University of Surrey & Thames Water Utilities Ltd.

Engineering Doctorate

Evaluation of Robust, Low Energy Wastewater Treatment Systems for Small Populations

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ABSTRACT

The aim of this research is to evaluate the potential of low energy wastewater treatment processes to meet UK performance requirements, with respect to an increasingly strict regulatory framework

This research proposes the implementation of double filtration trickling filters (TF) operating in series without the requirement for intermediate settlement. Performance data is analysed and presented to demonstrate how a 50-80% biological offload of organic carbon (BOD) using a primary plastic media TF can enhance nitrification of existing conventional TFs. This configuration is capable of providing 97.4%, ammoniacal nitrogen (NH_4-N) removal with effluent concentrations as low as 1.2mg/L.

Process performance data from 120 TF wastewater treatment works (WWTW) are analysed in order to evaluate the relative nitrification performance of TF WWTWs, both with and without aerated tertiary nitrifying processes. Multivariate regression analysis whilst considering flow, temperature and infiltration determines that tertiary nitrification contributes to a significantly higher risk of NH_4-N consent being exceeded during colder winter periods. This directly challenges the current strategy of adopting tertiary processes for enhancing nitrification on TF WWTWs.

A decentralised facultative aerated lagoon (FAL) system with novel mixing and point source aeration is investigated and evaluated to determine its suitability for offloading existing WWTWs. Computational fluid dynamics (CFD) modelling describes the systems complex hydrodynamics and is validated with an experimental tracer study. Overall, this study showed that low energy mixing is capable of preventing hydraulic short circuiting and thermal stratification, which are notorious for reduced performance in traditional waste stabilisation pond variants.

To my family. I couldn't have completed this without you. Thank you for all of your incredible support along the way.

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