Biodegradable

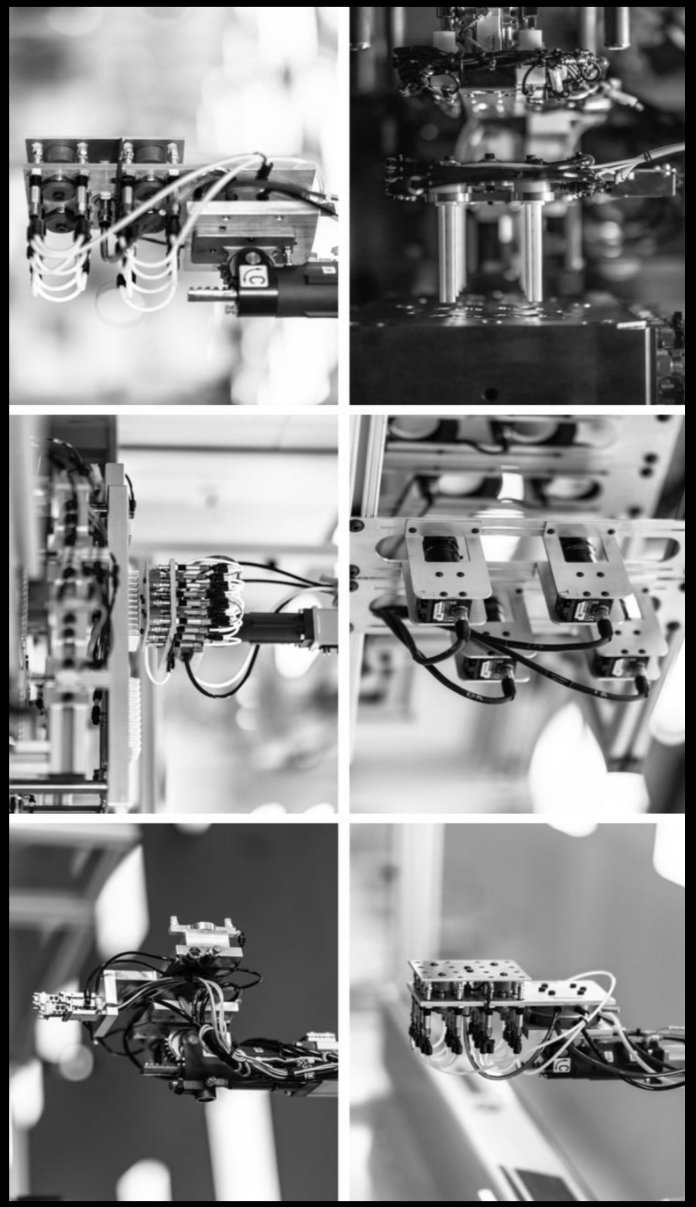
- Biodegradable *Custom* Blend
  - FDA approved polypropylene
  - USDA certification

- Biodegradation and Composting
  - ASTM-D5338 test (industrial compost) definition
  - ASTM-D5511 test (landfill) definition

- Biodegradability Testing
  - ASTM-D5511 (landfill) biodegradation test result of a similar product made with NuPlastiQ /PP.
  - ASTM-D5511 (landfill) lab results.

- Greenhouse Gas Reductions (example)

- BioLogiQ Quick Refence Guide



- FDA approved Hival polypropylene resin.
- NuPlastiQ plant based additive. *USDA certification.

About NuPlastiQ

- **NuPlastiQ** contains 100% USDA Certified Biobased Content.
- It is made from plant-based **carbohydrates**, along with small amounts of **naturally sourced glycerin**.

