# Earth Nurture Additive Past, Present and Future

## HISTORY

Our quest to develop an additive that will render all conventional plastic either biodegradable and/or compostable began several years ago. During this time we have worked with universities, plastics manufacturers and accredited laboratories in the USA, Europe and Eastern Asia.
During this time we have been developing a user friendly, economical additive that is not only compatible with non food applications but one that also meets and surpasses food contact safety legislation in the USA and Europe and almost all other countries worldwide. ENA now contains almost THIRTY different active ingredients, all of which have their own important role to play in biodegrading conventional plastic.

## MANUFACTURING

ENA's active ingredients are all commercially available chemicals. They are all either food or pharmaceutical grade and all of which are approved for food contact by the FDA and the EU Europe.  ENA is a mixture of these ingredients and not a compound. In other words, there are no chemical reactions involved in making ENA.  They are simply mixed together, injected into an extruding machine that mixes and melts the conventional plastic with the ENA ingredients. The extruder then ejects small pellets of plastic that incorporate ENA ingredients.

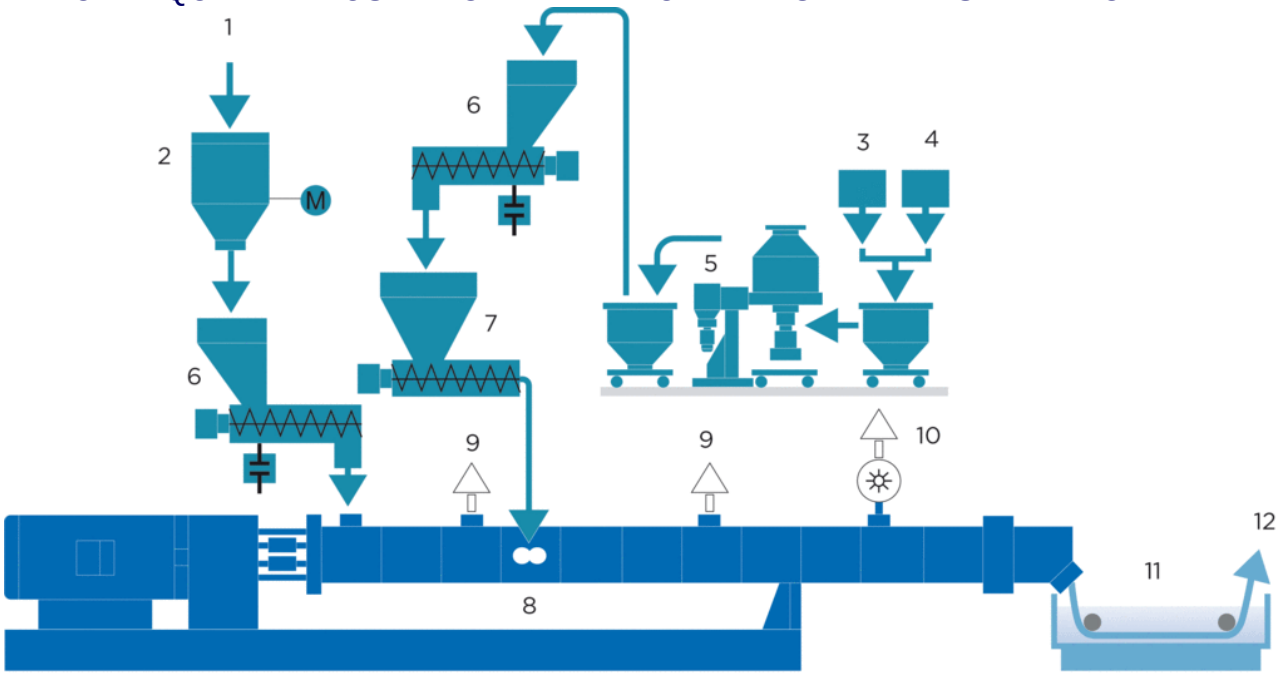
**TYPICAL MASTERBATCH PELLET**
**98% CONVENTIONAL PLASTIC AND 2% ENA**

These masterbatch pellets are sold to plastics manufacturers known as Plastics Converters. These companies already have similar, compatible extruder machines and it is therefore simplicity itself for them to add ENA to their own plastic products at very little additional cost.

