

New Advances in Biodegradable Films



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GlobalPouchForum.com



Welcome to The Future of Plastics

What You Need to Know About Biodegradation

Presented by Dale Brockman,
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Who is BioLogiQ?

- Idaho Falls based company, founded in 2011.
- Established to create a useful plastic from the excess starch produced during potato processing.
- Our goal is to provide plant-based biopolymers that enable material & energy reductions, recyclability, and/or biodegradability, helping to build a world free of pollution caused by plastics.
- Our pre-compounded base resin is known as NuPlastiQ[®] BioPolymer.



What is NuPlastiQ?

- **NuPlastiQ** is made from plant-based carbohydrates, along with small amounts of naturally sourced glycerin.
- **NuPlastiQ** contains 100% USDA Certified Biobased Content.
- Passed ASTM D6400 testing for industrial composting and ASTM D6691 for marine biodegradation. TÜV has also certified **NuPlastiQ** to be compostable and marine biodegradable.



What is **NuPlastiQ**?

- **NuPlastiQ** is designed to be mixed with other plastic resins.
- Therefore, we normally blend **NuPlastiQ** with other traditional plastic or bioplastic resins via a proprietary process (Eco-Alloysm Reactive Extrusion). The result is a new family of **BioBlend**[®] Resins with enhanced functional and environmental performance.
- Typical legacy compounding partners include polyolefins - LLDPE, HDPE, PP, PS and HIPS.
- We have also successfully created compounds by blending **NuPlastiQ** with bioplastic resins such as PLA, PHA and PBAT.



BioLogiQ Quick Reference Guide

Based on current information. Subject to change at any time.



100% Natural, Renewably Resourced, Plant Based



Polyolefin-Based BioBlend Resins

BioBlend XP
Packaging & Single Use Products

BioBlend XD
Durable Goods & Rigid Containers

Cost Effective, High Performance, Renewable Content Resins

Designed for Applications Requiring:

- High performance, renewable content
- Carbon footprint/fossil fuel reduction

Cost-Effective Solution for Adding 5 to 40% Renewable Content



Blown and Cast Film Extrusion

FFS films, lamination films, stand up pouches, shrink, stretch, trash liners, shopping bags, etc.

Drop-In Processing/Runs on Existing Equipment



Blow and Injection Molding

Personal care bottles, home care, caps & closures, reusable cups, disposable cutlery, etc.

Potential for Light Weighting of Extruded Films and Sheets

Compatible with Most Existing Recycling Systems¹



Thin-Wall Thermoforming

Yogurt cups, margarine cups, etc.

Encapsulate for Odor Control & Better Optics

Note on BioBlend XP/XD Resin Biodegradability

Some BioBlend XP/XD Resins have been observed to biodegrade using ASTM D5338 and D5511 test methods. BioLogiQ is investing significant resources to understand underlying mechanisms and how lab test results correlate to real world environments. However, BioBlend XP/XD resins will not meet current certification requirements (e.g. ASTM D6400) and therefore are not considered to be biodegradable for consumer environmental claim purposes.



100% Natural, Renewably Resourced, Plant Based



CG BioPolymer
(Certified Grade)



Biodegradable BioBlend Resins

BioBlend BC
Biodegradable & Compostable

BioBlend MB
Marine Biodegradable

Cost Advantaged, Compostable/Marine Biodegradable Solutions

Designed for Applications Requiring:

- Industrial or thin wall, home compostable items
- Future marine biodegradability requirements

Biodegradation Without Need for Prior Fragmentation

Cost-Effective Solution for ASTM D6400 Compliant Industrial Compostability²

May Accelerate Biodegradation²



Blown and Cast Film Extrusion

Agricultural mulch films, shopping bags, trash can liners, etc.

Qualifies for:



Blow and Injection Molding

Disposable cutlery, etc.

Check local requirements and label accordingly



Thin-Wall Thermoforming

Food trays, reforestation planters, disposable cups, plates, etc.

What is Biodegradation?

- Biodegradation occurs when materials are converted, by bacteria, fungi, or other biological means, into natural substances like carbon dioxide and water. Composting requires biodegradation in order for organic matter to decompose and be turned into fertilizer and soil conditioners.
- *Biodegradation can occur without composting, but composting cannot occur without biodegradation.*



Disintegration and fragmentation are forms of degradation. But they are not biodegradation!

1. In most cases, degradation means that the structural integrity of a product is compromised (often due to chemical or mechanical actions).
2. It is possible for a product to degrade or fragment without actually biodegrading.
3. Fragmentation can sometimes help increase the rate of biodegradation, but simple degradation does not guarantee that a product will biodegrade.

