Open-BIO
Opening bio-based markets via standards, labelling and procurement

Work package 6
Managed end-of-life options

Deliverable N° 6.8:
Validated biogasification test

Public summary

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List of abbreviations and acronyms

AD	Anaerobic Digestion
Aerobic	In the presence of oxygen (O_2)
Anaerobic	In the absence of oxygen (O_2)
ASTM	American Society for Testing and Materials
BSI	British Standards Institution
CEN	*Comité Européen de Normalisation* - European Committee for Standardization
CeRSAA	Centro di Sperimentazione e Assistenza Agricola
Digestate	Effluent from a digester
EC	European Community
ISO	International Standards Organization
NOP	National Organics Program
OECD	Organisation for Economic Co-operation and Development
PAS	Publicly Available Specification
PBAT	Polybutyrate Adipate Terephthalate
PBSeT	PolyButylene Sebacate - co-butylenTerephtalate
PHA	PolyHydroxyAlcanoate
PHB	Poly(3-HydroxyButyrate)
PLA	Poly Lactic Acid
SEPA	Scottish Environment Protection Agency
TOC	Total Organic Carbon
TS	Total Solids
USDA	United States Department of Agriculture
VFA	Volatile Fatty Acids
VS	Volatile Solids

1 Public summary

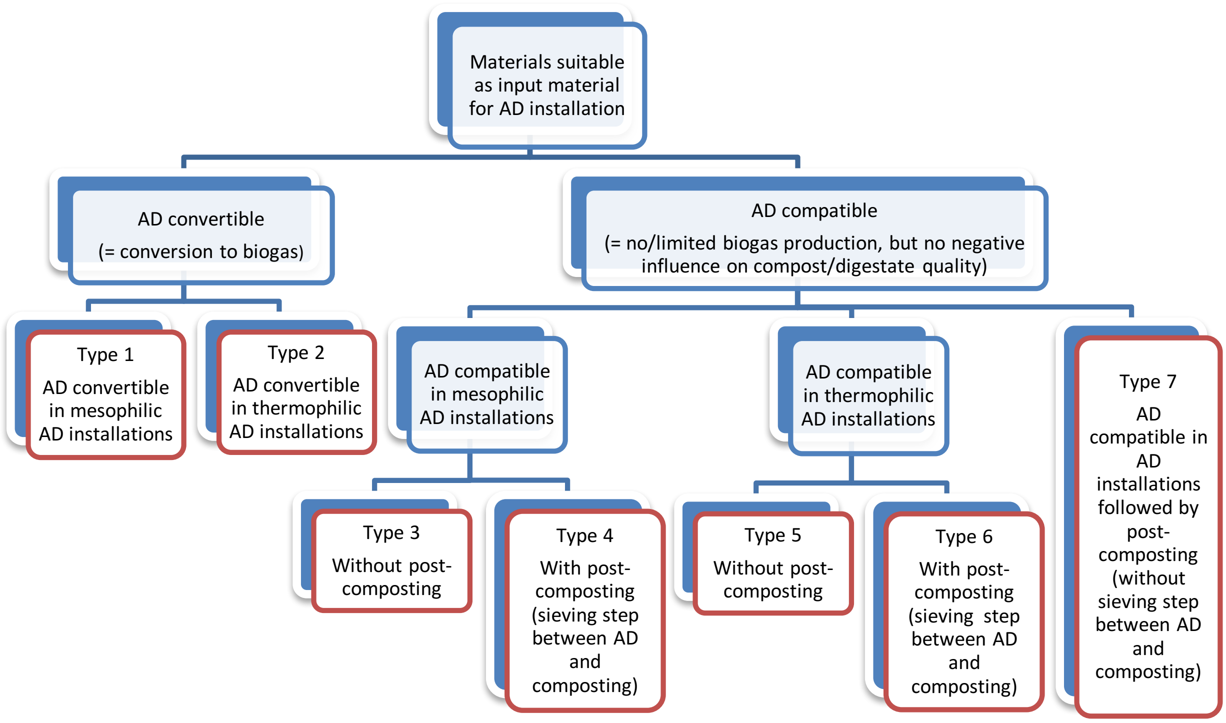
Work Package 6 of Open-Bio investigates the suitability of several managed end-of-life options for bio-based products: industrial and home composting, anaerobic digestion, mechanical recycling and chemical recycling. The objective of the Open-Bio project is the development of a test scheme to evaluate if bio-based products can be disposed in an anaerobic digestion installation (with or without post-composting phase) without having a negative impact on the process and the produced digestate or compost. This work is a follow-up of work carried out earlier in the project (see Deliverable 6.6 “Review on standards for biogasification” and Deliverable 6.7 “Draft standard for biogasification”).

Anaerobic digestion (AD) is a proven biological waste treatment technology. The possibility to recover biogas and its valorization by cogeneration into electricity and heat or direct use as a fuel makes this technology very interesting and economically favourable. The final product of AD, the digestate, is commonly stabilized in situ with a post aerobic composting phase. The final digestate or compost obtained is normally used in agriculture as source of high quality organic carbon and other nutrients. Different types of anaerobic digestion installations exist. They can be subdivided based on total solid content (wet versus dry), temperature (thermophilic versus mesophilic) and based on the presence of a separation of the metabolic stages (single versus multi stage).

