Policy Brief: Wastewater

INNOVATION IN WASTEWATER & THE ROLE FOR BIOFILM TECH

Science Biofilms are communities of microorganisms - bacteria, archaea, fungi, protozoa and viruses – that represent the predominant lifestyle of microbial life on earth. Research on biofilms is fundamentally interdisciplinary, including microbiologists, engineers, physicists, mathematicians, chemists, geologists and beyond. Biofilms research can significantly enhance wastewater treatment by leveraging the unique properties of biofilms.

Microorganisms are intrinsic to wastewater treatment. So called "activated sludge" systems consist of microbial communities suspended in waste streams where they degrade organic components to produce high-quality outflows. A constant supply of oxygen is needed. After aeration, the microbial communities are allowed to settle as sludge, which is then either reused in the next cycle, or processed for further use. Alternatively, "attached growth" systems employ microbial communities adhered to solid supports such as gravel (e.g. in trickling filters), membrane bioreactors or rotating biological filters.

KEY INFRASTRUCTURE CHALLENGES

- Capacity: The largely Victorian sewer system was not built to accommodate the significant population growth and urban expansion that has occurred since the 19th century.
- Age: Old pipes and treatment facilities are prone to leaks and blockages, requiring frequent maintenance and repairs.
- Climate Change and Flooding: During heavy rainfall, the combined system of surface water and sewage can overflow, leading to untreated waste entering rivers and seas. Phosphorous reduction targets [1]: phosphorous release from treated wastewater can cause algal blooms and oxygen starvation. The Environment Act 2021 sets an ambitious target of an 80% reduction in phosphorous emissions by 2038 and a 50% reduction in the next 4 years.
- Greenhouse gas emissions: existing wastewater treatment processes can lead to emissions of difficult-to-measure "fugitive" greenhouse gases.

The need for innovation in the UK's wastewater system is clear, and while there are challenges, there are also ongoing efforts and potential strategies to address them. The success of these initiatives will depend on continued investment, innovation, and collaboration across sectors and stakeholders. Harnessing innovation in microbial and biofilm science will provide a partial solution to many of these challenges. NBIC is well-placed to address many of these issues from various perspectives given its multi- disciplinary approach.

WE RECOMMEND

- Investment in Infrastructure: Substantial funding is needed to replace and/or upgrade the aging network with more modern, efficient, and resilient biofilm-based systems, and to re-invent wastewater infrastructure.
- Investment in research: developing new materials for more effective prevention of 'bad biofilms' and promoting formation of 'good biofilms' for removal of phosphorous and remediation of e.g. metals, pharmaceuticals or "forever chemicals" (PFAS/PFOA).
- Improved design: enabling automation, utilising biofilm communities to track and remote sense environmental pollutants and pathogens. Recover resources for use in the circular economy.
- Enhanced performance and innovation: decrease emissions of greenhouse gases as a by-product of microbial activity e.g. nitrous oxide. Additional investment in technologies to harvest energy through use of microbial electrochemistry.
- Public Engagement: involve local communities in wastewater management and adopting sustainable practices.
- Public-Private Partnerships: Collaboration between the government and private sector can accelerate the development and implementation of infrastructure projects.

[1] UK Government Plan for Water.