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Micropollutant Removal in Sustainable Biological Wastewater Treatment Systems

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Background/Objectives. Concerns over the effects of chemicals in the aqueous environment has seen the introduction of more stringent water quality regulations and tertiary treatments using advanced oxidation processes such as ozonation. These interventions make existing wastewater treatment more energy-intensive; as just aeration in activated sludge alone accounts for up to 1.5% of UK electricity use. The transition to carbon-neutral wastewater treatment will require the adoption of low-energy biological treatment systems that operate with little or no active aeration, such as those extensively used in Latin America (up-flow anaerobic sludge blanket reactors; UASBs and waste stabilisation ponds; WSPs). However, little is known about the true biological limits of micropollutant removal especially in these low-energy systems.

Approach/Activities. This project intends to shed some light on this by comparing micropollutants removal by these low energy systems to conventional activated sludge ones. We started off by validating analytical methods for the quantification of triclosan and priority PAHs in both wastewater and solids using solid phase extraction and gas chromatography with mass spectrophotometry (SPE-GC-MS). This was followed by batch laboratory studies to determine first order biodegradation rates for the chemicals under aerobic and anaerobic conditions.

Results/Lessons Learned. The developed analytical methodology in effluents assured detection limits of 5 ng/L for triclosan, 0.4 – 1.2 ng/L for low molecular weight PAHs and was between 4 and 12 ng/L for high molecular weight PAHs. Recoveries of compounds were mostly between 70 – 130% with an RSD ≤ 20.

Under aerobic conditions, about 75% of triclosan degraded in 7 days, following a pseudo first order kinetics (0.0071 h^{-1}); with controls showing no losses due to volatilization, photo-degradation or chemical degradation. 1.6% of the triclosan was converted to methyl triclosan, suggesting other major primary degradation products. Between 0 and 90% biodegradation of PAHs was recorded from the higher to lower molecular weight PAHs. However, volatilization was observed to contribute hugely to the disappearance of low molecular weight PAHs in the abiotic controls (between 26 and 70%).

We are currently determining first order rates for the chemicals under anaerobic and low-temperature anaerobic conditions. In the final stage, the fate and removal of the selected chemicals will be assessed in full-scale UASBs and WSPs from Brazil compared to conventional systems.