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Mainstream SCEPPHAR configuration for integrating P and PHA recovery in the water line of WWTPs

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Abstract: This work presents a novel pilot-scale configuration, mainstream SCHEPPAR (Short-Cut Enhanced Phosphorus and PolyHydroxyAlkanoate Recovery), within the framework of resource recovery. This configuration is designed to: i) efficiently remove C, N and P, ii) recover up to 50% of incoming phosphorus in struvite form, iii) reduce aeration requirements up to 25%, and iv) recover about 9% of influent organic matter as PHA.

Keywords: SCEPPHAR, mainstream, nutrient recovery, struvite; PHA; EBPR

The new paradigm of circular economy requires new technologies for resource recovery during urban wastewater (WW) treatment. This work presents a novel configuration named mainstream SCEPPHAR (Short-Cut Enhanced Phosphorus and PHA Recovery) which is one of the novel technologies tested in the SMART-Plant project (Scale-up of low-carbon footprint Material Recovery Techniques, EUH2020, grant agreement 690323). The SMART-Plant project aims to prove the feasibility of novel WW treatment technologies at pilot-scale towards a circular economy scenario with nutrient recovery, and reduction of energy consumption and carbon footprint.

Mainstream SCEPPHAR aims not only at treating urban WW, but also at recovering P and N as struvite and part of the inlet organic matter as PHA. This configuration is an evolution of the two-sludge system proposed by Marcelino et al. (2011) including resource recovery. The system is based on two sequential biological reactors (SBRs): the HET-SBR performs EBPR by alternating anaerobic/anoxic/aerobic conditions while the AUT-SBR is in charge of nitrification (or partial nitrification process up to nitrite). Regarding P-recovery, this combines EBPR and struvite precipitation from the main water line profiting from the high P concentrations in the anaerobic stage (Acevedo et al., 2015; Baeza et al., 2017; Guisasola et al., 2019). Thus, part of the supernatant rich in P and ammonia is diverted to a precipitation reactor, where pH is increased and $MgCl_2$ is added in order to produce struvite. EBPR performance is constrained by a low concentration of organic matter. Hence, its integration with nitrogen removal via nitrite would decrease the organic matter needs for simultaneous biological removal of N and P (Marcelino et al., 2011).

In a conventional EBPR process, P is removed by purging biomass at the end of the aerobic phase (i.e. where biomass has the maximum internal P-content). This leads to undesired and uncontrolled struvite precipitation in the subsequent anaerobic digestion of this sludge. SCEPPHAR implements a purge at the end of the anaerobic phase, when biomass has the lowest internal P-content, thus decreasing the problems of undesired precipitation. Moreover, the biomass of the purge contains a high fraction of PHA, which is highly beneficial since i) PHA can be used as a precursor for bioplastics production and ii) anaerobic digestion of this sludge produces higher methane yield. The new configuration recovers up to 50% of the inlet P, while aeration savings up to 25% are obtained due to the nitrite short-cut implemented in AUT-SBR and some ammonia removal by struvite precipitation.

The pilot plant started its operation during June 2017. The full presentation will give all the experimental data from two years of continuous operation of mainstream SCEPPHAR including N_2O emissions (e.g. Figure 1 and Figure 2). We will detail successes and hurdles found through this experimental period and give guidelines for a future implementation of this technology at full-scale.

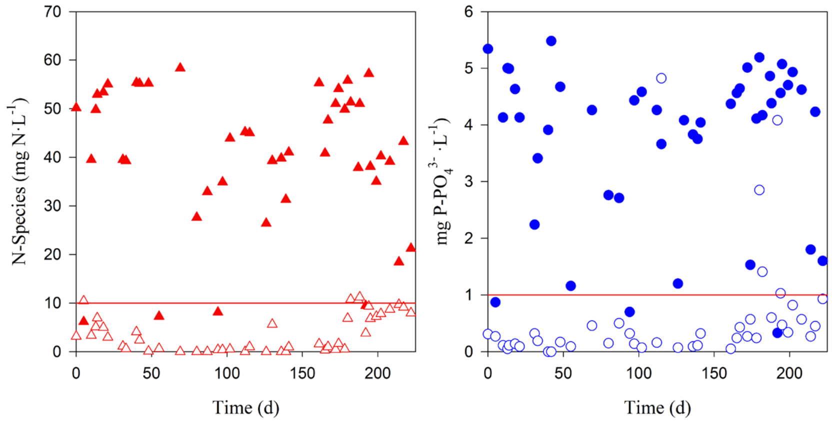

Figure 1 Results of removal during the start-up of the mainstream SCEPPHAR pilot plant. Ammonium at the influent (▲), ammonium at the effluent (Δ), phosphate at the influent (●), phosphate at the effluent (○).

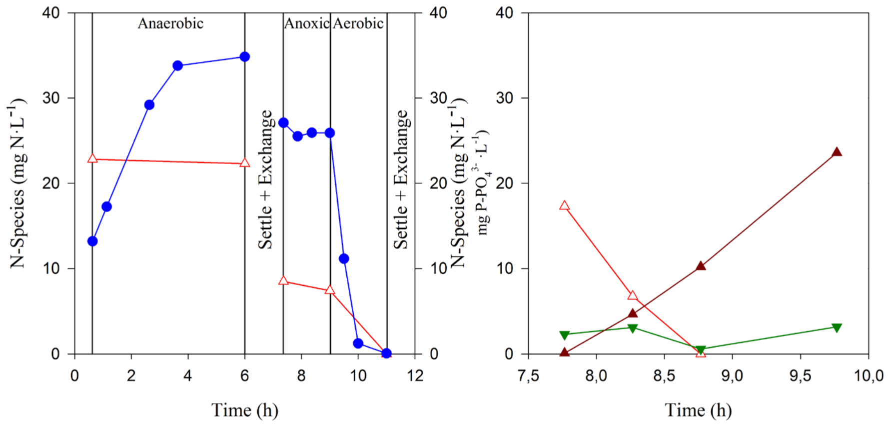

Figure 2 Example of full cycle monitoring of the mainstream SCEPPHAR pilot plant with complete P and N removal. HET-SBR (left) and AUT-SBR (right). Ammonium (Δ), nitrite (▼), nitrate (▲), phosphate (●).

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