ENSO Bottles Technical Datasheet

ENSO Bottles, LLC
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22 July 2009

Around the globe, manufacturers in business today have environmental concerns. Companies and individuals worldwide are taking on responsibility for the health of our planet. ENSO Bottles has taken an active interest in doing our part, and as such, have developed products that are easy and effective solutions for your biodegradable PET plastic bottling needs.

ENSO Bottles, LLC™, in partnership with Resilux America, is bringing biodegradable additive technology to the PET bottle industry through specially formulated ENSO additive, preforms and blown bottles. ENSO bottles are the first biodegradable and recyclable PET bottles on the market today.

From the manufacturing standpoint, we believe that the most important aspects of our products are that they maintain the same physical properties as standard PET. Our bottles use materials that do not affect the flavor or smell of the bottle or the product contained in the bottle. This is important when using bottles for water, juices and other beverage and consumable products. Since our bottles maintain the same physical properties as current PET bottles, there is no requirement to utilize special manufacturing equipment, or require additional time away from current processes for change-over. We provide our customers a biodegradable end product that has the same shelf life, physical properties and does not affect the integrity of the product **<u>until</u>** placed in an active microbial environment, at which time the bottle will break down into inert humus or biogas.

Our biodegradable PET preforms and blown bottles can be manufactured in clear as well as most colors. ENSO bottles are a cost affordable solution for your earth-friendly bottling needs; and having the same physical properties as your current plastic bottles make for an easy transition.

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- **ENSO Biodegradable PET bottles**
  - biodegrade naturally in aerobic and anaerobic environments, into inert humus and biogases
  - biodegrade without the need of light or additional heat
  - biodegrade within 1 – 10 years*
  - no hazardous materials remain after biodegradation
  - 3rd party biodegradation testing through various labs
  - tested via ASTM D5511 and ASTM D5226 for biodegradability
  - do NOT use valuable food resources to create our product
  - do NOT fragment or degrade into smaller pieces of plastic
  - are fully recyclable in existing PET recycle streams
  - comply with FDA title 21 CFR 177.1350, 177.1520, 177.1630, CFR 184,
  - comply with CA Prop 65
  - are environmentally safe / non-toxic per RAL GZ 251
  - no hazardous substances under SARA 311/312/313 and EPA 40 CFR Part 2610
  - all components comply with TSCA
- **ENSO Bottle Physical properties – same as standard PET bottles**
  - same Natural Stretch Ratio (NSR)
  - same crystallization and tensile strength
  - same glass transition temperature
  - same barrier properties – same permeation of oxygen, water and CO_2
  - same Intrinsic Viscosity (melt temperature and heat resistance)
  - same AA (Acetaldehyde) levels
  - do NOT add flavor or smell to product
  - same shelf life of the product
  - no requirement for specialized manufacturing equipment
  - recycle testing; ASTM D1003B, D4603, F2013, Fluorescence Visuals, Black Specks and Gels
  - MSDS and TDS available on request
- **ENSO bottles Products – additive, preforms or blown bottles**
  - single and two-stage bottle blowing processes
  - various preform and bottle gram weights available
  - standard neck finishes in various sizes
  - standard or specialized blown bottles
  - clear bottles as well as various colorants/pigments are available
  - additive available for in-house bottle injection and blowing
  - additive made from renewable materials
- **Biodegradable bottle closures available in 4Q 2010**
- **Biodegradable bottle labels available in 4Q 2010**

*** Time requirements for biodegradation depend on the environment in which the materials are disposed, as type, quantity and quality of micro-organisms may vary (see biodegradation analytical summary).**

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Analytical Summary

Reported To:
ENSO Bottles
1500 East Bethany Home Rd
Suite #120
Phoenix, AZ 85014

Data Collected & Analyzed By:
Northeast Laboratories, Inc
129 Mill Street
Berlin, CT 06037

ASTM D 5511 – 02
Standard Test Method to Determine Anaerobic Biodegradation of Plastic Materials Under High-Solids Anaerobic-Digestion Conditions

The degree and rate of anaerobic biodegradability of a plastic type material may be predictive of the period required to reduce the proposed plastic from the environment depending on the given conditions. Where disposal is considered a major issue, this test method may be useful to estimate the degree and persistence of biodegradable plastic in a biologically active anaerobic disposal situation. ASTM method D5511-02 determines the degree of anaerobic biodegradation of plastic materials in a high-solids anaerobic conditions. The test sample is exposed to methanogenic inoculum cultivated from a wastewater treatment facility's anaerobic digesters operating on household waste. Anaerobic decomposition in this case employs a high solids environment. High solids conditions are usually considered to be greater than 20% solids. The sample conditions remain static.

