Bioedaria

CONAMA 2020
CONGRESO NACIONAL DEL MEDIO AMBIENTE

New biorefinery concept for biogas, biofertilizer and bioplastics production from WWTP sludge.

Facsa ciclo integral del agua

ainia centro tecnológico

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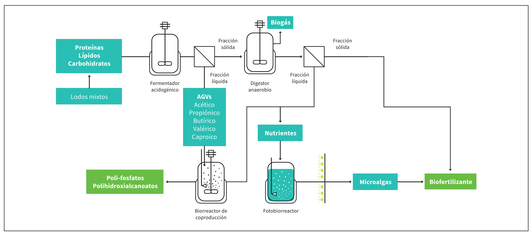
Abstract

Most wastewater treatment plants (WWTP) are based on the activated sludge process, which produces large amounts of sludge as a secondary waste which contains most of the organic and nutrients load form the wastewater.

In the BIOEDARIA project, a new approach for simultaneous **biogas, polyhydroxialkanoates (PHA) and polyphosphates (Poly-P)** production from sewage sludge, with simultaneous **microalgae cultivation**, has been proposed and validated at pilot scale. For this purpose, a novel combination of different biotechnologies including two phase anaerobic digestion (TPAD), PHA and Poly-P enrichment and accumulation reactors (ER & AR) and a high-rate algal pond (HRAP) reactor for microalgae culture has been operated in Alcoi WWTP (Spain).

Introduction

In the proposed process, a stream rich in volatile fatty acids (VFA) and phosphates is extracted from the acidogenic fermenter of a TPDA, to feed the enrichment and accumulation sequencing batch reactors (SBR) where the growth of PHA and Poli-P accumulating microorganisms is stimulated Albuquerque et al., 2010). Moreover, nutrients (namely N and P) from rejected water streams have been recovered by microalgae cultivation to produce biofertilizers (Abdel-Raouf et al. 2012).



BIOEDARIA Biorefinery process diagram.

Methodology

Laboratory and pilot scale experiments have been performed during almost two years. Real sewage sludge and alimentary wastes co-sustrates have been used as feed. Operational parameters have been optimized and regular analysis performed.

LABORATORY SCALE

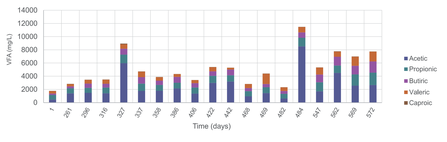
Different stages of the laboratory tests: Left | Anaerobic digestors; Centre | Enrichment reactor; Right | Accumulation reactor.

PILOT SCALE

Different stages of the pilot plant: Left | Anaerobic digestors; Middle | Co-production reactors; Right | HRAP.

Results (1)

TPAD:

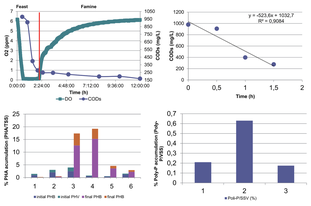


VFA-rich stream produced in acidogenif fermenter stabilized between 4000-8000 mg/l and reached maximum values of 11500 mg/l.

Results (2)

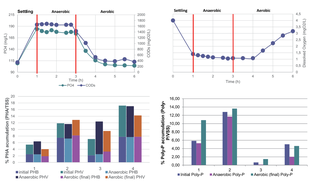
PHA and Poly-P bioaccumulation:

Feast-Famine Strategy:



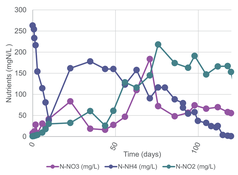
CODs consumption maximum slope in feast –famine cycle is used to determine the feeding rate during accumulation stage. PHA accumulation is has been achieved but no Poly-P.

Anaerobic-Aerobic Strategy:



CODs and phosphate evolution in anaerobic-aerobic cycle shows the PHA and Poly-P bioaccumulation trend, which is confirmed by analytics in each stage.

HRAP:



N evolution in HRAP showed ammonia depletion, partial nitrification and nitrites accumulation.

Conclusions

TPAD system performance has been optimized to maximize VFA production by adding cosubstrates. VFA-rich stream between 4000 and 8000 mg/l of VFA (as CODs) has been produced.

Two different strategies for PHA and Poly-P accumulation has been explored in the coproduction reactors.. Feast famine strategy allows accumulation of up to 19% of PHA but negligible Poly-P is produced. Anaerobic-aerobic strategy allows up to 17% of PHA and 14% of Poly-P accumulation.

Microalgae cultivation in HRAP resulted in difficult operation due to high solids and nutrients concentration in the feed. Assimilation ratios od 10-15 mgN/L·d and 2-3 mgP/L·d for N and P, respectively, have been quantified.

References

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Acknowledgements

The authors want to thank the public entity of sanitation of wastewaters in the Valencian Region (EPSAR) for allowing the operation of the pilot plant in their facilities in Alcoi WWTP. This research has been funded in the 2019 call by the Valencian Innovation Agency (AVI) of the Valencian Regional Government (Spain), reference: INNCAD00/19/061.

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