led to a successful Knowledge Transfer Partnership award that will see the outcomes applied to the Water industry during 2011-2012. The most recent CASE award (Closing the loop for phosphorus) attracted considerable interest from the UK Water Industry, with 14 parties (including all the major UK water companies) signing up to support the research. This research is leading the area in the UK and has resulted in her being invited to join, in 2011, an ambitious world-wide research project on global phosphorus security (Global TraPs) led by ETH, Zurich. Dr Carliell-Marquet’s research group have also been very involved in the setting up and running of the Global Phosphorus Network (http://globalpnetwork.net), which was newly launched at the Sustainable Phosphorus Summit in Arizona in January 2011. The Global Phosphorus Network provides a virtual meeting place for the emerging international research community working on phosphorus and food security.

Teaching

Teaching Programmes

- Water Supply and Treatment (CE3WST)
- MEng Individual Research Project (CE4A4)
- Water Quality Management (CE5WQM)
- Water and Environmental Management (CE5WEM)
- Management and Research (CE5MAR)
- Industrial Research Project (CE5IRP)

Postgraduate supervision

- Optimising methane production from anaerobic digestion (3 PhD projects)
- Metal speciation in wastewater and sludge (2 PhD projects)
- Phosphorus recovery from water and wastes (3 PhD projects)

PhD opportunities

Research

RESEARCH THEMES

Dr Carliell-Marquet's research falls within the broad theme of resource recovery from waste and covers two distinct areas:

The first area, and where she has spent most of her research career, is the anaerobic digestion process. Dr Carliell-Marquet is particularly interested in developing our knowledge of biochemical reactions at the cellular level and relating this knowledge to operational and engineering aspects of these systems to maximise methane recovery and improve system resilience and robustness. A significant part of her current research is aimed at understanding the complex metal-microbe reactions that occur in anaerobic digesters, which involves laboratory experimentation and equilibrium speciation modelling to understand the factors that render metals bioavailable or unavailable within digesters. The goal of this research is to predict how a digester will react to changes in the metal balance within the digestion environment and to use these predictions to enhance process performance and methane recovery. As part of this on-going research, her research group is also trying to understand the relationship between acetate-to-methane conversion rates, methanogenic populations and the inorganic environment in sludge digesters. A third aspect of the anaerobic digestion research is investigating the implications of digester mixing on biological methane production, relating the physical aspects of digester mixing to methanogenic diversity and biochemical reactions rates.

The second area of research is recovery of phosphorus from wastewater and organic wastes. Current projects include an assessment of global phosphorus reserves to determine when and how phosphorus recovery could become an economically viable proposition for the UK Water Industry. Combining both the anaerobic digestion and phosphorus recovery elements is a second project which aims to determine how phosphorus recovery can be sustainably combined with energy recovery for various scales of anaerobic digestion facilities, both in the UK and India.

RESEARCH ACTIVITY

2011-2014 Global transdisciplinary processes preparing for sustainably coping with phosphorous from a supply chain perspective (Global TraPs). This project is led by ETH, Zurich, our contribution is to the phosphorus recycling node.

2011-2012 Building biogas profiles for anaerobic sludge digesters to benchmark biogas potential and boost this with nutrient supplementation. Knowledge Transfer Partnership, Severn Trent Water Ltd.

2011-2014 Combined resource recovery of energy and phosphorus from wastewater and agricultural wastes. Collaborative research project with TERI University (India) funded by the College of Engineering and Physical Sciences, Birmingham.

2010-2014 Towards closed-loop phosphorus management for the UK. EPSRC CASE Award with UK Water Industry Research.

2010 -2014 Increasing the efficiency of anaerobic waste digesters by optimising flow patterns and producing more renewable energy, EPSRC CASE Award with Severn Trent Water Ltd.

2007-2011 Nutrient supplementation to enhance biogas production from anaerobic sludge digesters. EPSRC CASE Award with Severn Trent Water Ltd.

2002 – 2006 Effect of iron dosing for chemical phosphorus removal on biogas production from anaerobic digesters. EPSRC First Grant.

Publications

Bateman A, van der Horst D, Boardman D, Kansal A and Carliell-Marquet CM (2011) Closing the phosphorus loop in England: the spatio-temporal balance of phosphorus capture from manure versus crop demand for fertiliser. Accepted for publication in Resources, Conservation and Recycling, June 2011.

Oikonomidis I, Burrows LJ and Carliell-Marquet CM (2010) Mode of action of ferric and ferrous iron salts in activated sludge. Journal of Chemical Technology and Biotechnology, 85 (8) pp 1067-1076.

Carliell-Marquet C, Smith J, Oikonomidis I and Wheatley A (2010) Inorganic profiles of chemical phosphorus removal sludge. Proceedings of the Institution of Civil engineers: Water Management, 163 pp 1-13. [Awarded the ICE Robert Alfred Carr Prize for best paper in 2011].

Roussel J, Ishaq F, Renshaw J, Buckley CA and Carliell-Marquet CM (2010) Metal analysis in anaerobic digester sludge – a preliminary investigation. Proceedings of the 12th World Congress on Anaerobic Digestion (IWA Specialist Conference) in Guadalajara, Mexico, 30 October - 4 November 2010.

Ishaq F, Roussel J, Bridgeman J and Carliell-Marquet CM (2010) Increasing economic performance from sludge digesters using trace element supplements. Proceedings of the 12th World Congress on Anaerobic Digestion (IWA Specialist Conference) in Guadalajara, Mexico, 30 October - 4 November 2010.

Carliell-Marquet CM, Auty D and Marquet R. Sewage Sludge – challenge or asset? Water and Sewerage Journal, vol 1 (2009), pp 37 – 39. Online at **http://www.waterjournal.co.uk/ (http://www.waterjournal.co.uk/)** .

Hudson, N., A. Baker, D. M. Reynolds, C. Carliell-Marquet, and D. Ward (2009), Changes in freshwater organic matter fluorescence intensity with freezing/thawing and dehydration/rehydration, J. Geophys. Res., 114, G00F08, doi:10.1029/2008JG000915.

Smith JA and Carliell-Marquet (2009) A novel laboratory method to determine the biogas potential of iron-dosed activated sludge. Bioresource Technology, 100 (5) pp 1767-1774.

Smith JA and Carliell-Marquet (2008) The digestibility of iron-dosed sludge. Bioresource Technology, 99 (18) pp 8585-92.

N. Hudson, A. Baker, D. Ward, D. Reynolds, C. Carliell-Marquet, S.Browning (2008) Can fluorescence spectrometry be used as a surrogate for the Biochemical Oxygen Demand (BOD) test in water quality.

Expertise

Anaerobic digestion; the microbiological production of methane; phosphorus – global phosphorus security to phosphorus capture from water and agricultural wastes

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