## CUSTOMERS

By far our largest potential customers are Plastic Converters. Over the past few years worldwide interest has been generated and we have a substantial list of companies awaiting samples for evaluation. Because of the simplicity, user friendliness and low cost of ENA, these companies would be able to easily produce biodegradable and/or compostable products.
If the Converter is working under contract, it would be their customers that would specify the use of ENA. Marketing and sales efforts would be directed to both the Converters and their customers.
As you can see there is no need to buy pelletizing equipment to make the pellets, simply because there are many existing companies that offer the service of pelletizing ingredients in plastic. This service is called toll compounding. Perhaps the largest of these companies is Alloy Polymers, which pelletizes a half of a billion pounds annually.

TYPICAL EQUIPMENT USED TO MIX ENA ACTIVE INGREDIENTS WITH NORMAL PLASTIC




**Split-Feed Process**
**1** Polymer pellets I **2** Polymer silo I **3** Wax I **4** Pigment(s) I **5** Mixer I **6** Gravimetric feeder I **7** Twin-screw side-feeder ZS-B I **8** Twin screw extruder ZSK I **9** Degassing I **10** Vacuum pump I **11** Water bath I **12** To pelletizer

ENA already has a manufacturing partner for preparing and mixing the active ingredients. This company is a South Korean chemicals distributor, which is a spin off of Lanxess, which was itself a spin-off of Bayer Chemical. This partner also subcontracts the pelletizing of ENA, and will do the warehousing and distribution of ENA.

## COSTING

The cost details are, of course, confidential at present  but what we can say with certainty is that ENA can be sold at a very substantial profit if offered for sale at a cost of $300 USD or less. This is the amount needed to treat one metric ton of plastic. To illustrate, a metric ton of polyethylene (PE) currently sells for $1400 to volume buyers. By adding $300 you arrive at a total materials cost of $1700 a ton. This may be compared to Mater-Bi biodegradable plastic which costs about $5,000 per ton, and has far inferior mechanical properties compared with conventional PE.

## TESTING ENA FOR BIODEGRADATION

Due to a ruling by an administrative judge in the US last February, it is *already* legal for ENA treated plastics to be labeled and advertised as biodegradable in the US based on ASTM D5511 testing of ENA treated LDPE. ENA has been sufficiently tested to prove that it does indeed biodegrade LDPE in both aerobic (composting) and anaerobic (landfill) environments, at a rapid rate.

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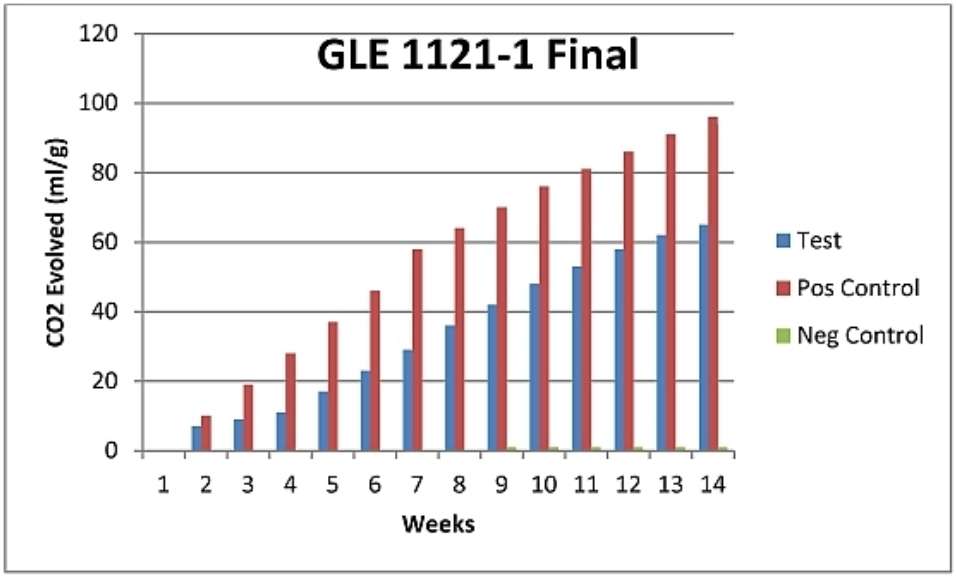
**Final* Laboratory Analysis Report**

