AHPI

Association of Hellenic Plastics Industries

“Plastics and the Environment”

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Addressing the Issue of Plastics Littering.

Presented by Andrew Barclay

Chairman BPF Biobased and Degradable Plastics Group

Technical Director

Wells Plastics Limited

Content

- The British Plastics Federation.
- Plastics in the Environment.
- The enhanced degradation of polymers
- Myths surrounding the technology
- How the products work
- Testing the claims
- Summary

BRITISH PLASTICS FEDERATION

BPF OVERVIEW

The British Plastics Federation

- Oldest plastics Trade Federation (established 1933).
- We work to promote the best interests of the UK Plastics Industry as a whole.
- Unique in Europe due to diverse membership which includes materials, machinery and processors.
- We represent 75% of UK Plastics industry by turnover.
- 430 direct member companies covering 140,000+ staff.
- Function through specific industry / interest groups.

Group Structure

This presentation

- This presentation is given in my capacity as chairman of the BPF's Bio-based and Degradable Plastics Group.

- It aims to give a non-parochial overview of oxo-biodegradable technology and its role in mitigating the effects of littering.

- Much of the technical data given is derived from Wells' own R&D activities but, of my colleagues and competitors within this industry, many have similar, independent information.

Wells Plastics Limited

- Wells has over 27 years experience as a specialist additive masterbatch manufacturer and compounder.
- We have our own in-house testing and development facilities.
- We are a major supplier to the polymer film, fibre, sheet, profile and moulding industries.
- Our additive masterbatch portfolio includes antimicrobials, flame retardants, process aids and many others.
- We manufacture hydro-biodegradable compounds as well as oxo-biodegradable masterbatches.
- We aim to add value for our customers through innovation and the provision of technical solutions.

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Littering and the Environment

- **Littered plastics waste is a growing global problem in both land and sea environments.**
- **Europe generates around 27 million tonnes of plastic waste every year of which Greece's share is around 515 thousand tonnes. Of the European total around 19 million tonnes is plastic packaging.** *(source : Eurostat)*
- **Recycling and energy recovery schemes are currently accounting for approximately 58% of the plastics waste available. The remaining 42% finds it way to landfill.** *(source : Plastics Europe 2011)*
- **A small proportion, however, is discarded outside of the normal waste stream and the greatest source of this "White pollution" has been attributed to supermarket plastic packaging.** *(source : China Daily News)*
- **To try and quantify this, "The U.S. Environmental Protection Agency says plastic grocery bags make up less than 0.5 percent of the litter stream."** (*source : Washington Examiner 31/10/11)*
- **Although this is a tiny proportion of the waste mountain, it can be seen to be a significant and increasing problem due to the high durability and longevity of plastics.**

The Oceanic gyres

- We are probably all familiar with the so called North Pacific and North Atlantic garbage patches.

- They may not be quite as you imagined.

- Here are two photographs taken by the well known oceanographer Miriam Goldstein ; the first taken from the centre of the Pacific Gyre and the second of a “table top” area of sea that she says contains “the highest plastic densities I’ve ever seen in three trips to the Gyre”

The Pacific Garbage Patch

Source : Miriam Goldstein, Seaplex Oceanic Study January 2011

The Pacific Garbage Patch

Source : Miriam Goldstein, Seaplex Oceanic Study January 2011

The Oceanic gyres

- **If, like me, you were expecting floating flotsam and jetsam then I guess you're as disappointed as I was!**
- **However, this is not to minimise the issue, just to put the journalistic hyperbole into perspective .**
- **These areas do exist and are largely (60-80%) made up from tiny plastic fragments which are thought by many to constitute a future environmental problem for the world.** *(Source : Gregory, M.R., Ryan, P.G. 1997. Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives.. In Coe, J.M., Rogers, D.B. (Eds.), Marine Debris- Sources, Impacts, Solutions. Springer-Verlag, New York, pp.49-66.)*
- **These plastic fragments are formed by the natural erosion of littered plastics by sun, waves and tides. The large items from which they are derived mainly come from land litter finding its way to the sea (80%) and litter / fishing tackle tipped / lost straight into the sea (20%).** *(Source :Faris, J. and Hart, K., Seas of Debris: A Summary of the Third International Conference on Marine Debris, 1994.)*
- **Despite the conjecture that surrounds the issue, one thing is apparent – we must look for a solution!**

