A Comparison of ENSO Plastics, Oxo-degradables and PLA

Significant studies have shown that plastic packaging is superior to glass and aluminum in both physical properties and environmental impact. Still, plastic is commonly seen as an environmental scourge and the industry is looking for solutions to address this issue. As a result, the past few years have been a proving ground for advancements in biodegradable and renewable plastics.

With the variety of options available, many manufacturers and brand owners find themselves in a sea of conflicting and confusing information regarding different technologies. To make it more difficult, it is common for compostable, degradable and biodegradable materials to be categorized together, however these materials are very different in the science behind the technologies, sourcing, physical properties and end of life options. This document will evaluate the environmental impact, science and commercial viability of the three primary options available to manufacturers.

The Science

ENSO Plastics uses specially formulated additive to create biodegradable polymers without sacrificing the beneficial properties of the primary polymer including recyclability. This type of technology is fairly new to the polymer market, yet well tested and validated. To create the biodegradable material, ENSO adds specific renewable nutrients and organic compounds into the polymer which, once discarded, allows microbial action to colonize in and around the plastic and completely metabolize the polymer. The end result being inert humus (biomass) and biogas (anaerobic) or Co2 (aerobic).

Oxo-degradable are additives that create a degradable polymer. Oxo-degradable additives have been on the market for a number of years and as such there are a number of different versions used which will affect the breakdown of the products. These additives use metal ions to create weak links in the polymer chain which oxidize to create brittle plastic reducing the visible plastic. Oxo-degradable products break down through exposure to light and oxygen. There has been no data to show that Oxo-degradable products completely degrade, this leaves concern of heavy metals and chemicals (plastic polymers, Cobalt, Cadmium and other toxic residue) in the ground and oceans.

PLA (poly lactic acid) is a commercially compostable polymer derived from renewable resources, such as corn starch or sugarcane. Although PLA has been known for more than a century, it has only been of commercial interest in recent years, in light of its commercial compostability and renewable sourcing. The applications have been limited due to the reduced physical properties and high cost in comparison to traditional polymers.

Sourcing

Sourcing is currently an area of great interest, there is significant research being done on creating standard plastics from renewable feedstock, such as algae and sugar cane. The importance of sourcing addresses two issues; the limited supply of fossil fuels and the increased carbon output from fossil fuels. Plastics that address sourcing often require large supplies of fossil fuel during processing and often negate out the carbon benefit. It is also important to note that renewable is not synonymous with sustainable. Sourcing

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from renewable materials does not address end of life and pollution issues. Sourcing and disposal are separate and important issues.

ENSO Plastics is working to address both the sourcing and disposal of plastics. Currently the materials used in the additive are sourced from renewable materials. This is a small percentage of the overall plastic used in the finished product and ENSO is researching sourcing materials for the base polymer from renewable sources to create a traditional polymer that is both sustainable and biodegradable.

Oxo-Degradable are sourced primarily from metals and salts and are added into traditional plastics sourced from petroleum.

PLA is sourced from renewable resources. This is the primary benefit promoted by manufacturers of PLA materials, so it is important to carefully evaluate this proposition. From an environmental perspective, PLA products require the allocation of valuable food resources (land, food products, etc) which could be used for producing food. Many reports indicate that fossil fuels used in processing of plant starch for plastics is harder on the environment than the fossil fuels used in making traditional plastics. There is also significant controversy over the use of GMO (genetically modified) materials as the primary feedstock for PLA.

Physical Properties and Shelf-life

ENSO additives are used as a colorant, adding them during the melt phase of manufacturing. Products made using ENSO additives maintain the same physical properties as the base polymer. Specific shelf-life with ENSO products will depend on the product application and is the same as that found in standard polymers. ENSO polymers will not biodegrade on the shelf, warehouse or storage facility, they must be placed in a high microbial environment for biodegradation to take place.

Both Oxo-degradables and PLA products have limited shelf life and other handling issues. These are important facts to consider when using either oxo-degradable or PLA packaging for your product.

Oxo-degradables are also introduced to the polymer much like a colorant. The cost is very low for these types of additives however; the product shelf-life for oxo-degradables is between 2 to 6 months. Some of the 2nd generation oxo-degradable products claim the shelf-life has been increased to 6 months to 2 years (if the environment is right). The process of degradation of oxo-biodegradable begins immediately after manufacturing and will accelerate when exposed to heat, light or stress. Anti-oxidants and UV inhibitors are placed in the product to help counteract this degradation and short shelf-life. It is important to note that other manufacturing issues may arise from the use of oxo-degradables.

PLA or starch based products are more difficult to process and often require modification to manufacturing systems or new equipment to accommodate the low processing temperatures required. PLA products currently have a shelf-life of approximately 2 to 4 months. These products react adversely to heat and moisture and require the product to remain in a temperature controlled environment. It is important to note that other manufacturing and product issues may arise from the use of PLA. For

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example, PLA has a lower oxygen barrier and is less impact resistant than PET and traditional colorants cannot be used.

Biodegradability

ENSO products are biodegradable in anaerobic (no oxygen, no light), and aerobic (with oxygen) environments, this includes common landfills. When these materials are placed in a microbial environment the additive attracts specific microbes which digest the entire polymer, thus leaving behind inert humus (soil) and CO2 or Biogas.

From an environmental perspective there are a number of issues which arise from using oxo-degradables and PLA (plastics made from plant starch) products. Both oxo-degradable and PLA products require an environment with oxygen, UV, and heat in order to begin breaking down, these conditions are NOT often found in landfills.