USDA CERTIFIED BIOBASED PRODUCT
PRODUCT 100%

NuPlastiQ is blended with other polymers to produce a family of BioBlend Resin Product Lines:

1. **XP** High Performance Resins for Packaging (blends with polyolefins)
2. **XD** High Durability Resins for Durable Goods (blends with resins like PS, PC, ABS and TPE)
3. **BC** Biodegradable/Compostable Resins for Packaging and Industrial Films
4. **MB** Marine Biodegradable Resins for Packaging and Foodservice Items

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What You Need to Know About Biodegradation and Composting

1. Biodegradation occurs when materials are broken down by bacteria, fungi, or other biological means. Composting requires biodegradation in order for organic matter to decompose and be turned into fertilizer and soil conditioners. *Biodegradation doesn't necessarily require composting, but composting requires biodegradation.*

2. Degradation and/or fragmentation are not the same as biodegradation. In most cases, degradation means that the structural integrity of a product is compromised (often due to chemical or mechanical actions). It is possible for a product to degrade or fragment without actually biodegrading. Note that *fragmentation can sometimes help increase the rate of biodegradation, but simple degradation and/or fragmentation do not guarantee that a product will biodegrade.*

   If the intention is to produce compost or reduce the presence of solids, the most desirable results for plastic packaging and products is that they biodegrade. Biodegradation of a plastic is confirmed through testing by measuring the actual amount of carbon elements that are converted into carbon dioxide and methane gases during the test period.

3. 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 need to produce food and drink products.) Anaerobic digestion occurs naturally in some soils and in lakes and oceans. Methane (CH_4) and carbon dioxide (CO_2), both greenhouse gases, are two end products of this process.

   - **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. Water vapor, carbon dioxide, and ammonia (NH_4) are end products of this process.

4. Testing and certification is performed by several organizations which include:

   - Test Facilities:
     - Eden Research Laboratories
     - NSF International
     - OWS

   - Certifying Bodies:
     - (TÜV Austria) is a non-profit accredited inspection and certification organization that has several offices located through Europe. They review test results performed by test facilities and issue several different certifications including: OK COMPOST, OK BIOBASED AND OK BIODEGRADABLE.
     - Din Certco (TUV Rheinland) is a certifying body located in Germany. They review test results performed by test facilities and issue certifications for: "Seedling" and / or DIN-Geprüft mark.
     - 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.

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5. These are the primary test standards used by the test facilities to measure biodegradation and compostability:

   ASTM-D5338 is a biodegradation test that measures the natural elements that are converted into gas to indicate how much of a product is actually biodegraded in **industrial compost** conditions (aerobic conditions). The ASTM-D5338 test does not include any testing for disintegration. 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.

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

   - Measurement of the amount biodegraded for ASTM-D5338 and ASTM-D5511 tests is done as follows:

     Biodegradation results are compared to negative and positive controls that are tested along with the sample that is being biodegraded to confirm that the test results will be acceptable. **90% biodegradation compared to the positive sample is considered fully biodegraded**. Please note that even the control samples may not 100% convert into gas, but they are actually completely biodegraded and are known as materials (usually cellulose) that are 100% biodegradable.

     The amount of product that is shown in the test reports as being biodegraded requires complete conversion from plastic into natural elements such as CO_2, CH_4 and water. Once converted into natural elements through biodegradation, small fragments (including micro-fragments) do not remain, because they have been completely converted (biodegraded) back into natural elements. Scientists believe that 90% biodegradation compared to the cellulose (positive sample) indicates full biodegradation.

   - ISO 16929:2013 is a test that measures the amount of **disintegration** of a product that is exposed to industrial compost conditions. This is not a pass/fail test. The reports indicate what percentage disintegrated over the tested time period. Disintegration is measured by collecting samples through various sizes of mesh screen.

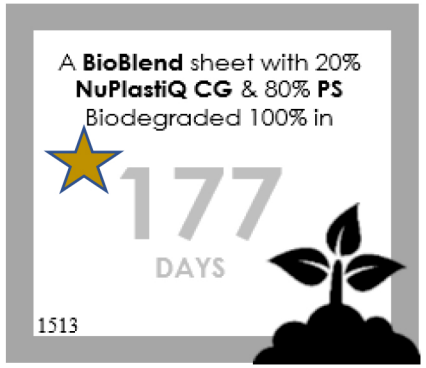
   - ASTM-D6400 is a **pass-fail compostability test** that imposes time limits on 1) the biodegradation in industrial compost conditions according to ASTM-D5338 and 2) disintegration according to ISO 16929:2013. The ASTM-D6400 test standard also specifies limits on 3) Heavy Metal content and 4) the percentage of seeds that must germinate in the soil after a plastic product is biodegraded into compost.

