



create 100% recycling of plastics together

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Abstract

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Chemical Recycling of PLA/PHA composites by TORWASH

The technologies for the recycling of biodegradable polymers is non-existent, but it is considered to be a necessity before biodegradable polymers like PLA (polylactic acid) can grow to their full potential. TORWASH is an emerging technology based on hydrothermal depolymerization, bringing those polymers back to their monomers, into an aqueous solution that is easily purified with existing techniques.

Extensive testing of PLA and PHA has been performed on lab-scale, confirming that in the case of PLA a conversion towards 99% lactic acid can be accomplished with preservation of the original ratio between optical isomers, as found in the original PLA. The tests have been confirmed on bench scale (20-50L autoclave tests). This enables recycling as a source of lactic acid for the existing industry, including the synthesis of PLA. Although formally recycled PLA, it is technically indistinguishable from virgin PLA.

In the case of PHA, full depolymerization is found as well, but the resulting aqueous liquid contains a variety of monomers and their derivate fatty acids. Purification and chemical synthesis may theoretically be possible, these liquors are currently being tested as a feedstock for PHA bacteria and – bottomline – anaerobic digestion.

The TORWASH system allows for the recycling of mixed materials, i.e. foils and blends where PLA and/or PHA are the bulk. By careful manipulation of the conditions, PLA can be separated from blends or laminates with PHA, PET, nylon, and many other polymers. The lactic acid solution can be obtained while leaving behind, fillers, pigment, and other components that prohibit mechanical recycling. We acknowledge that TORWASH for plastics is not easy and may not be a low cost solution, but it offers the potential for recycling composites like layered snack packaging, blends like PLA modified for injection molding, and high-end objects like single use tools in hospitals that cannot be made from monomaterials. Even (fast) food or catering waste (festivals, airlines) is under consideration, but this requires back-and-forth discussions and improvements in the design before it can be implemented.

TORWASH works together with Corbion and Paques Biomaterials for the assessment of the liquors produced and with manufacturers of PLA and PHA objects and packaging. We work with designers and students to make a Guide for the manufacture of plastic-based objects that comply with the requirements for "Designed-for-Recycling-by-TORWASH".

At the submission of this abstract, TORWASH is designing a movable pilot installation on the scale of 1 m³ autoclave, which can be operated at the locations where recovered/sorted PLA and PHA are generated. We select cases where we work with like-minded partners on controlled (industrial) cases. We emphasize industrial cases where the collection of waste is sizeable and can be guaranteed, and that moreover have the potential to grow big. These demo's must provide data for



better techno-economic evaluations and LCA's. Our pilot installation must also process tons of materials in order to make the tons of liquor needed by our partners to demonstrate the other steps in this circular value chain. The demonstration of recycling PLA/PHA recovered from household waste must wait until the waste collectors are ready to sort it out and deliver tons per day.