In general, **anaerobic digestion (with or without a post-composting stabilisation phase) can be a suitable and interesting managed end-of-life option with energy recuperation (under the form of biogas) for certain types of bio-based products**. Especially for product types which are difficult to recycle mechanically biogasification might be an opportunity. Bio-based products that are strongly contaminated with food waste, laminated films, packaging to which a barrier layer is added (e.g. coated cups) or new bio-based products characterized by a too low production volume to make mechanical recycling from an economical point of view interesting are good examples of products suitable for biogasification. The research carried out by others and within the framework of the Open-BIO project demonstrated that several bio-based polymers/products (e.g. polyhydroxyalcanoate (PHA), polylacticacid (PLA), coated paper cups, etc.) show partial or complete biodegradation and disintegration under anaerobic conditions. In order to stimulate the disposal of such bio-based products in biogasification plants, the producer of bio-based products should be able to inform the operators of the biogasification plants correctly about the behaviour of their products under anaerobic digestion conditions. Therefore, **a clear communication tool is needed which gives information about the biogas production of bio-based products and their disintegration during the process**. Such communication tool is currently not existing.

A standard specification with criteria for products suitable for anaerobic digestion was developed in the Open-Bio project. The goal of this standard specification is the improvement of the communication between producers of bio-based products and biogasification installations (= Business to Business). Taken into account that (1) anaerobic digestion installations are characterised by a high variation between the installations (dry versus wet, thermophilic versus mesophilic, with versus without post-composting stabilisation phase) and (2) different types of behaviour (e.g. convertible to biogas, only fragmentable during the anaerobic process and biodegradable afterwards, etc.) can be acceptable, it was necessary to define different typologies in the standard specification. Research in this project demonstrated that thermophilic conditions are more aggressive when compared to mesophilic conditions (due to the higher temperature which is needed to start the hydrolysis of certain polymers). A difference between biodegradation under anaerobic dry and wet conditions was not clearly observed and therefore no distinction was made between these test conditions although it should be emphasised that wet anaerobic digestion installations might be negatively influenced by the addition of products like plastic bags due to possible problems with entanglement in pumps and rotating equipment. Dry anaerobic digestion systems are normally more robust and less sensitive towards such problems.

A distinction is made between AD convertible products and AD compatible products (see scheme mentioned below).



AD convertible products are converted to biogas during the anaerobic phase (= biodegraded during the anaerobic phase = energy recuperation). A distinction is made between products which are biodegradable and fragmentable under mesophilic anaerobic conditions (type 1) and products which are only biodegradable and fragmentable under thermophilic anaerobic conditions (not under mesophilic conditions) (type 2). Research on several products in this project, has demonstrated that products which are biodegradable under mesophilic conditions will also biodegrade under thermophilic conditions, while the opposite is not applicable.

AD compatible products do not disturb the process, but no biogas or only a limited amount of biogas is produced.

Type 3 and Type 5 are useful for biogasification installations without a post-composting stabilisation phase. Such materials should completely disintegrate (to fragments with a diameter < 2 mm) during the anaerobic mesophilic (type 3) or thermophilic (type 5) phase in order to ensure that no plastic residuals remain present in the digestate. Biodegradation should be demonstrated in soil or as a combination of anaerobic and soil.

Type 4 and Type 6 are useful for biogasification installations followed by a sieving step and a post-composting phase. Such materials should completely disintegrate (to fragments with a diameter < 2 mm) during the anaerobic mesophilic (type 4) or thermophilic (type 6) phase in order to ensure that no plastic residuals remain present at the end of the anaerobic phase. Biodegradation should be demonstrated in combination of anaerobic, controlled composting and/or soil.

Type 7 is useful for biogasification installations followed by a post-composting phase (without a sieving step after the anaerobic phase). Such products should disintegrate (to fragments with a diameter < 2 mm) in a combination of anaerobic conditions and controlled composting conditions in order to ensure that no sample pieces remain present in the compost, while biodegradation should be demonstrated in combination anaerobic, controlled composting and/or soil.

Besides the criteria towards biodegradation and disintegration as described above per typology, a material should also fulfil the requirements related to material characteristics (minimum volatile solids content, maximum levels for heavy metals and fluorine), absence of substances of very high concern and toxicity towards higher plants. These requirements are comparable to the requirements as prescribed by European and international standards for compostable products.

The developed standard specification includes a reference to existing test methods (if already available). **One additional test methodology (based on the existing ISO 15985) is proposed in order to evaluate simultaneously the biodegradation and the disintegration of a bio-based products under anaerobic conditions (possibly combined with a**

conversion to controlled composting conditions to simulate the behaviour in the post-composting process). Normally biodegradation is always evaluated as an inherent material characteristic and consequently products are normally always milled to powder in order to determine their biodegradation. For products suitable for anaerobic digestion it is especially interesting to know how much biogas a certain product might produce during the anaerobic phase. A product made of PHA, which is known to be inherently biodegradable under anaerobic mesophilic and thermophilic conditions, will be completely converted to biogas (and fragmented) when it would be a thin film, but the thickness of the product determines the extend of disintegration within the fixed time scale of the test method proposed even with a product that is biodegradable under mesophilic and thermophilic conditions. This was clearly illustrated by research in this project on PLA. This polymer needs a thermal trigger (i.e. thermophilic conditions) before anaerobic biodegradation will occur. Therefore, the fate of PLA was assessed in thermophilic conditions in two thicknesses (100 µm and 500 µm). For the lowest thickness a higher level of biodegradation (= biogas formation or energy recuperation) and disintegration was obtained when compared to the higher thickness. Therefore, it is important that biodegradation and disintegration is measured on the final product. Additionally **also combinations of different testing methodologies (e.g. ISO 15985 combined with ISO 14855 or ISO 14855 combined with ISO 17556) are proposed**.

As mentioned before, **the standard specification needs to be seen as a B2B communication tool. The typology is too complex in order to be able to provide a label on the product.** Moreover, consumers have only 1 choice: green bin or not. Consumers cannot estimate if the biowaste of the green bin will be treated in an industrial composting plant or in a thermophilic or mesophilic biogasification plant with or without post-composting stabilisation phase.

Website: http://www.open-bio.eu