Environmental Biotechnology Network (EBNet)

Summary of outcomes fomr the workshop on:

Sludge modelling: best practice, challenges and opportunities

Hosted by the EBNet Engineering/Biology theme

Novotel Hotel, York, 4 - 5 December 2024

Workshop participants

John Bridgeman, University of Liverpool (*Co- convenor*)
James Chong, University of York
Tom Curtis, Newcastle University
Ziye Dai, Severn Trent Water
Davide Dapelo, University of Liverpool
Sonia Heaven, University of Southampton (*Co-convenor*)
Michael Short, University of Surrey
Tom Taylor, Yorkshire Water
Jim Wicks, The Fluid Group

Supported by

Louise Byfield, EBNet Co-Manager
Angela Bywater, EBNet Co-Manager

Cite as: EBNet, 2025. Summary of outomes from the workshop on: Sludge modelling: best practice, challenges and opportunities. EBNet Engineering/Biology theme. https://ebnet.ac.uk/resources/.

Contact:

Prof Sonia Heaven, University of Southampton, S.Heaven@soton.ac.uk
Environmental Biotechnology Network ebnet@ebnet.ac.uk

Biotechnology and Biological Sciences Research Council
EBNet Environmental Biotechnology
The Carbon Recycling Network
Engineering and Physical Sciences Research Council

Executive Summary

Recent years have seen an increase in the development of approaches to modelling the flow and mixing of sludge amongst a relatively small group of academic researchers.

The modelling of sludge flow is complex, being a non-Newtonian fluid phase with an entrained solid phase, often mixed by injected gas bubbles over time periods of days. Recent developments have extended the modelling techniques which now encompass lattice Boltzmann approaches as well as finite volume computational fluid dynamics (CFD). The challenge of coupling a biokinetic model with a hydrodynamic model to optimise mixing remains an open question. Other challenges include the heterogeneity and spatial and temporal variations in sludge quality, and the multiscale nature of mechanisms and processes at play.

Sponsored by the Environmental Biotechnology Network and falling within the remit of its Engineering / Biology theme which considers interactions between microbial and engineering factors, this two-day workshop brought together sludge flow modellers with microbiologists and end users to discuss best practice, challenges and opportunities in sludge predictive behaviour from both a flow and biogas generation perspective. Specifically, the workshop considered the following questions:

1. Who is doing what, where and what are the recent innovations?
2. What are the challenges? What is preventing developments in certain areas?
3. What is, or might be, the role of AI / ML / NN in sludge modelling?
4. What does the industrial community want from sludge predictive behaviour?
5. How can we develop, drive and sustain a national or international sludge predictive behaviour network?

The key R&D priorities arising from the workshop are summarised as:

Modelling:

- The need to link microbiology and CFD with an improved understanding of the biology of AD systems
- Consideration of AD as a system comprising: operations, storage, emissions, varying electricity prices, energy usage.
- AI-enabled individual models
- Parameterising the biology to apply to a CFD model – i.e. achieve a 6% feed and 3% product in a model
- Compartmentalise mixing in reactors – how achievable is this in practice?

Operations:

- Asset optimisation with limited budget and reduced staffing levels.
- Reducing secondary emissions
- Maximising gas production and minimising energy use
- Addressing the feedstock – *i.e.* tailoring the feedstock to maximise gas production

Data:

- Accurate sludge characterisation to drive change in sludge management – which parameters?
- Quick and accurate sampling techniques

UKRI Biotechnology and Biological Sciences Research Council | EBNet Environmental Biotechnology | UKRI Engineering and Physical Sciences Research Council