Disintegration and fragmentation are forms of degradation. But they are not biodegradation!

4. If a plastic cannot be reused or recycled and is unfortunately leaked into the environment, then the most desirable result is for that plastic product to biodegrade.
5. Biodegradation of a plastic can be confirmed through testing by measuring the actual amount of carbon elements that are converted into carbon dioxide and methane gases during the test period.

Composting and biodegradation are different!

- Biodegradation and disintegration are processes that are a part of compostability.
- To be considered “Industrial Compostable”, a plastic product must meet ASTM-D6400 or EN13432 standards by:
 - *biodegrading 90% in 180 days in aerobic conditions (ASTM D5338),*
 - *passing stringent tests for disintegration [90% in 12 weeks (ISO 16929)],*
 - *meeting toxicity and heavy metals requirements.*

There are two types of biodegradation:

- **Anaerobic digestion** occurs when microorganisms break down material in the absence of oxygen. It is used in industrial processes to manage waste or to produce fuels, and also causes the fermentation needed to produce food and drink products.
- Anaerobic digestion occurs naturally in some soils as well as in **landfills**. Methane (CH_4) and carbon dioxide (CO_2), both greenhouse gases, are two end products of this process.



There are two types of biodegradation: (cont.)

- **Aerobic digestion** occurs when material is broken down in the presence of oxygen. It has traditionally been used as a sewage treatment process, but recent technology allows for the aerobic treatment of food, cardboard, and plant waste in **industrial compost facilities** and **water environments**.



- Water vapor, carbon dioxide, and ammonia (NH_4) are among the most common end products of this process.

How are products tested for biodegradation?

1. Sample and control materials are placed in inoculum (material prepared specifically for the test) that is maintained at a controlled temperature and humidity throughout the test.
2. Gases (NH_4 , CH_4 , CO_2) that are produced by the biodegradation process are captured and measured on an ongoing basis.
3. The amount of carbon captured via gas is compared to the amount of carbon in the initial sample to determine the level of biodegradation.
4. Biodegradation results are compared to a negative and positive control that is tested along with the sample that is being biodegraded to confirm that the test results will be acceptable.

How are products tested for biodegradation? (cont.)

5. Please note that even the control samples may not 100% convert into gas. However, they are actually completely biodegraded and are known as materials (usually cellulose) that are 100% biodegradable.
6. The amount of product that is shown in the test reports as being biodegraded is completely converted from plastic into natural elements such as CO₂ and water.
7. It's normally considered that 90% biodegradation compared to the cellulose (positive sample) indicates full biodegradation.
8. While test specific, results are generally "accepted" when the positive control hits 70% biodegradation.

Who performs the tests?

- Eden Research Laboratories
- NSF International
- OWS Belgium
- Others

Who certifies the tests?

- TÜV Austria is a non-profit accredited inspection and certification organization that has several offices located through Europe. They review test results performed by certain test facilities and issue several different certifications including: OK COMPOST, OK BIOBASED and OK BIODEGRADABLE.
- Biodegradable Products Institute (BPI) is located in the USA and uses test results from certain test facilities to certify the compostability of plastic products. BPI reviews test results that were performed by approved test facilities and issues a certification for products to be compostable.

Primary test standards: ASTM-D5338

- ASTM-D5338 is a biodegradation test that measures the carbon elements that are converted into gas to indicate how much of a product is actually biodegraded in **industrial compost environments (aerobic conditions)**, usually requiring temperatures of at least 50°C.
- ASTM-D5338 is not a pass/fail test. The reports indicate what percentage biodegraded over the tested time period, which can be selected by the test requestor.

Primary test standards: ASTM-D5511

- ASTM-D5511 is a biodegradation test that is performed in conditions that simulate **anaerobic digestion**, similar to **landfill conditions**.
- This is not a pass/fail test. The reports indicate what percentage biodegraded over the tested time period.

Measurement for ASTM-D5338 & D5511:

- The percentage of biodegradation shown on the test reports is calculated based on the number of carbon atoms that were converted from the plastic structure into natural elements containing carbon such as CO₂ and CH₄.
- Cellulose is used as the positive control in these tests because it is known to completely biodegrade in these environments. When cellulose reaches a biodegradation level of 70%, the test is considered to be valid; and when the test material reaches a biodegradation level of 90% compared to cellulose, it is considered to be fully biodegraded.

Disintegration Standard for Compostability: ISO 16929

- ISO 16929 tests the rate and amount of material disintegration for a product when exposed to industrial compost conditions.
- For reference, disintegration is successful when less than 10% of the starting reference material is captured on a screen 2mm x 2mm in size.