Oxo-Biodegradable Polymers

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- The current issue has been caused by man's failure to properly control the disposal of conventional plastics.
- In an ideal world we would have adequate and universal recovery and recycling infrastructures with no littering, but in the meantime…
- Oxo-Biodegradable additives appear to offer the best solution to the problem of both terrestrial and marine littering.
- But, we must first overcome the antagonism towards the technology and dispel the incorrect myths that have been levelled at it.
- This is best done through the issue of transparent results from recognised test methods and the ongoing education of the public.

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Enhanced oxo-degradation of Polymers

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- **The basic technology behind the concept is certainly not new!**
- **Pioneering work was carried out by, for example, Gerald Scott (1973), Dan Gilead (1985), Gerry Griffin (1987) and others.**
- **This work led to the development of polymer based oxo-biodegradable masterbatches containing pro-oxidants and reaction enhancers/modifiers.**
- **These products have been in the commercial arena for at least 20 years and have found uses in many areas.**
- **Modern developments have improved the control over the reaction and this has widened the scope of use.**
- **Applications are predominately in the polyolefin film industry but there are other applications in a variety of sectors.**

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Myths surrounding the Technology

- **A broad variety of misinformation, disinformation and myth surrounds the oxobiodegradable technology.**
- **Anti-claims include :**

1. Products are dangerous / contain toxic heavy metals / are unsafe.

2. OBD films merely fragment into smaller pieces of plastic which remain in the environment with no further change.

3. Subsequent biodegradation (mineralisation) does not occur.

- **These untruths can be dispelled once the science is better understood and results scrutinised.**

Technology 1

Initial Polymer Breakdown

Degradation of Polymers

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- **The natural degradation of polyolefins occurs relatively haphazardly and at a low rate.**
- **The breakdown is generally instigated by exposure to heat and/or UV light, but subsequent microbial biodigestion remains very, very slow due to the polymer's high molecular weight and intrinsic hydrophobicity.**
- **This is the situation seen with the plastics fragments in the oceanic gyres.**
- **However, microbial digestion (biodegradation) can commence when the polymer's molecular weight is sufficiently reduced by initial degradation.**
- **Oxo-biodegradable additives have been developed to enhance, accelerate and control this breakdown process.**

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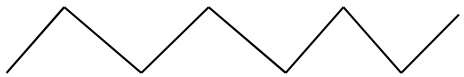
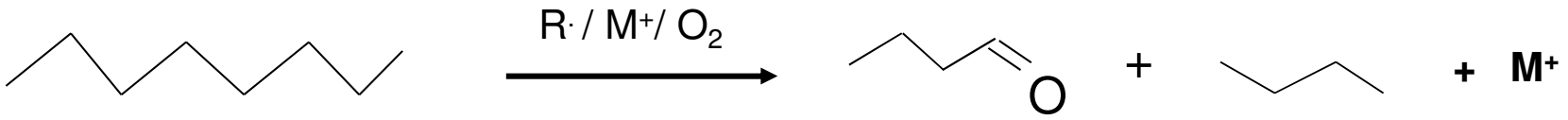
The Breakdown of Polyolefins through oxo-degradation.

eg POLYETHYLENE $[CH_2 – CH_2]_n$



Typical molecular weight 150,000 to 250,000

Chain scission can be achieved through free radical initiated catalytic oxidation by certain metal ions :



