National Biofilms Innovation Centre

Case Study

INNOVATIONS IN WASTEWATER TREATMENT

Assisting the academic community to find the right industrial partner

The Wastewater treatment (WWT) market is estimated to be worth over $300bn worldwide, yet globally 44% of municipal wastewater is not treated safely, with up to 2.3bn people not having access to basic sanitation. Recent news reports about sewage release into the UK's waterways have highlighted several grand challenges associated with this process. Researchers at the University of Edinburgh, in collaboration with Veolia UK, have been investigating three strands of research helping to address this. Dr Gavin Melaugh, Professor Cait MacPhee, Dr Efthalia Chatzisymeon, Dr Ryan Morris and PhD students Anne-Maelle Penot and Holly Bridge are working on these projects in collaboration with Paul Banfield, Technical Operations Manager at Veolia UK.

Understanding how filamentous cells impact flocculation in activated sludge (AS)

In collaboration with Veolia and ETH Zurich, researchers have performed a systematic study on the activated sludge bacteria *Comamonas denitrificans* to understand how bacterial cell length impacts connectivity in aggregating suspensions of cells. This work was initiated by an NBIC Proof of Concept award and the team now have a new PhD student (Holly Bridge) developing the research further through agent-based modelling.

Developing the Sludge Characterisation Platform (SCP)

There has been little modernisation in WWT over the last 100 years. For example, in this era of sophisticated software, e.g., AI, sludge health is still assessed by periodic visualisation of WWT samples under the microscope and relies heavily on the expertise of the operator. In collaboration with Veolia, Dr Melaugh and his team were awarded an Impact Acceleration Award (IAA) to develop the Sludge Characterisation Platform (SCP); a machine learning tool for AS health.

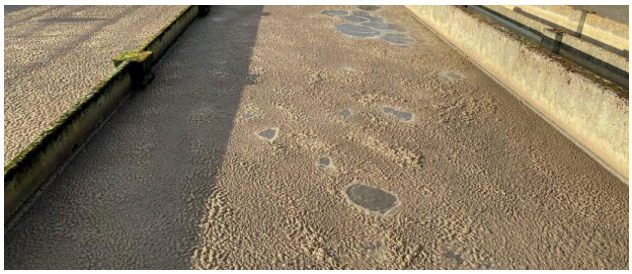
In the 9-month IAA, the team successfully trained the SCP using the library of images provided by Veolia, and after optimising the parameters, the SCP was then used to assess unseen microscopy images of the sludge as either "healthy" or "unhealthy" with an accuracy of up to 85%. They are currently exploring funding options to develop this technology further.

Understanding the microbial generation of nitrous oxide in WWT

Nitrous oxide (N_2O) is generated as a microbial metabolic by-product in nitrogen-removal processes in WWT. It is ~300 times more potent than CO_2 and is the main contributor to ozone depletion. As a result of regulatory pressure, there is now a need for WWT companies to develop methods to detect N_2O, as well as understand how the microbes can be manipulated in order to reduce its release into the atmosphere. As a result, Veolia have sponsored a PhD studentship (Anne-Maelle Penot) in collaboration with the School of Physics and Astronomy and the School of Engineering at the University of Edinburgh in order to develop an understanding of N_2O-generating bacteria in WWT.

Dr Gavin Melaugh said,

"The initial funding from the NBIC Proof of Concept award was crucial in seeding the team's now long-term collaboration with Veolia UK".



Foam forming on the aeration tank in Veolia's Newbridge WWT facility. The foam is caused by the proliferation of filamentous organisms.

Dr Gavin Melaugh

Dr Gavin Melaugh is a Chancellor's Fellow at the University of Edinburgh, joint appointed between the School of Physics and Astronomy and the School of Engineering. He leads a group that uses a combination of experiments, microscopy, and computer simulations to understand the collective behaviour of microorganisms in the natural environment and in biotechnological processes. Dr Melaugh has been a core team member of NBIC since its formation in 2017.