OXO-BIODEGRADABLE PLASTICS ASSOCIATION

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THE RELEVANCE OF BIODEGRADABLE PLASTIC

At the present time and for most applications plastic is the best option for protecting our food and other goods from damage and contamination and for carrying them home. It is waterproof, strong and flexible; it can be adapted for a variety of products, it is not expensive, and is made from raw materials which are readily available. A Life-cycle Assessment[1] done by Intertek for the UK Government put plastic ahead of all the other materials used to make shopping bags.

Special plastics are now available which are biodegradable. For the sake of clarity, there are two very different types of biodegradable plastic:

- Oxo-biodegradable - made from polymers such as PE, PP, and PS, containing extra ingredients (which do not include "heavy-metals") and tested according to ASTM D6954 or BS8472 or AFNOR AC T51-808 to degrade and then biodegrade in the open environment.

- Vegetable based plastics - (also loosely known as "bio-based plastics" or "bioplastics" or "compostable plastics") tested according to EN13432 or ASTMD6400 to biodegrade in the special conditions found in industrial composting.

There are in addition some additives marketed as "enzymatic" or "microbiological" but these are not oxo-biodegradable, and it is doubtful whether the plastic (as distinct from the additive) will degrade.[2]

There are three issues to which biodegradable plastic is relevant:

- LITTER
- RESOURCE DEPLETION
- FOOD WASTE

LITTER

It is a fact that every year, approximately 280 million tons of plastic is produced globally, but much of it ends up as litter polluting land and sea. Plastic pollution of the open environment is a worldwide problem, and that is why campaigners around the world are trying to ban plastic bags[3].

In an ideal world all plastic waste would be collected, but we don't live in an ideal world. So here we have a dilemma - what do we do with the thousands of tons of plastic which cannot realistically be collected for recycling or other forms of responsible disposal, and escapes into the open environment, endangering wildlife and clogging up waterways? We have to make sure that it does not remain as a plastic in the open environment for decades.

In order to meet this challenge oxo-biodegradable plastic was invented In Britain and developed by very distinguished polymer scientists in Britain, France, Sweden, Italy, Brazil, Australia and Canada. There is little or no additional cost, as it can be made with the same machinery and workforce and with the same raw-materials as conventional plastic.

The problem which oxo-biodegradable plastic addresses has nothing to do with landfill, because if the plastic has been collected and sent to landfill it is no longer in the open environment. Biodegradation is not desirable in landfill, because biodegradation in anaerobic conditions generates methane, which is a dangerous greenhouse gas, more powerful than CO_2. Plastic should not be

[1] http://www.biodeg.org/files/uploaded/biodeg/Carrier_Bags_Report%20EA%2018-02-11(5).pdf
[2] http://www.biodeg.org/files/uploaded/biodeg/executive_summary/ENZYMATIC%20ADDITIVES%201.7.13.pdf
[3] http://www.biodeg.org/files/uploaded/biodeg/executive_summary/PLASTIC%20BAG%20BANS%20AND%20TAXES%2013.11.13.pdf

landfilled at all, and soon it will not be allowed in Europe – because plastic is useful for its calorific value and for recycling. Some landfills are designed to collect methane but how do you know at the point of manufacture whether your plastic item will end up in one of them? A bio-based "compostable" plastic will generate methane in anaerobic conditions but an oxo-biodegradable plastic will not.

Oxo-biodegradation is officially defined by CEN[4] as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively." It has been studied by scientists for many years, most recently at the Technical Research Institute of Sweden and the Swedish University of Agricultural Sciences, and a peer-reviewed report of the work was published in Vol 96 of the journal of Polymer Degradation & Stability (2011) at page 919-928. They found 91% biodegradation within 24 months. See also statement by French academics at http://www.biodeg.org/French%20academics%20criticise%20EU%20for%20failing%20to%20understand%20oxo-biodegradable%20plastics%2014.11.14(1).pdf

Oxo-bio plastic has the same strength as ordinary plastic, but it automatically and entirely converts in the presence of oxygen into CO_2, water, and biodegradable materials after its designated useful life. Light and elevated temperatures are not necessary for the conversion process, but they will accelerate it. Nor is moisture necessary. The plastic does NOT just fragment into small pieces. When it has become biodegradable it is no longer a plastic, and it has to pass the tests in BS8472 or ASTM D6954 or AFNOR AC T51-808 to prove that it is biodegradable and non-toxic and that it does not contain heavy metals. It does not therefore leave microplastics, and the particles of plastic found in the oceans by NGOs and scientists are particles of ordinary plastic.[5]

If oxo-biodegradable plastic merely fragmented without biodegrading, CEN would not have defined oxo-biodegradability, and the American and British and French Standards authorities would not have included tests for biodegradability in ASTM D6954, BS8472 and AC T51-808.