Note: The above descriptions of the ASTM testing are not intended to be definitive statements of these test procedures, but only to provide general guidelines for comparison of the methods. See the actual ASTM standards for complete test details.

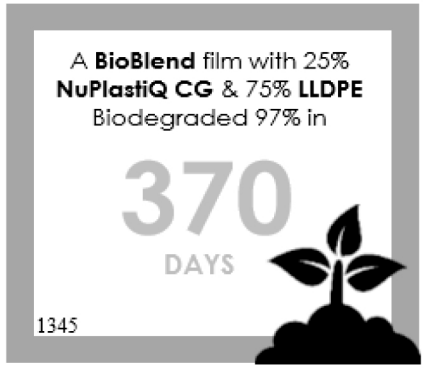
Biodegradability Testing: NuPlastiQ CG & Polyolefins

Studies* indicate that NuPlastiQ CG accelerates polyolefin biodegradation when subject to industrial compost and simulated landfill conditions. BioLogiQ is commissioning studies to understand the underlying mechanisms to determine if and how this biodegradability might occur in the event of environmental leakage.

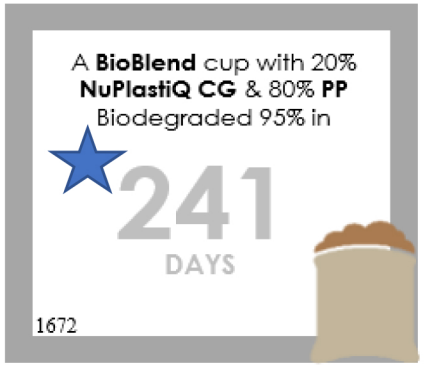
Lab results on following slide



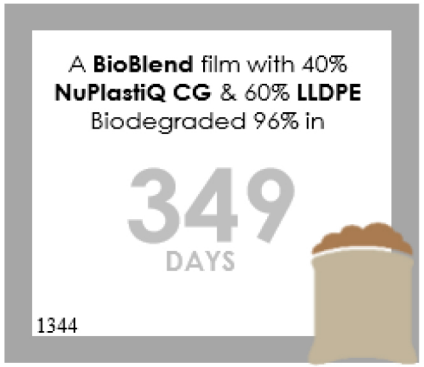
ASTM-D5338
AEROBIC DIGESTER
INDUSTRIAL COMPOST



ASTM-D5338
AEROBIC DIGESTER
INDUSTRIAL COMPOST



ASTM-D5511
ANAEROBIC DIGESTER
SIMULATED LANDFILL
CONDITIONS



ASTM-D5511
ANAEROBIC DIGESTER
SIMULATED LANDFILL
CONDITIONS

*All tests were performed by independent third party laboratories. Copies of the reports are available for review.
These results are for the specific resins listed, and are not applicable to other resins made using **NuPlastiQ** *BioPolymers.*

Eden Research Laboratory

Update

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To: BiologiQ

Date: 11/28/18

From: Thomas Poth

Number of pages including cover: 2

Regarding: D5511 BiologQ 1672 Samples (321 days)

	Inculum	Negative	Positive	1672 - ESR/PP green
Cumulative Gas Volume (mL)	3601.6	2154.8	11481.9	31859.0
Percent CH_4 (%)	44.0	35.6	42.0	55.0
Volume CH_4 (mL)	1585.0	766.5	4820.4	17525.7
Mass CH_4 (g)	1.13	0.55	3.44	12.52
Percent CO_2 (%)	40.3	40.0	41.2	36.2
Volume CO_2 (mL)	1453.2	860.9	4735.0	11536.3
Mass CO_2 (g)	2.85	1.69	9.30	22.66
Sample Mass (g)	10	10	10	20.0
Theoretical Sample Mass (g)	0.0	8.6	4.2	14.7
Biodegraded Mass (g)	1.63	0.87	5.12	15.57
Percent Biodegraded (%)		-8.8	82.7	94.8
* Adjusted Percent Biodegraded (%)		-10.7	100.0	114.6