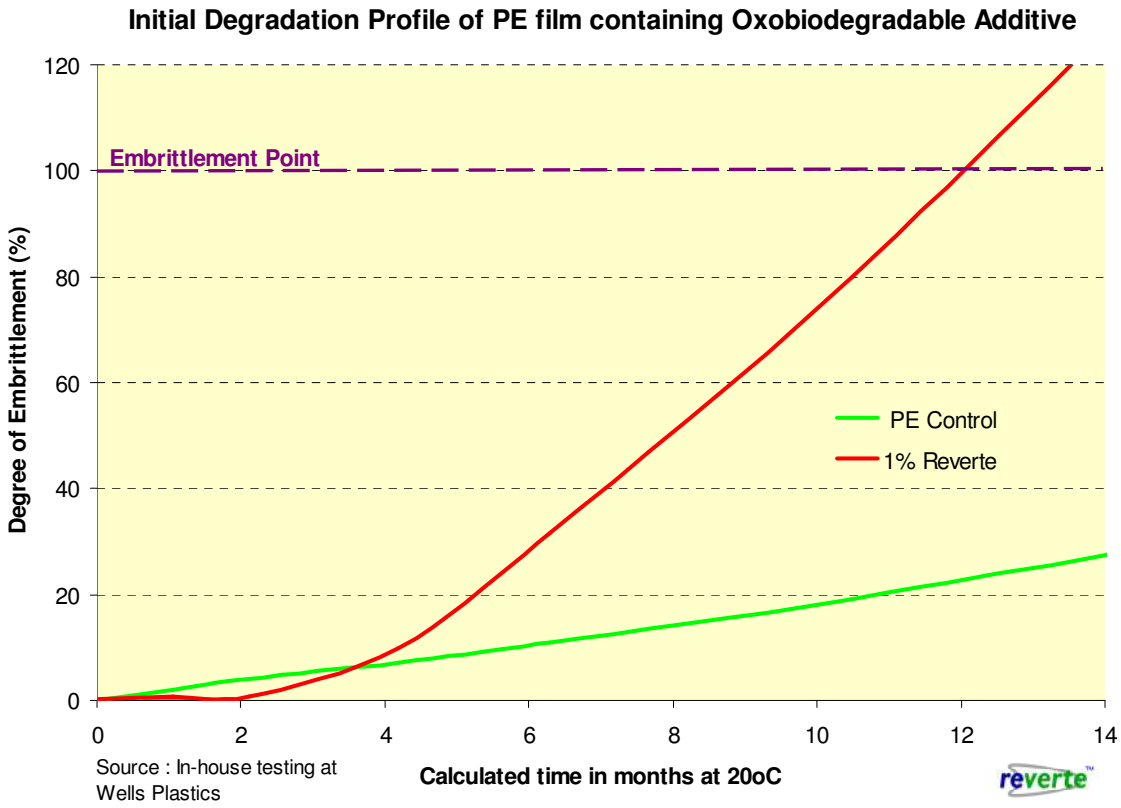
Oxidative degradation causes chain scission. A carbonyl group is formed at each break point. The carbonyl level can be measured to chart the reaction kinetics and Arrhenius principles used to estimate real-life performance.

The Metal ion catalyst is regenerated allowing the reaction to continue and chain lengths to become progressively smaller.

When the MW is reduced to below ~10,000 then microbial attack can occur in aqueous or non-aqueous environments.

PE Film Breakdown

Reverte HDPE check-out bag – After heat/UV exposure in an ageing cabinet at 50°C.



Results show a distinct dwell time of around 4 months followed by embrittlement after the equivalent of 12 months at 20°C.

Technology 1

So what does the initial breakdown look like?