Oxo-biodegradable plastic is already used by environmentally-responsible companies around the world, and is mandatory in Africa, Asia and the Middle East, where governments recognise that making plastic smarter is preferable to trying to ban it. They do not want to leave plastic waste in the environment as a problem for future generations, and they understand that oxo-biodegradable plastic offers an "insurance policy" if all else fails. These countries have a combined population of 195 millions, and other countries will be following their example. Factories and retailers will not be able to export to those countries unless their plastic products contain oxo-bio technology.

Intertek wrote another LCA for shopping bags in 2012[6] which this time included the litter metric, and they put the environmental credentials of oxo-biodegradable plastic ahead of bio-based and conventional plastic.

Oxo-biodegradable technology can defend the polymer resin-suppliers and their manufacturing customers from complaints from politicians and environmentalist around the world that their products should be banned because they can lie or float around in the environment for many decades. There are also non-biodegradable polymers made from vegetable sources such as sugar-cane, and they too would benefit from the inclusion of oxo-biodegradable technology because they are not otherwise degradable.

The abiotic phase of oxo-biodegradation can be as short as a few months depending on the heat, UV light, and stress in the disposal location, and as the fragments are invisible at the end of that phase it is not important (except in some special applications which do not apply to shopping bags) how long they take for total bio-assimilation. The residues are completely harmless, as proved by the OECD eco-toxicity tests required by the international standards for oxo-bio, and it is also proved that they do NOT include heavy metals. The material has also become hydrophilic and polar - so it will stick to the earth and will be much less likely to blow around as dust than would fragments of conventional plastic. Materials such as twigs and straw, which are obviously biodegradable, will usually take much longer than oxo-biodegradable plastic to completely bio-degrade.

In the USA the FTC has issued guidelines as to timescale for degradation. Their one-year time limit is applicable only to cases where an unqualified claim is made - but not where the claim is qualified by stating the expected timescale, if more than one year.

[4] the European Standards Organisation
[5] http://www.biodeg.org/files/uploaded/biodeg/Plastics%20in%20the%20Marine%20Envmnt%20-%20Sym%203%20Aug%202013_1_.pdf
[6] http://www.biodeg.org/files/uploaded/biodeg/Intertek%20Final%20Report%2015.5.12(1).pdf

Starch is not used in oxo-biodegradable plastics, as the starch will degrade but not the plastic. Undegraded polymers will repel water, and commonly-occurring microbes have not been proved capable of biodegrading plastics unless the molecular weight of the plastic has been substantially reduced by oxidation. This reduction can be promoted rapidly by an oxo-biodegradable catalyst - or by a natural process over many decades.

After the molecular reduction has occurred the material has become hydrophilic and will be converted into water and humus by commonly-occurring bacteria and fungi, and no special micro-organisms are required. When anything degrades in aerobic conditions CO_2 is released, and in the case of bio-based plastic this occurs very rapidly to satisfy EN13432 and ASTM D6400. By contrast, oxo-biodegradable plastics release CO_2 much more slowly, and it can be absorbed by surrounding vegetation as a food-source.

It is often said that biodegradable plastic is a licence to litter, but this is no more than an assertion. It is impossible to tell the difference by appearance, touch, or smell, and even if there were a label, the type of people who cause litter are not likely to look for the label before deciding to throw a plastic bag out of a car window.

If we are concerned about litter in the environment which cannot realistically be collected, there is no point in choosing "compostable" plastics, which obviously have to be collected before they can be composted. By contrast, oxo-biodegradable plastics can be re-used and recycled during their useful life, and only if they do not get collected will they ultimately degrade and biodegrade in the open environment.

RESOURCE DEPLETION

Oxo-biodegradable and other oil-based plastic do not cause resource-depletion, because they are made from a by-product of oil which used to be wasted. The oil is extracted to make fuels, and the same amount would be extracted even if oil-based plastics did not exist. For the foreseeable future therefore until other fuels are found for vehicles, ships, and aircraft, it makes sense to use this by-product instead of consuming huge amounts of fossil fuel in the agricultural production and polymerisation process of "bio-based" plastics.[7] It would therefore be misleading to describe bio-based plastics as renewable. By contrast the supply of raw material for oil-based plastics is for all practical purposes unlimited for the foreseeable future.

There are some who regard recycling as the greatest good, to which every other environmental and economic factor should be subordinated, but perhaps we need to revisit that assumption. Yes, let's recycle where the raw material is in short supply or is particularly valuable, or where it makes sense for other reasons, but we must take into account the fossil fuel used, the road space occupied, the CO_2 and pollution emitted, and all other factors involved in collecting, baling, cleansing and reprocessing plastics. In some circumstances and with some types of plastic e.g. PET bottles, it makes sense, but not always.