Eden Research Laboratory

Update

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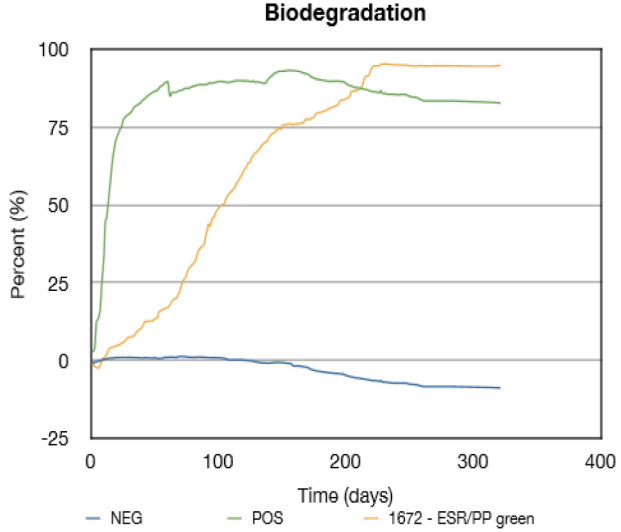
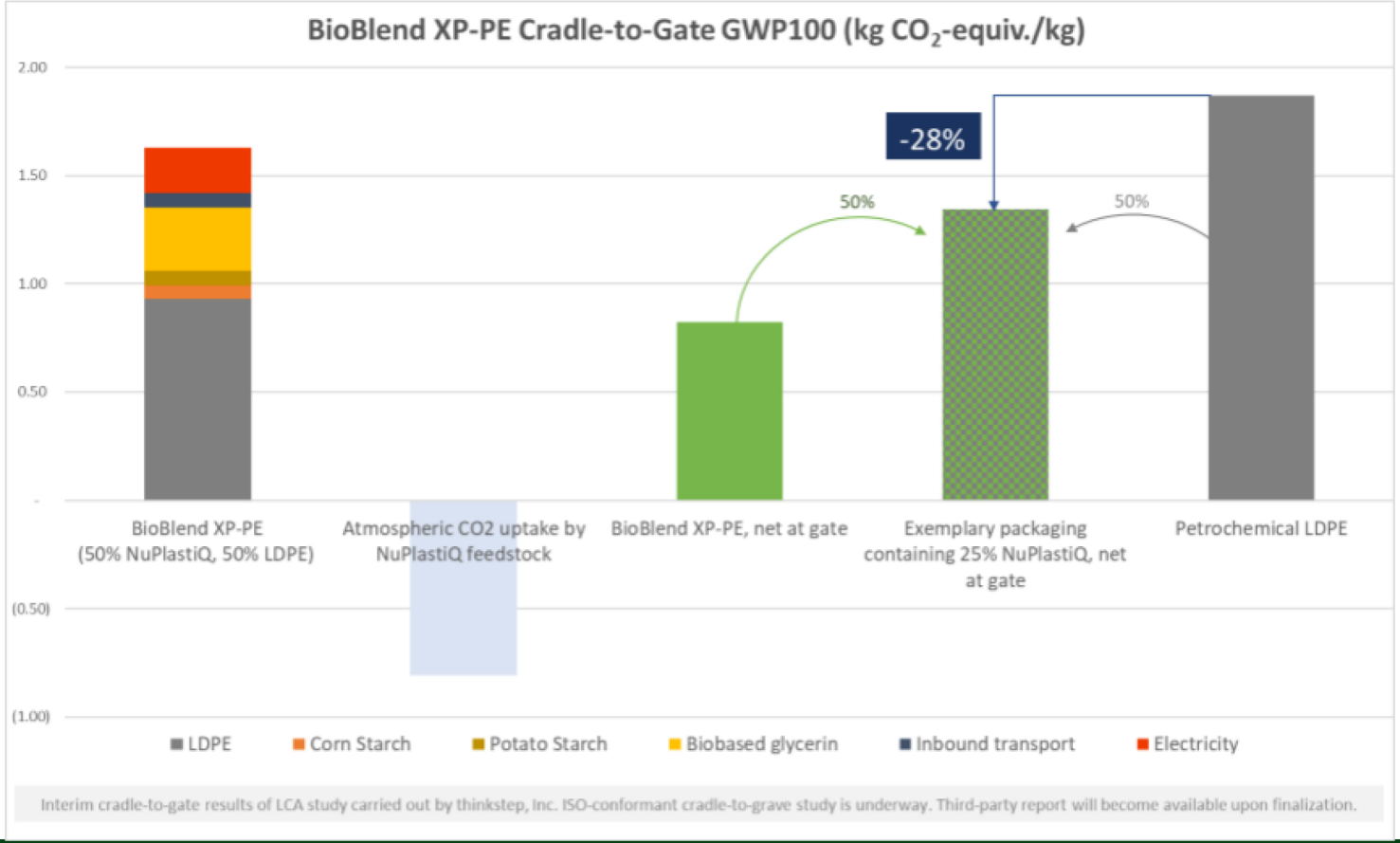
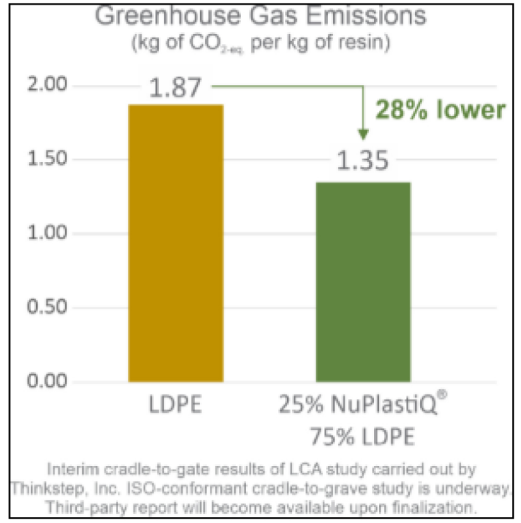