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Technology 2

Molecular Weight reduction

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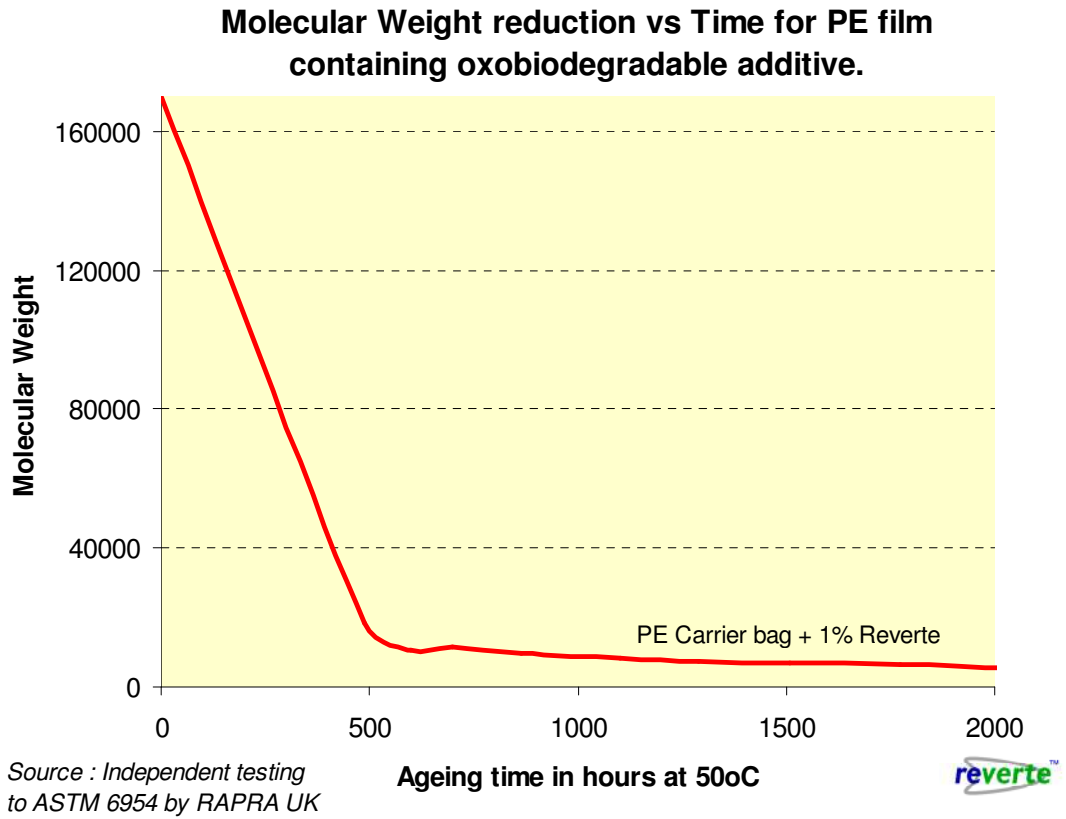
Molecular Weight Reduction 1

Reverte HDPE check-out bag – After heat/UV exposure in an ageing cabinet at 50°C.



Source : Independent testing to ASTM 6954 by RAPRA UK

The sample's MWt has been reduced from its initial 170,000 to <5,000 during the test period.