Report No. 814-11121-1 5 Pages Report Date: 28 December, 2011




*Final Report as of 12/28/2011 (13 weeks)

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# Final* Laboratory Analysis Report

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| BML No. | Sample ID/Description | Analyte/Test Protocol | Results |
|---|---|---|---|
| 11121-1 | LDPE treated with ENA 2.0<br>150 g (6 Templates) | Aerobic Biodegradation<br>ASTM D-5338 | See Below |

| | | Aerobic Biodegradation | | |
|---|---|---|---|---|
| | | ----------CO2 Production---------- | | |
| 11121-1 | Week | Test | + Control | - Control |
| | 0 | 0 | 0 | 0 |
| | 1 | 7 | 10 | 0 |
| | 2 | 9 | 19 | 0 |
| | 3 | 11 | 28 | 0 |
| | 4 | 17 | 37 | 0 |
| | 5 | 23 | 46 | 0 |
| | 6 | 29 | 58 | 0 |
| | 7 | 36 | 64 | 0 |
| | 8 | 42 | 70 | 1 |
| | 9 | 48 | 76 | 1 |
| | 10 | 53 | 81 | 1 |
| | 11 | 58 | 86 | 1 |
| | 12 | 62 | 91 | 1 |
| | 13 | 65 | 96 | 1 |

The charts above are of the biodegradation of LDPE treated with 0.8% of ENA active ingredients. This is the biodegradation test used in ASTM D6400 / EN 13432. The LDPE is being converted by the microbes into carbon dioxide, something which many people have claimed to be impossible. This is a remarkable result, especially considering that the culture used by the laboratory resulted in slower biodegradation of the cellulose (positive sample) than the standard requires for validation.

The positive control, cellulose, biodegraded at about 1/2 of the rate of the validation requirement, so in fact the microbial culture was far less viable than required by the test standard.
Please note that these tests were done to prove conclusively that the concept that ENA causes a conventional polymer to quickly biodegrade into carbon dioxide. Full biodegradation testing is normally done over a 26 week period. The composting standards require that the plastic biodegrade by 90% of the biodegradation percentage of the cellulose sample, or about 86.4%, in six months.)

Further testing is being organized now in Germany. These new test regimes will enable us to label ENA treated plastic as compostable per the ASTM D6400 / EN 13432 standards. The manufacturing of the latest version of ENA3 and the biodegradation testing are being financed by our South Korean partner.

## THE BREAKDOWN PRODUCTS OF PLASTICS

The breakdown products of conventional plastics are well known, because they occur during the manufacture of thermoplastics. Every time plastics such as polyethylene or polypropylene are heated, they break down. They are heated repeatedly during the manufacturing process. First, when manufactured, they are melted in order to add additives such as antioxidants, and to form pellets. They are again heated when they are going to be made into something such as plastic film. During that second heating, they have various additives added to them to impart various properties, such as resistance to sunlight, resistance to sticking together, being made less slippery, adding color, increasing flexibility, etc.

If the end product is to be a plastic bag, the plastic is again heated at the points where it is to be welded together. Despite the inclusion of antioxidants, plastics deteriorate every time they are melted.
If anything toxic were generated during these processes, conventional plastics would not be permitted to be used for packaging food.

