AquaEnviro

Modelling Techniques for Optimising Wastewater Treatment Plant Performance

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TheStudio, Leeds

Consultancy and events in environmental science and engineering

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Event Outline

A wide range of modelling tools is now readily available to aid in the design, operation and optimization of wastewater treatment processes. Mathematical models of the biological treatment process developed slowly from the late 1960s and with a huge leap forward with the introduction of the Activated Sludge Model (ASM in 1989). This evolved to incorporate nutrient removal processes and simplify the calibration such that ASM3 is now a widely used and respected tool. Although libraries are freely available that contain components of ASM3 to build treatment models, commercial versions such as GPS-X, Simba and BioWin are more user friendly and thus with a wider usage. Freeware models such as STOAT are also available with their own user groups. These models can help designers to predict the performance of plants and thus give confidence to the Client that is will prove fit for purpose. They can also help operators to take cost-effective and timely remedial actions to ensure consistent treatment efficiency whilst meeting discharge consents. As improved on-line monitoring sensors and instrumentation becomes more readily available and affordable, these models are now being applied to real-time control of the treatment process. Data from sensors provides the input for the models and the model output can then be used to control, for instance the MLSS and dissolved oxygen concentration in the aeration basin.

But as well as modeling the biological processes that occur in the basin, application of computational fluid dynamics (CFD) to modelling, also permits the performance of the physical structure to be modelled and optimized. The flow velocities within unit processes such as primary and final settlement tanks, whose performance relies both on achieving quiescent conditions within the tank and controlling operation to match the settling properties of the MLSS, can be visualized using CFD. In this way placement of baffles and other peripheral equipment can be undertaken to minimize these velocities and thus enhance settlement.

But these models are sophisticated tools and their successful application requires an understanding of their limitations as well as the input data that is necessary to ensure their effectiveness. It is the aim of this event to examine those models that have found widespread usage in the UK. By use of case studies it will explore their effectiveness and seek to understand the information necessary for their successful application.

Programme

Simulation for optimizing STW power demand and opex
Peter Dold, EnviroSim Associates

Integrating whole plant simulation with assessment of power requirements and opportunities for energy recovery, consumption of chemicals, sludge disposal costs, etc. enables comprehensive evaluation of optimization alternatives while meeting effluent limits.

- Assessing power needs including: aeration, mixing, pumping, other mechanical power, site HVAC, heating streams for anaerobic digesters and thermal hydrolysis,
- Opportunities for energy recovery
- Process performance evaluation and opex assessment

Balancing Energy Use and Effluent Quality in Wastewater Treatment using Plant wide Modelling
Benoit Chachuat, Imperial College

- The water sector in the UK is legislated to protect to protect receiving water quality, but is also required under the UK Climate Change Act to reduce carbon emissions, two potentially conflicting requirements
- A plant-wide modelling and optimisation approach can quantify the impacts of current and potential future WWTP effluent quality constraints on energy use and fugitive GHG emissions.
- This methodology has been applied to two WWTPs: one discharging to an inland waterway and the other into the ocean.
- As well as having direct operational implications in terms of treatment cost and quality, this approach takes a step forward to enabling better planning and upgrading of treatment facilities by considering the whole environmental picture

When Process met Hydraulics
Chris Robinson, Principal Consultant, MMI Engineering

Process modelling – when is it worth the effort?
Jeremy Black, Principal Process Engineer, United Utilities

Process models for waste-water treatment range from the very simple, based on “rules of thumb” to the highly sophisticated, such as the Activated Sludge Models (ASM 3 etc.). Given the highly variable nature of waste-waters both in terms of composition and flows, what levels of detail and accuracy are appropriate to make informed decisions? This paper will look at 3 main questions:

- What are the advantages of using sophisticated process modelling rather than simple spreadsheet based ones?
- Which modelling techniques are best at identifying optimisation opportunities?
- Which modelling techniques are best at quantifying potential optimisation benefits?

Where has all my sludge gone?
Simon Jarvis, Principal Modeller, Thames Water

- The use of BioWin to understand the mass balance across an entire works
- Exploring the importance of accurate wastewater characterisation and the role (and accuracy) of BOD measurement
- Evaluating the impact (on opex) of non-optimal PST performance

Structured (ASM) and Data-Driven Models Compared
Matthew McEwan, Principal Engineer, Perceptive Engineering

- Brief explanation of mass-balance approach of structured models such as ASM compared to the advanced regression techniques used for deriving a model from data
- What each technique needs to work (i.e. fundamental equations and design data, vs good quality process data), and what they are used for (clean sheet design vs online optimisation)
- When does each approach work well, and when it works badly and where are they best employed within the asset life cycle (i.e. pilot scale ups vs modelling and optimising a degraded process)

A modelling journey: from small scale dynamic modelling to full scale Real Time Control
Bart Verrecht – Wastewater Treatment Optimisation Specialist, HACH LANGE Belgium

- The PhD perspective: Dynamic modelling for MBR optimisation
- The Engineering Company perspective: The Capex – Opex trade-off
- The Water Company perspective: Elimination of compliance risk and opex reduction

Virtual Works™ & myPlant™: Integrated real time optimisation
Charlotte Smith, Principal Process Engineer, MWH

- Mass-energy model coupled to live dashboard
- Predictive performance with target setting
- Real-time efficiency: monitoring and sustaining

An international perspective on modeling for design
Bikram Sabherwal and Andrew Shaw, Black and Veatch

- This presentation will start with a description of the good modeling practice unified protocol developed by the International Water Association (IWA) task group.
- Several examples will be given showing the use of process models for design from an international perspective (examples from North America, Australia and Singapore)

The presentation will conclude with some perspectives on where modeling is going next, including an overview of the capabilities of newer simulators such as SUMO and SIMBA2 that are being developed on both sides of the Atlantic.

Coupling biokinetic and hydrodynamic models for optimal wastewater process modelling
Duncan Borman, School of Civil Engineering, University of Leeds

- Developing a framework for modelling wastewater treatment processes that includes both the flow behaviour and biological models such as ASM (Activated Sludge Model). The intention is to facilitate improved modelling of inhomogeneously mixed bioreactors through modelling the coupling between biokinetics and the hydrodynamics.
- Examples will be presented for a range of bioreactors with incomplete mixing, demonstrating that although average values in the coupled model for the biomass growth can be similar to those of the bulk solution, significant local variations are still present.
- Coupling a biokinetic growth model with a multidimensional computational fluid dynamic hydrodynamic model. This coupling enables the investigation of how nonhomogeneous mixing in bioreactors can affect bioreactor operation. This is particularly important where bioreactors have incomplete or intermittent mixing, which can result in reactor instability when high local concentrations of certain biomass species are found.

Venue

The Studio
Riverside West, Whitehall Road Leeds LS1 4AW
http://www.studiovenues.co.uk

Booking

To register online please visit www.aquaenviro.co.uk or email Clare for a booking form
e. clarehunter@aquaenviro.co.uk

Fees

Full Delegate £320 + £64 VAT = £384
Students, Academics and Charities £100 + £20 VAT = £120