There is no oxo-biodegradable additive effective for PET bottles, so we are here concerned with short-life products such as shopping bags, garbage sacks, and other products made from PE, PP or PS.

Post-household plastic waste consists of a variety of different polymers, usually contaminated with other materials. Separation is possible but is expensive and is hard to justify in economic or environmental terms. These polymers are not suitable for food-contact if recycled, and if recycled at all they will typically be used for low-value, short-life items for which degradability is a desirable feature. Supermarket carrier bags are normally made from HDPE + $CACO_3$, and these bags are not suitable for recycling into long-life films. They would be used to make similar short-life products.

Oxo-biodegradable plastic CAN be recycled if collected during the useful life of the product, without the need for separation,[8] but if separation were required the oxo-biodegradable plastics industry could easily include a marker at little or no extra cost.

Unlike bio-based plastic, the useful life of oxo-biodegradable plastic can be controlled by adjusting the

[7] See Infographic at http://www.biodeg.org/files/uploaded/Hydro-biodegradable%20Plastic%20Production%20Process.pdf
[8] http://www.biodeg.org/files/uploaded/ROEDIGER%20REPORT%2021%20May%202012.pdf

formulation of the additive (not the amount of the additive) as required. Typically degradation will not start for 6 months in the case of a bread wrapper, or 18 months for a plastic shopping bag (in order to allow re-use), and if the item is not collected for recycling during this time it probably never will be. Oxo-biodegradable plastics are designed so that they will not degrade in storage, and fitness-for purpose for the required period can be guaranteed.

A specialist laboratory carried out detailed tests in 2012, and 2013[9]. They concluded that (a) bio-based 'compostable' plastics cannot be safely recycled with oil-based plastics, but that (b) plastics made with oxo- biodegradable technology could safely be recycled in a post-consumer waste stream without the need for separation. In the last two years alone, enough masterbatch has been sold to make 600,000 tons of oxo-biodegradable plastic products. We know that these products have been successfully recycled for the past 10 years by OPA members and their customers around the world, and in those ten years we have heard no reports of any difficulty encountered.

Our experience is entirely consistent with the Roediger report, that oxo-bio plastic can be safely recycled, and recyclers have presented no technical evidence and no experience to the contrary.

It is time for a much better dialogue between the recyclers and the oxo-biodegradable plastics industry. If we can combine the use of oxo-biodegradable technology with the three R's of 'Reduce, Reuse and Recycle', we can all help win the war against plastic waste for the lasting benefit of future generations.

FOOD WASTE

In the first place we need to protect food from damage and contamination, and for this purpose plastic is indispensible. In today's fast moving society it is inconceivable that enough food could be put on enough tables within the required timescale, without using plastic. For the reasons given above this should be oxo-biodegradable plastic.

Second, we need to educate ourselves not to waste food, and not to use scarce agricultural land and water resources for producing bio-fuels and bio-plastics, instead of producing food.

Third, we need to collect food waste from our dining tables and kitchens and send it for anaerobic digestion instead of to landfill. For this purpose, and for this purpose only, bio-based "compostable" plastic is useful, as it will biodegrade in anaerobic conditions. It is already being made available to households by Local Authorities and there is no need to legislate for this. The plastic can not however be converted into compost, because EN13432 and ASTM D6400 require it to convert rapidly to CO_2 gas.

It is not appropriate to make shopping bags from bio-based plastics, because they would be hydrophilic and not strong enough, and would be up to 400% more expensive. Most of the shopping bags would not go to a composting facility, and would end up in landfill where they would generate methane, or in the outdoor environment where they have not been tested for biodegradation.[10]

There is no type of plastic suitable for home-composting and there is no Standard for this nor likely to be. This is because composting has to be carefully managed to create and maintain the conditions prescribed by a Standard, and this cannot be expected in home composting. Home composting has been used for grass and other garden wastes for many years but it is not suitable for kitchen waste, because temperatures are not likely to be high enough to kill the pathogens, and an incorrectly managed composting unit will attract rats, foxes, and other vermin.

See below as to:

HYDRO-BIODEGRADABLE
(Sometimes known as bio-based or "compostable" plastic)

This is designed to be taken to an industrial composting or anaerobic digestion unit, of which there are very few, and to biodegrade in the special conditions found in those industrial processes. It does not therefore address the problem of plastic litter in the open environment. In addition:

1. It is too expensive for everyday use – costing up to 400% more than ordinary plastic. Even if this cost were substantially reduced in the future it is far too expensive for ordinary people.
2. When something is described as compostable an ordinary consumer would think that it can

[9] http://www.biodeg.org/files/uploaded/biodeg/Roediger%20on%20TCKT%20Rept%205%20Dec%20'13.pdf
[10] EN13432 and ASTM D6400 test for biodegradation in the special conditions found in industrial composting, not in the outdoor environment.

be converted into compost, but the Standards for this type of plastic (ASTM D6400, EN13432 etc.) require it to convert into CO_2 gas within 180 days. You cannot therefore make compost from it – only greenhouse gas. This process contributes to climate change but does nothing for the soil, and it cannot be described as organic recycling.