Furthermore, mulch films (agricultural film) made of LDPE are often treated with oxodegradable additives, which causes them to break down by oxidizing them, when they are heated or when exposed to UV light. The mulch film then fragments into pieces of oxidized plastic. These additives have been causing the break down of LDPE in fields for about 30 years, with no toxicity to plants or animals.

The breakdown products of polyethylene and polypropylene, the commonest plastics, are: lactones, ketoacids, alcohols, alkanes, alkynes, alkenes, mono and dicarboxylic acids, ketones and aldehydes. Essentially, these are descriptions of simple carbon / hydrogen chains of various lengths, with oxygen attached at various points. The human body is full of lactones, ketoacids, alkanes, alkynes, alkenes, mono and dicarboxylic acids, alcohols, ketones and aldehydes, because they are a part of our metabolism.

When polyethylene terephthalate (PET) is broken down, it becomes the materials it was made from, which are terephthalic acid and ethylene. Both of these materials have long been known to be intrinsically biodegradable, and harmless to the environment. It takes nature only a few weeks to fully mineralize the terephthalic acid and ethylene to carbon dioxide.

To those with little knowledge of chemistry, chemical names may sound imposing, but consider that our foods when described chemically sound very similar. For example, extra virgin olive oil is a mixture of various fatty acids bound together with glycerol, an alcohol, into triglycerides. Olive oil also contains many phenolic compounds, which give it its characteristic flavor.

## A NEW CONCEPT IN BIODEGRADABLE PLASTIC

ENA + THERMOPLASTIC STARCH (TPS)

Earth Nurture's current proposal is to manufacture thermoplastic starch, TPS, made out of casava (tapioca) starch mixed and heated with glycerol, a ubiquitous product found in nature, and which is abundant and inexpensive because it is a byproduct of biodiesel production. Water is used as a solvent in this process, and it is vented off as steam, so that there is very little moisture left in the TPS.

Glycerol is the substance that binds together fatty acids into triglycerides, the natural form in which vegetable oils are found.

TPS is a natural, amorphous biodegradable filler which can be used as a vehicle for the active ingredients of ENA. Furthermore, the use of the TPS as a filler in polyethylene and polypropylene, in a percentage between 30 and 70%, will result in the swift biodegradation of the plastic end product. This would occur because the filler will biodegrade, resulting in a sponge of the more recalcitrant to biodegradation conventional plastic - which will biodegrade much more quickly than a solid mass of plastic, due to the greatly increased surface area of the plastic.