NuPlastiQ® offers significant GHG savings when blended with fossil-based resins.



Interim cradle-to-gate results of LCA study carried out by thinkstep, Inc. ISO-conformant cradle-to-grave study is underway. Third-party report will become available upon finalization.



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Quick Reference Guide

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

PE or PP or PS

HDPE
LDPE
LLDPE

NuPlastiQ® BioPolymer
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

Designed for Applications Requiring:

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

$ cost effective $ solution for 5 to 40% renewable content (in many cases only practical route)

RECYCLABLE with special consideration

potential for LIGHT WEIGHTING extruded films and sheets

DROP-IN manufacturing

CO_2 REDUCED carbon footprint versus fossil-based

BioBlend XP or XD encapsulate for odor control and better optics

Blown and Cast Film Extrusion
FFS films, lamination films, stand up pouches, shrink, stretch, trash liners, shopping bags, etc.

Blow and Injection Molding
Personal care bottles, home care, caps & closures, reusable cups, disposable cutlery, etc.

Thin-Wall Thermoforming
Yogurt cups, margarine cups, etc.

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 certifications requirements (e.g. ASTM D6400) and therefore are not to be considered to be biodegradable for consumer environmental claim purposes.

BioBlend® Resins

PHA and or PLA and or PBAT

USDA CERTIFIED BIOBASED PRODUCT

TÜV AUSTRIA OK compost INDUSTRIAL

TÜV AUSTRIA OK biodegradable MARINE

NuPlastiQ® CG BioPolymer (Certified Grade)
100% Natural, Renewably Resourced, Plant Based

Biodegradable BioBlend Resins

BioBlend BC
Biodegradable & Compostable

BioBlend MB
Marine Biodegradable

Cost Advantaged, Compostable/Marine Biodegradable

Designed for Applications Requiring:

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

Plastic to CO_2 and H_2O Biodegradation without need to prior Fragmentation

$ cost effective $ solution for ASTM D6400 compliant Biodegradability [Industrial Compost]

Blown and Cast Film Extrusion
Agricultural mulch films, shopping bags, trash can liners, etc.

Qualifies for TÜV AUSTRIA OK compost INDUSTRIAL

Blow and Injection Molding
Disposable cutlery, etc.

Thin-Wall Thermoforming
Food trays, reforestation planters, disposable cups, plates, etc.

Please check local requirements and label accordingly

NOT RECYCLABLE IN MOST STREAMS