3. The Federal Trade Commission of the USA has said[11] that it is not sufficient to show that a test item had complied with ASTM D6400 or D6868 [or EN13432 or the ISO equivalents]. The Commission found that those standards "likely do not typify compost facility operations nationwide. Rather they reflect "optimum [operating] conditions and ignore wide variation in actual facility operations. Because of these variations, the test protocols likely do not replicate typical compost facility environments. Therefore, consumers whose local facility [if they have one at all] operates differently than the ASTM assumptions would be deceived if the item were incapable of being composted."
4. It is not suitable for home composting.
5. It should not be described as "biodegradable" because it will fragment in the open environment but is tested for biodegradation only in the special conditions found in industrial composting or anaerobic digestion.
6. It is not really suitable for shopper bags because they need to be strong and inexpensive, and to be capable of re-use many times before final disposal.
7. It cannot be made by plastics factories with their existing machinery and workforce, and any large-scale introduction of this type of plastic would lead to job-losses in the existing plastics industry.
8. It is not "renewable." It contains up to 70% oil-based polyester, and consider also, the non-renewable fossil fuels consumed and CO_2 emitted by the machines used to clear the land, plough the land, harrow the land, sow the seed, make the fertilisers and pesticides and bring them to the farm, spray the crops, harvest the crops, take the crops to a polymerisation factory, and operate the autoclaves.[12]
9. Deep in landfill it can generate methane, which is a greenhouse gas much more powerful than CO_2. Oxo-biodegradable plastic does not degrade deep in landfill and does not therefore generate methane.
10. It is not desirable to use land and water resources to grow crops to make plastic. Those resources should be used to produce food for the many people in the world who do not have enough to eat. The European Parliament[13] has resolved not to encourage the use of land and water resources for producing bio-fuels (and the same reasoning applies to bio-plastics). The UN issued a report to the same effect on 31st March 2014. Nestlé believes[14] that allocating agricultural land and water to biofuel production will severely impact food and water security. In their view *"Forecasts of food production suggest that significant challenges exist for the world to feed future generations…..Even a small percentage of energy from crop based biofuels has a devastating effect on the food market. Biofuels are often promoted as a strategy for reducing anthropogenic GHG emissions. However, according to the agricultural practices used, there may be no net GHG benefits from converting agricultural crops to biofuels, whilst the conversion of forests or land for biofuels may lead to emissions that are higher than fossil fuels (in addition to losses in biodiversity). The water intensity of biofuel crops will put additional stresses on surface and ground water supplies and act as competition to other water users, particularly the water needed to grow food."*
11. There is in any event not nearly enough arable land and water to grow crops to make enough bio-based plastic to replace ordinary plastic, even for shopping bags.
12. It is sometimes claimed that the growing crops absorb CO_2 but that would be true of the vegetation that was there before.
13. It is not really suitable for agricultural mulch films, because the degradation time cannot be controlled in line with the growing cycle.[15]
14. It cannot be recycled with ordinary plastics,[16] so anyone who is in favour of recycling should be against it.
15. It is generally thicker and heavier, so it needs more trucks to transport it, using more road

[11] http://www.ftc.gov/os/fedreg/2012/10/greenguidesstatement.pdf
[12] See Infographic at http://www.biodeg.org/files/uploaded/Hydro-biodegradable%20Plastic%20Production%20Process.pdf
[13] (P7_TA-PROV(2013)0357)
[14] Appendix to The Nestlé Policy on Environmental Sustainability Feb 2013
[15] Oxo-biodegradable plastics can be controlled by adjusting the formulation of the additive
[16] http://www.biodeg.org/files/uploaded/biodeg/executive_summary/Roediger%20on%20TCKT%20Rept%205%20Dec%20'13.pdf

space, consuming more fuel, and emitting more CO_2 and other forms of pollution to atmosphere.

16. Bio-based plastic will not comply with the laws of the United Arab Emirates, Pakistan, and other countries which require all short-life plastic goods and packaging exported to those countries to be oxo-biodegradable.
17. An LCA by Intertek, published by the UK Government in 2011 and a further LCA by Intertek in 2012[17] found that ordinary plastic and oxo-bio plastic has a better LCA than bio-based plastic or paper bags.

[17] http://www.biodeg.org/files/uploaded/biodeg/executive_summary/Intertek%20Final%20Report%2015.5.12(1).pdf