Research Summary Sheet

Summary of Deliverable 3.3

Poly-hydroxy-alkanoates production

Context and Challenges

Agricultural wastes represent nowadays a consistent amount of the waste generated in EU, achieving at least 50% of the fresh harvested crops and hence a huge amount of biomass resources. These streams are often treated via anaerobic digestion to produce biogas. One of the main aims of the NoAW project is the implementation of modified AD processes to produce high added-value products like hydrogen, biomethane and poly-hydroxy-alkanoates.

In particular, among many bio-based biopolymers, poly-hydroxy-alkanoates (PHA) presents some unique features, such as:

1. *microbially synthesized under mild process conditions,*
2. *not a single polymer, but a family of copolymers with largely tuneable properties,*
3. *full biodegradability under both aerobic and anaerobic conditions*

Based on their good properties, PHAs have a very good potential in the bioplastic market, especially provided that the production costs that can be achieved with processes based on agro-waste as feedstock become more and more competitive.

The activity is performed in the frame of Task 3.3, whose aim is to upgrade an AD-based pilot-scale platform (task 3.2) with an ad-hoc designed section, to valorise agricultural waste towards the production of biodegradable bioplastics, namely PHA. The PHA production process is based on aerobic PHA accumulation from selected mixed culture (instead of pure cultures presently used at industrial level) by using a side-stream effluent, rich in volatile fatty acids (VFA), from the first reactor of the 2-phase AD process. This way, we can obtain a full integration of a low-cost PHA production in the overall AD process.

A large pilot-scale plant for PHA production has been designed and operated in the frame of an AD-based platform (task 3.2), located in a farm in the North Italy (Isola della Scala, Verona)

The pilot-scale plant was started up and is presently under operation in order to optimize its performance by using true feedstock (a mixture of manure/straw/grass silage). The feedstock is grinded through a pump and then fed into a fermentation unit of 4 m^3 operated in mesophilic and

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anaerobic conditions at Hydraulic Retention Time (HRT) = 4days) in order to produce Volatile Fatty Acids (VFAs). Then, the same volume is discharged and processed by the screw-press separator. The solid fraction feeds the anaerobic digester (1 m^3 of working volume), which operates at mesophilic conditions (37°C) and HRT of 14-20 days. Around 800 L of liquid fraction rich in VFAs is processed through a screening unit with the objective to remove the coarse solids which have not been removed by the screw-press. The carbon source obtained was planned to be fed into the two Sequencing Batch Reactors for the PHA production.

Results and Applications

After more than one year of operation, some of the units forming the biorefinery platform were optimised and others revamped to solve some technical problems, so that the whole process is now in continuous operation. However, due to a few residual unsolved difficulties, especially in the solid/liquid separation of both anaerobic fermentate and mixed culture sludge, the plant is working at a lower capacity than expected and by using acetic acid as the feedstock for PHA production (instead of VFA-rich mixture from acidogenic fermentation).

Breakthroughs, benefits and added value

Under present operating conditions a polymer content in the range 30-35% PHB in the biomass has been achieved.

The pilot plant is presently under operation for production of PHA foreseen in WP6.

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

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