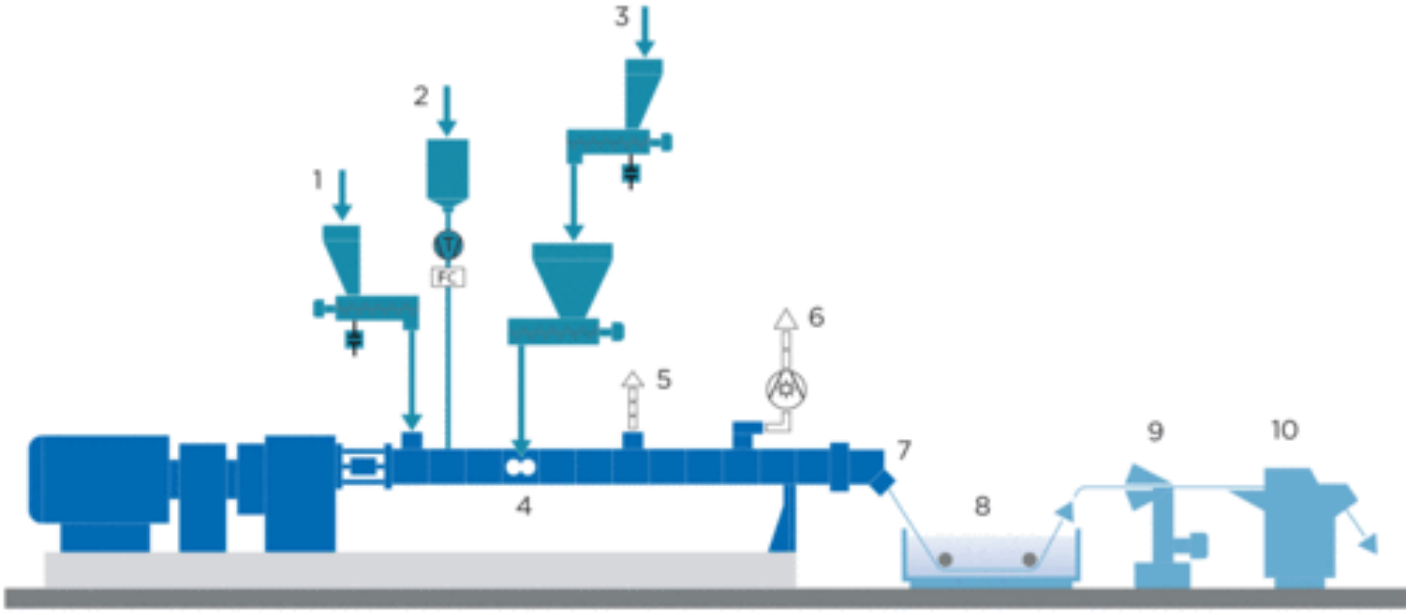
There is very little manufacturing capacity for TPS, and no company currently producing it wished to partner with Earth Nurture, so Earth Nurture proposes to make a factory for the manufacture of TPS.

The equipment required to manufacture TPS is called a reactive compounding twin screw extruder, and is available as a commercial product. The process is old enough that it is off patent, though certain details of some methods of making TPS are under current patent.

End products made by mixing TPS with conventional plastics can be advertised as having the given percentage renewable content. There is a Vincotte certification which can be used in labeling to advertise this feature in advertising and packaging. The TPS is sold in the form of pellets, like ENA, plastic raw materials, and other plastic additives. Both the TPS pellets, and TPS pellets incorporating ENA can be sold to plastics converters.

TPS can also be used as fillers with expensive bioplastics, such as aliphatic polyesters, in order to reduce the price of products made with the aliphatic polyesters. The US government has a policy of preferring the purchasing of products with renewable content, so there is a ready market for TPS filled plastics. Mater-Bi is said to be such a mixture of TPS and an aliphatic polyester.

## Equipment used to manufacture TPS




**Typical set-up for the production of Biodegradable Products**
1 Strach / Powder Premix I 2 Plasticizer / Liquid Additives I 3 Polymer Pellets I 4 Twin-screw Side-feeder ZS-B I 5 Atmospheric Degassing I 6 Vacuum Degassing I 7 Die Head I 8 Water bath I 9 Airknife I 10 Strand Pelletizer

The same factory line could also be used to make bioplastics such as PLA. Speaking of PLA, We also have an ENA version that would render PLA products biodegradable at ambient temperatures such as home composters.

| | | | |
|---|---|---|---|
| OK biobased VINÇOTTE | OK biobased VINÇOTTE | OK biobased VINÇOTTE | OK biobased VINÇOTTE |
| between 20 and 40 % Biobased | between 40 and 60 % Biobased | between 60 and 80 % Biobased | more than 80 % Biobased |

## Marketing and Sales

During the development of ENA we have, with our European partner Earth Nurture Europe, also developed a worldwide network of contract ENA agents and agencies. Each and every agent has been chosen because of their connections with the plastics industries in their geographical area. These agents have been granted the freedom to sell, not only in their own particular country or countries, but anywhere else in the world. This is a new marketing concept and instead of limiting the agent to a small exclusive geographical area the system relies on customer exclusivity anywhere in the world. Our latest agent is from Pakistan which is not shown here.