This test method is designed to yield a percentage of conversion of carbon in the sample to carbon in the gaseous form under conditions found in high-solids anaerobic digesters, treating municipal solid waste. This can be validated using change in mass of the original sample. This test method is also designed to resemble many conditions in a biologically active landfill. This method is applicable to all plastic materials that are not toxic to microorganisms present in wastewater treatment facility's anaerobic digesters that are operating on household waste.

ASTM Method D5511 determines the rate and degree of anaerobic biodegradation by measuring the volume of carbon dioxide (CO_2) and methane (CH_4), or change in mass as a function of time (days) of exposure to anaerobic-digester sludge. This method is considered an accelerated representation with respect to anaerobic environments. Landfill sites that plastics encounter in usual disposal methods are a prime example of this environment.

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Analytical Summary

Experiment:

1. Inoculum
   - 1.1. Isolation of an inoculum is the primary step.
   - 1.2. The dependability of the inoculum is determined by the positive control sample test.
   - 1.3. Sludge Characteristics and Preparation
     - 1.3.1. Sludge from Organic Compost – McEnroe Organic Farms, Millerton, NY
     - 1.3.2. Fifteen day hold period observed @ 53 ± 2°C
     - 1.3.3. Solid Content - 24%
     - 1.3.4. pH - 7.9
     - 1.3.5. Volatile Fatty Acids - 0.9 g/kg
     - 1.3.6. Ammonium Nitrogen 1.3 mg/kg
2. Sample characteristics are observed and recorded.
   - 2.1. Carbon Content - 61.2%
   - 2.2. Structure - PETE
   - 2.3. Sample Form – PETE Bottles
   - 2.4. Temperature Range During Study - 52 ± 2°C
   - 2.5. Duration of study - 29 days
3. Experiment commences in an appropriate apparatus to verify gas evolution and sample isolation for final mass analysis.
   - 3.1. Incremental mass and gas evolution is measured for sample, control and positive control by considering mass loss.
   - 3.2. The experiment is continued for a given period of time.
     - 3.2.1. Twenty-nine days in this case.
     - 3.2.2. If gas production of actual sample reduces to that of the control sample the experiment is terminated.

Results:

After consideration of gas production of all samples, there appears to be no gross inconsistencies that would deem this experiment unusable. There is excellent continuity among the three samples.

	Average		Methane (CH_4)			Carbon Dioxide (CO_2)			Total Carbon (C)		Biodegradation	
	Wt (g)	Total Vol (ml)	%	Vol (ml)	Wt CH_4 (g)	%	Vol (ml)	Wt (g)	Total Wt (g)	Theoretical (g), C_t	%	Adjusted %
ENSO	12.3	12,010.0	50.9	6113	4.37	1.90	228	0.45	3.40	7.53	13.81	16.93
Positive	10.0	20,967.0	51.2	10735	7.68	1.98	416	0.82	5.98	4.44	81.54	100.00
Inoculum	250.0	8671.0	48.8	4231	3.03	2.00	173	0.34	2.36			

There was indication that the inoculum was viable, because the positive and sludge control results indicated biodegradation when gas production is considered.

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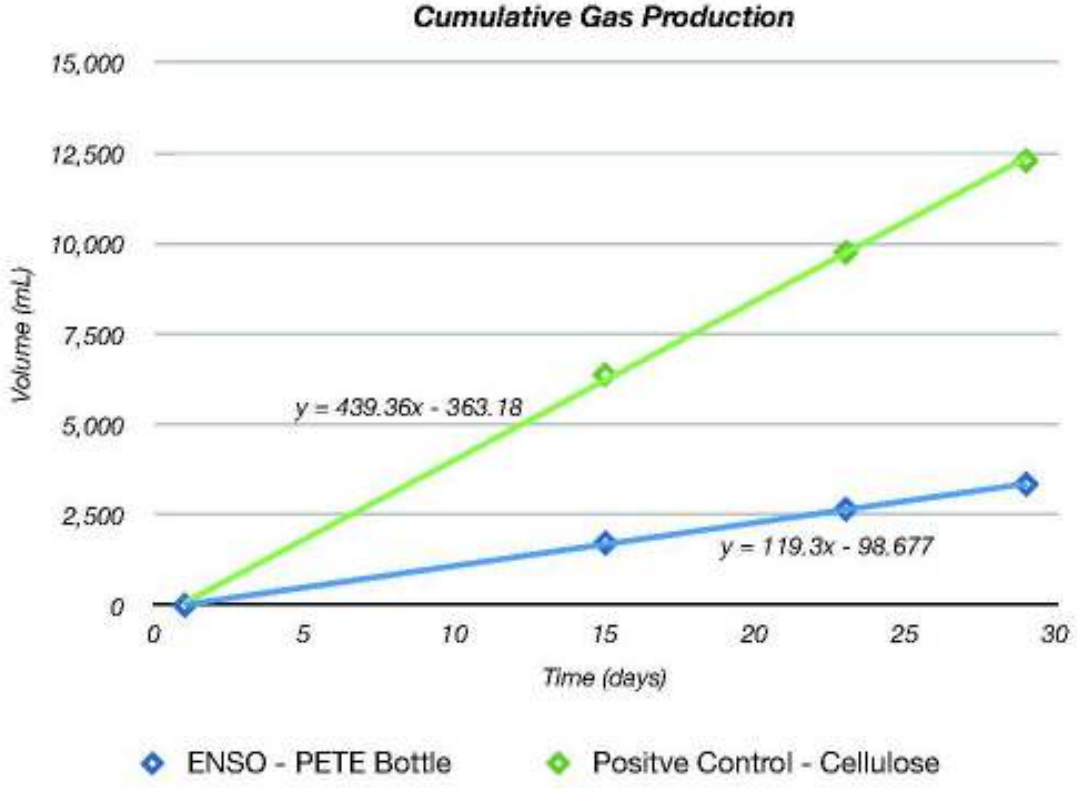
Analytical Summary