Oxo-degradables are not biodegradable, they are simply degradable. It is important to understand that degradation is simply the loss of physical properties and does not necessarily include actual breakdown of the polymer chain or monomer. Oxo-degradable additives have been on the market for a number of years and as such there are a number of different versions used which will affect the breakdown of the products. These additives create weak links in the polymer chain which oxidize to create brittle plastic reducing the visible plastic. Oxo-degradable products do not completely degrade leaving behind harmful heavy metals and chemicals (plastic polymers, Cobalt, Cadmium and other toxic residue) in the ground and oceans. As a requirement, ALL oxo-degradable additives require oxygen, heat and UV in order to break down. These conditions are NOT found in landfills and will result in the products existing for many, many years.

PLA products require a very stringent environment to break down. These products must be placed in professional composting environments and **will not break down in landfills or on road sides or oceans**. The process for professional composting requires the products to be placed in a specialized compost facility which controls the specific heat, oxygen and moisture levels.

Recycling

The ability to recycle is an important aspect when choosing an earth-friendly polymer solution. There are billions and billions of bottles and packaging being dumped in landfills throughout the world, and recycling is one way to postpone the pollution problem. The majority of recycled plastics are either PET or PE bottles and products that contaminate these polymers should not be considered environmentally sound solutions.

ENSO products are completely recyclable and should be comingled with existing plastics recycling. Scientific data and independent recyclers support that these products will not contaminate recycle streams as the material used does not impact the polymer chain in any way.

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A Comparison of ENSO Plastics, Oxo-degradables and PLA

Oxo-degradable products bond to the polymer chain and create “weak links” that oxidize when exposed to oxygen and UV light. The simple fact that oxo-degradable products weaken the polymer chain and have a limited life span, makes successful recycling of these products very unlikely unless extremely diluted with standard polymers.

PLA is recyclable but not within the current recycling infrastructure; most recyclers have trouble with PLA due to PLA visually looking like PET. With PLA’s low melting temperature compared to PET, PLA is considered a contaminant and is causing some batches of recycled PET plastic to be unusable.

Conclusion

An ideal environmental solution will address both the sourcing and the customary disposal of the material evaluated. Unfortunately a sustainable sourcing solution is several years from commercial availability. Until then we are obligated to evaluate the disposal process and select the most comprehensive option available. Most all plastics will be recycled or disposed of in a landfill. It is almost impossible for most plastics today to enter commercial composting facilities.

It is estimated that more than 100 billion plastic bottles are added to landfills each year, and this is a small fraction of the overall plastic discarded. When a traditional plastic enters a landfill, it can take thousands of years to break down - if ever. This is because some landfills are so tightly packed and the available oxygen and moisture is severely reduced, creating conditions that are not optimal for product breakdown. As you can imagine, this can have a profound impact on our environment.

In order for plastics to properly break down, tiny microscopic organisms must find the discarded products an irresistible morsel, and begin consuming it bite by bite. Only then, can the item be broken down entirely. Traditional plastics are unattractive to microbes and therefore inedible.

Most plastic products on the market today cannot attract enough (if any) microbial activity to begin breaking down the polymer's molecular structure, thus leaving the process of reclamation to light, heat, mechanical stress and moisture. Products such as PLA and oxo-degradable materials claim to be biodegradable but are in fact only commercially compostable (unable to degrade in a landfill environment), or the product simply breaks down into smaller pieces (plastic flakes).

ENSO has created biodegradable polymers proven in both anaerobic and aerobic environments. ENSO products are designed to biodegrade in landfill environments leaving behind only inert humus (soil) and CO2 or Biogas.

An important characteristic of ENSO products is the ability to maintain the same physical properties (shelf life, texture, appearance, oxygen transfer rate, etc.) as traditional plastics and the ability to be recycled alongside traditional polymers. PLA and oxo-degradable products have a limited shelf life, reduced physical properties and contaminate the plastic recycling stream.

In conclusion, ENSO products are the ideal environmental solution for plastic applications and integrate beneficially in common disposal methods.

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Appendix A: A comparison between ENSO and other polymers on the market.

Table 1.0 – Comparison between ENSO and other technologies in the market.

Product	**ENSO**	PET Resins	PLA	Photo-degradable	Oxo-degradable	Wood Based Resins
Shelf Life	**Indefinite**	Indefinite	1 - 4 mo	2 - 4 mo	6 mo – 2 yrs	3 - 6 mo
Affected by Light	**No**	No	Yes	Yes	Yes	No
Affected by Heat	**No**	No	Yes	Yes	Yes	Yes
Affected by Moisture	**No**	No	Yes	Yes	Yes	Yes
Affected by Stress	**No**	No	Yes	Yes	Yes	No
Landfill Biodegradation	**<1 - 15 years***	Never	Never	Never	Never	Never
Compost Biodegradation**	**<1 - 15 years***	Never	30 - 180 days*	3 months - 5 years*	3 months - 5 years*	Almost impossible*
Remnants	**Biomass, Co2, Biogas**	Plastic resin	Co2, Biogas	Heavy metals, Plastic resin	Cobalt, Cadmium, and salts	Co2, Biogas

*Time requirement for biodegradation is dependent on a number of environmental factors such as temperature, moisture, Ph level and the quantity and quality of microorganisms – degradation results may vary.

** Commercial Composting requires a breakdown within 180 days. ENSO products are not commercially compostable.