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Technology 3

Biodegradation

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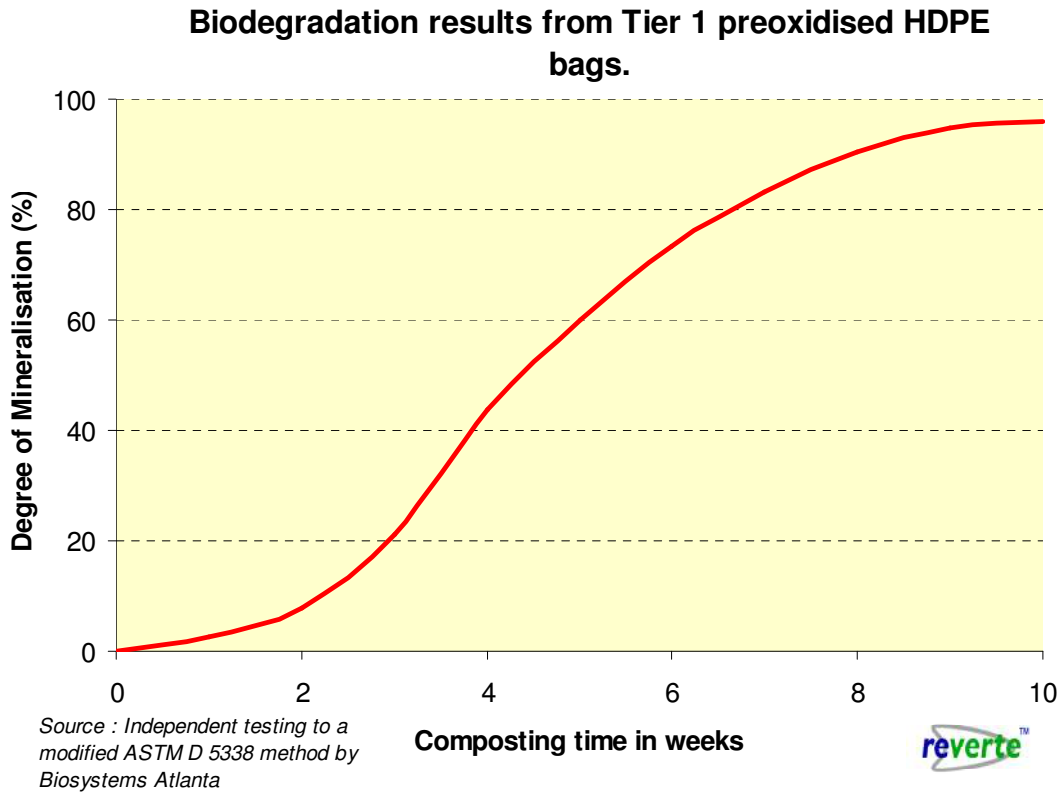
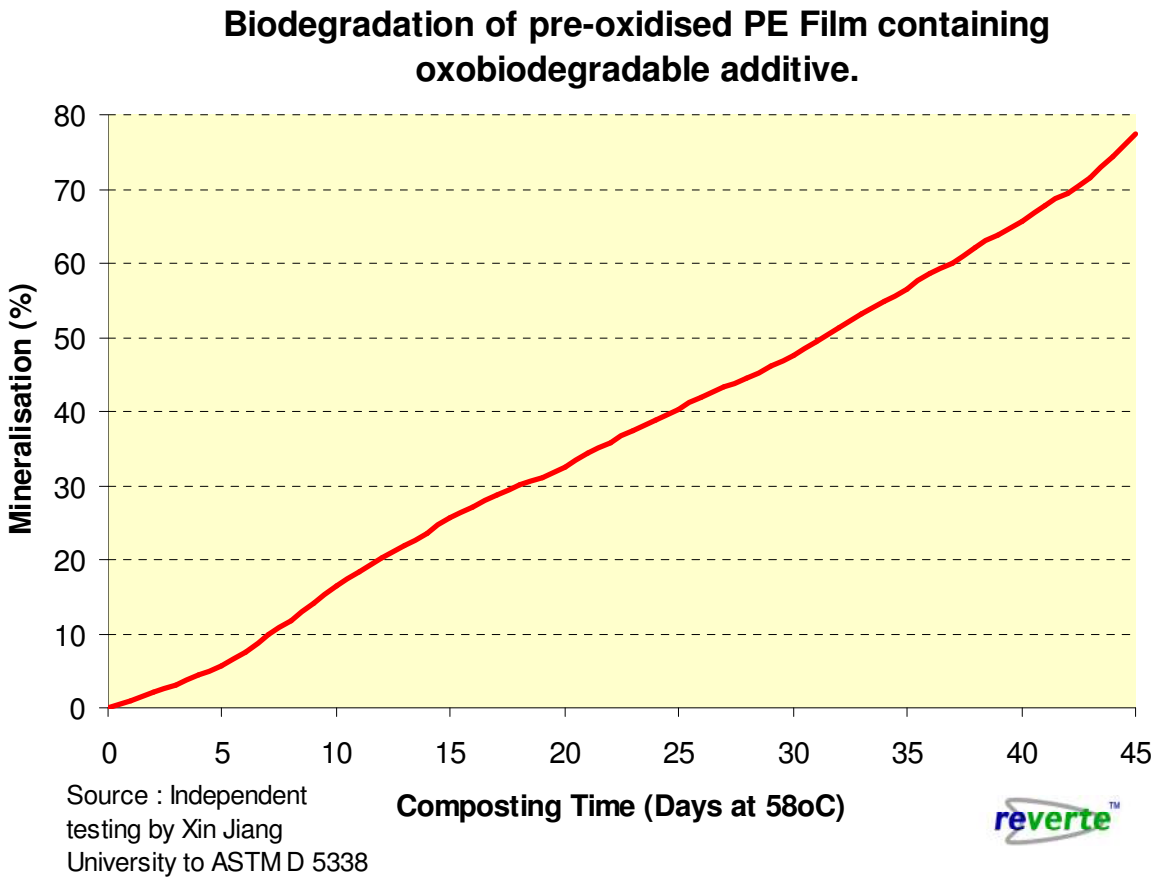
Biodegradation of Tier 1 preoxidised Reverte check-out bags



Mineralisation was achieved after only 10 weeks of biometry.