Conclusion & Analysis:
Upon consideration of gas production analysis, it becomes obvious that biodegradation has occurred. Biodegradation appears to be linear. There is no significant deceleration of degradation at the end of the first 15 day test period. The degradation will apparently continue in a linear fashion.



Prediction of time to total biodegradation is difficult. It is unknown if the slope of biodegradation will continue to be linear. Over a 29 day period there is a 13.8% carbon conversion. To accurately estimate the time of degradation two simultaneous samples would have to be run for varying times (30 and 90 days). This would help define an equation of degradation. It is worth noting that the degradation figures in the original test are likely skewed when considering the bottle shape. The neck - top and the bottom sprue contain the majority of the mass and they are the thickest portion. It is likely the thinner wall of the bottle side has likely degraded much more efficiently the thicker portions present in the first test. This should be quantified to determine the rate of degradation of these sections separately.

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Analytical Summary

These conditions are optimized. These results are very good. If your products were disposed of in a bioreactor landfill the biodegradation rate would be very fast. In this test, temperature and moisture are optimized as in a bioreactor. In a standard landfill these parameters are not optimized so biodegradation would not be as accelerated. To determine an accurate time to total degradation additional testing would be required.

At present rate of biodegradation ENSO's PETE biodegrades at least 99% faster than untreated PETE in a D5511-02 simulated landfill situation. For instance, if the Untreated PETE took 500 years to biodegrade the ENSO Treated PETE would only take 5 years.

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PLASTICS, POLYMERS and RUBBER TESTING
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May 20, 2009

ENSO Bottles, LLC
P.O. Box 15886
Phoenix, AZ 85060

Analytical Report

CFR 177.1630

Sample - PET Bottles

	mg/ in²	Maximum Limit (mg/ in²)
Condition F		
Water Extractables at 250°F/ 2 hrs.	0.103	0.5
n-Heptane Extractables at 150°F/ 2 hrs.	0.003	0.5
Condition G		
50% Ethyl Alcohol at 120°F/ 24 hrs.	< 0.001	0.5

Conclusions

The above PET bottles are compliant with CFR 177.1630 Conditions f, g and i.

Howard Kaye, Ph.D., FAIC
Director

HK/dr

All samples will be discarded within two months.

ENSO Bottles Technical Datasheet

POLYHEDRON LABORATORIES®, INC.

PLASTICS, POLYMERS and RUBBER TESTING

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May 19, 2009

ENSO Bottles, LLC
P.O. Box 15886
Phoenix, AZ 85060

Analytical Report

Sample - Clear PET Bottles

Haze and Transmission by ASTM D 1003

Nominal Thickness (mm)	Total Transmittance	% Haze
0.234	0.8723	3.9
0.240	0.9234	3.1
0.260	0.9359	3.4
AV = 0.245	AV = 0.9105	AV = 3.5
± 0.014	± 0.0337	± 0.4

Intrinsic Viscosity (Single Point) by ASTM D 4603

Intrinsic Viscosity (dl/g)
0.89

Acetaldehyde by ASTM F 2013

Acetaldehyde (ppm)	5.43

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Analytical Report
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Visual Black Specks and Gel

Gels / 25 Bottles =	253
Specks / 25 Bottles =	2

Fluorescence Visual

Fluorescence Specks / 25 Bottles =	1
Fluorescence Smear / 25 Bottles =	3

Howard Kaye, Ph.D., FAIC
Director

HK/dr

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