Standard for Compostability: ASTM-D6400

- ASTM-D6400 is a **pass-fail compostability test** that imposes amount and time limits on:
 - 1) the biodegradation in industrial compost conditions according to ASTM-D5338 (90% in 180 days), and
 - 2) disintegration according to ISO 16929 (12 weeks to reach 90% that will pass through a screen).
- The ASTM-D6400 test standard also specifies limits on 3) heavy metal content and 4) the percentage of seeds that must germinate in the soil after a plastic product is biodegraded into compost (toxicity).

Alternate Compostability Standard: EN13432

- EN13432 is a European **pass-fail compostability test** that is similar to ASTM-D6400, with two primary differences:
 - 1) Heavy metal testing is more stringent.
 - 2) Biodegradation testing is more relaxed than D6400, in that components accounting for less than 10% of the formulation do not have to pass the full specification independently.

Marine Biodegradation Test Method: ASTM-D6691

- ASTM-D6691 tests for the amount of degradation that occurs in a marine environment.
- This is not a pass/fail test. The reports indicate what percentage biodegraded over the tested time period.

Marine Biodegradation Standard: ASTM-D7081

- ASTM-D7081 is an *out of date* **pass-fail marine biodegradability test** that imposes amount and time limits on:
 - 1) the biodegradation in a marine environment according to ASTM-D6691 (30% in 180 days), and
 - 2) biodegradation in industrial compost conditions according to ASTM-D5338 (90% in 180 days).

Note that this standard has lapsed and is not active. Currently, there is no widely accepted standard for marine biodegradability certification.

Let's Sum It All Up

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Summary - Biodegradation

- Biodegradation occurs when materials are broken down by bacteria, fungi, or other biological means.
- Biodegradation is not the same as composting. In fact, even industrial and home composting are different: Some materials that are industrial compostable are not considered to be home compostable.
- Fragmentation and disintegration are not forms of biodegradation, but can sometimes lead to biodegradation.

Summary - Compostability

- To claim compostability, a material must disintegrate within 12 weeks, and biodegrade 90% within 180 days. It must also pass tests for low levels of plant toxicity and heavy metal content. Meeting all of these standards leads to meeting ASTM D6400 or EN 13432 compostability standards, which allows for certification by one of several independent bodies: BPI, TUV and others.
- To meet FTC Green Guide requirements for promotional claims, ASTM D6400 standards must be met and messaging must usually state that composting occurs in an industrial facility, which may or may not be locally available.

Summary – Marine Biodegradability

- Very specific claims regarding marine biodegradability can be made according to ASTM-D6691, by listing the percent that has biodegraded and the period of days in which that biodegradation occurs.
- **Note: This test does not lead to certification, nor is there currently any widely accepted testing protocol that can lead to certification for marine biodegradability.**



A Few Final Points

Biodegradation is a process, not an end result.

- Thus, **making promotional claims specifically related to biodegradability is not generally recommended.** (For reference, it is illegal in the state of California to make claims related specifically to biodegradability.)
- The best way to make claims is to have a specific package tested and/or certified for compostability or marine biodegradability. This can take 18-24 months, given the series of tests and approvals that must occur.

Biodegradation is not a panacea!

- Partially biodegraded materials can still be pollutants.
- The results of biodegradation are water vapor and greenhouse gases such as carbon dioxide, methane, and ammonia.

Biodegradation is the last line of defense

- It will always be preferable to reduce, reuse, and recycle packaging than to have it biodegrade.
- The real value of biodegradation is a safeguard against environmental impact, should packaging “leak out” of a closed loop system.

If you need compostability certification by TUV or BPI

- Generally speaking, certification for compostability requires that *the entire structure and/or all of its components be tested and certified*. This includes colorants, dyes, adhesives, and closures.
- Films that are certified at a certain thickness (e.g. 25 microns) will need to be retested and re-certified if a thicker film is being used, even if the resin formulation is the same.

Education is Critical

- Consumers must be educated to ensure that they don't simply toss compostable or marine biodegradable packaging into the environment because they believe it will simply "go away".

Standards May Not Reflect the State of the Art

- Existing biodegradation standards were developed to accommodate the first group of commercialized products made from PLA and include specific requirements for disintegration.
- BiologiQ's **NuPlastiQ CG** BioPolymer can biodegrade without any requirement for initial disintegration or fragmentation. We see a need for new or revised standards based on this new technology that can lead to a variety of new certifications.



Thank you!

Networking Break

Sponsored By



3:00 – 3:30 PM Grand Ballroom Foyer



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