Biodegradation of Reverte LDPE Mulch Film



1. **Natural "on the field" ageing for 120 days to achieve pre-oxidation.**
2. **Subsequent >77% mineralisation was achieved after only 7.5 weeks of biometry.**

Technology 4

Toxicity / Food Contact

Reverte - heavy metals/ toxicity

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1. **In the USA heavy metals are regulated through the CONEG legislation. European legislation is almost identical and is regulated through 94/62/EC.**
2. **A representative selection of Reverte grades has been independently analysed (EPA 3052 protocol) and assessed by Smithers-RAPRA.**
3. **All have been found to comply with the CONEG / EC legislations with NO regulated heavy metals measurable in the masterbatches.**
4. **It has been shown that there is no build-up of toxic (or other) residues in soil even after many repeated years usage of OBD additives[1,2]. In fact mulching films have been used continuously in successive seasons in Israel, USA, Japan, China, Taiwan and some South American countries since 1975 with no evidence of residual plastics particles or loss of soil fertility year on year.**

1. *A.Fabbri in Degradable Polymers: Principles and Applications, 1st Edition, Editors, G.Scott and D.Gilead, Chapman & Hall (Kluwer), 1995, Chapter 11.*
2. *G.Cassalicchio, A.Bretoluza and A.Fabbri, Plasticulture, 86, 21-28 (1990).*

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Reverte – Food contact Approval

- **All Reverte grades have been formulated to be suitable for food contact applications.**
- **The major food contact specification bodies include the European Community (through EC directives including 2002/72/EC), Canada (CFIA) and, in America, the FDA.**
- **Reverte masterbatches, various polymer films and many products containing Reverte have been independently verified for food contact suitability under the European, Canadian and North American directives as well as in other countries such as China.**
- **Smithers-RAPRA have undergone independent examination and testing of all categories of Reverte products and have found them suitable for food contact as above.**

Technology 5

Ecotoxicity

ASTM D 6954 - Tier 3 Ecotoxicity

- **The Reverte HDPE carrier bag material has been tested for ecotoxicity according to the above method.**

- **The eco toxicity testing included :**

1. **Short term toxicity - Amphipod, Hyalella azteca - survival and Growth Test.**
2. **Long-term Toxicity - Earthworm (OECD 207).**
3. **Long-term Toxicity - Germination - oat, radish and mung bean (OECD 208).**

- **The testing demonstrated no significant differences between the Reverte sample and the control.**

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ASTM D6954
Test Results

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ASTM D 6954 – test results

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- **The Reverte HDPE carrier bag has has now been serially put through all three testing tiers of ASTM D 6954.**

- **All testing was carried out by accredited third party test houses.**

- **The results obtained were :**

✓ **Tier 1 : The product was shown to have undergone a Molecular Weight reduction to <5,000 from its initial M Wt of 170,000.**

✓ **Tier 2 : Biodegradation of the pre-oxidised product gave a result of >96% biodegradation after 10 weeks of biometry.**

✓ **Tier 3 : Heavy metal analysis demonstrated that no proscribed heavy metals were found in the product. Ecotoxicological testing showed no differences between the Reverte sample and the control.**

It can be seen that very satisfactory results were obtained from the testing.

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SUMMARY

- **Terrestrial and oceanic littering is an ongoing issue that needs to be addressed.**
- **Oxobiodegradable polymers appear to offer the only technical solution to the littering problem.**
- **OBD additives are not a new concept but they have been technically refined over the years to increase their application suitability.**
- **The "myths" regarding toxicity, mere fragmentation into smaller plastic shards and no subsequent biodegradation have been shown to be ill-founded.**
- **In fact Reverte films have been shown to give excellent results in all three tiers of the demanding ASTM D 6954 test method with very rapid biodegradation following controlled oxidation and no adverse ecotoxicological ramifications.**
- **Oxobiodegradable additives have become an important product of choice in a broad variety of plastics products and their continuing growth is a testament to their proven efficacy in the right applications.**

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