Research Summary Sheet

Deliverable n°: 4.4

"Protocols for extracting VFAs issued from 2 steps AD and their ecoefficient transformation into bifunctional monomers and biopolymers"

Context and Challenges

Volitile Fatty Acid (VFA) aqueous mixtures were produced in the framework of the project WP3 by acidogenic fermentation processes. VFAs can represent suitable precursors for several added value chemicals and PHA biopolymers. As a whole, the "target residual biomass to VFAs to PHAs" route has been proposed, set up and developed in the framework of NoAW project WP3. Furthermore, fossil-based counterparts have a wide range of applications, among which the production of esters for the chemical sector. However, the relatively scarce VFA concentration in actual fermentation broths hinders their potential exploitation as bio-based substrates. Nanofiltration and reverse osmosis have been previously proposed for the concentration of VFAs; however, dead-end-filtration instead of the conventional industrial cross-flow approach was applied. Furthermore, preliminary evidences had to be integrated with a deep operational parameter screening.

Among possible new VFA valorisation routes, the production of alternative biopolyesters else than microbial PHAs can be pursued, provided that VFA functionalization by the addition of hydroxylic group in the acidic chain is a feasible option.

Results and Applications

In agreement with the NoAW DoA related to WP4, the development of integrated multi-operational strategies for a) VFA concentration, b) VFA functionalization by the addition of the -OH function in the terminal C (ω position) of the acidic chain and c) polyester production by condensation reaction of hydroxylated VFAs were pursued. In particular, membrane-based cross-flow filtration was applied by laboratory pilot-scale plant with the aim of getting scalable results for preliminary feasibility evaluation studies.

Regarding membrane processes, directly scalable experimental data was collected during operational parameter screening, which allowed defining pH as a key process parameter. The screening was followed by the development of a semiempirical model useful for NF/RO process design and simulation. Indeed, the model was used as to evaluate the concentration performances when utilizing (A) only RO modules or (B) RO + NF modules. Best overall economic performances were observed for the latter process configuration.

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Breakthroughs, benefits and added value

No exploitable results were obtained from activity dedicated to VFA functionalization, since the application of bioelectrochemical systems to provide reducing power for the hydroxylation of VFA chain was not effective and no hydroxylated acid production was observed. As a consequence, polyester production by condensation of difunctional compounds was not investigated anymore; as a matter of fact, biopolyesters would have been produced by well-known conventional condensation of carboxylic and hydroxylic functions: no particular technical difficulties are supposed to be associated to this consecutive operation.

Further information on NoAW project: *http://noaw2020.eu*

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