OXO-BIODEGRADABLE PLASTICS ASSOCIATION
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The New Plastics Economy

Rethinking the future of plastics

Applying circular economy principles to global plastic packaging could transform the plastics economy and drastically reduce negative externalities, but we need to go one step further.

Oxo-biodegradable plastic should be seen as part of an overall strategy to improve the environment

SUMMARY

- **All plastics fragment when they degrade**
- **Ordinary plastics (and fragments of them) lie or float around in the environment for decades**
- **Bag taxes, and encouragements to reduce and recycle, are not enough, because thousands of tons of ordinary plastic will still get into the environment every day.**
- **It is no longer acceptable to use ordinary plastic for everyday items.**
- **All plastics should urgently be made oxo-biodegradable, so that they will degrade and biodegrade in a much shorter time if they get into the open environment.**
- **It has been proved that Oxo-biodegradable plastics biodegrade on land and in seawater, and do not leave harmful residues**
- **Oxo-biodegradable plastics cost little or no more than ordinary plastics and can be made by the same factories.**
- **Oxo-biodegradable plastics can be recycled with ordinary plastics if collected during their useful life.**
- **Plastics do not cause oil-depletion, so there is no need to switch to expensive crop-based alternatives, which consume scarce land and water resources as well as fossil-fuels.**
- **Crop-based plastics are the wrong choice if we are concerned about litter – because they are tested to biodegrade in an industrial composting unit – not in the open environment.[1] Nor do they convert into compost – they convert into CO_2 gas.**

This Association fully supports the idea of a circular economy for plastics, and oxo-biodegradable plastic is entirely consistent with those principles. We support the redesign of plastics, we support re-use of plastics, and we support recycling of plastics.

Plastic is an important material for our economy. Global plastics production has grown exponentially since the 1960s, reaching 311 million tonnes produced in 2014, a twentyfold increase. It is expected to reach up to 1.2 billion tonnes annually by 2050.

At the present time and for most applications plastic is the best option for protecting our food and other goods from damage and contamination. 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[2] done by Intertek for the UK Government in 2011 put plastic ahead of all the other materials used to make shopping bags. Intertek wrote another LCA for shopping bags in 2012[3] which included the litter metric, and they put the environmental credentials of oxo-biodegradable plastic ahead of bio-based and conventional plastic.

[1] EN13432 para 1. provides that "This European standard makes provision for obtaining information on the processing of packaging in controlled waste treatment plants, but does not take into account packaging waste which may end up in the environment through uncontrolled means, ie as litter."
[2] http://www.biodeg.org/files/uploaded/biodeg/Carrier_Bags_Report%20EA%2018-02-11(5).pdf
[3] http://www.biodeg.org/lifecycleassessments.html

All plastics (whether oxo, bio-based, or conventional) create fragments when they degrade, and whilst the amount of plastic waste and leakage into the environment can be reduced by suitable policies, the only way to prevent plastic fragments getting into the environment entirely is to ban all plastics, which is clearly not practicable. However, special plastics are now available which are biodegradable, and will be naturally biossimilated in a much shorter time than fragments of conventional plastics.

The term "biodegradable plastic" should not be used, as it immediately begs the question whether you mean oxo-biodegradable or hydro-biodegradable. These two are completely different technologies, with different purposes:

- Oxo-biodegradable – is made from polymers such as PE, and PP, and contains special ingredients (which do not include any metals exceeding the prescribed limits). It is tested according to ASTM D6954 or BS8472 or AFNOR AC T51-808 to degrade and then biodegrade in the open environment with no toxicity.

- Crop-based hydro-biodegradable plastics - (also loosely known as "bio-based plastics" or "bioplastics" or "compostable plastics") tested according to EN 13432 or ASTM D6400 to biodegrade in the special conditions found in industrial composting.

There are also polymers made from crops such as sugar-cane, and they would benefit from the inclusion of oxo-biodegradable technology because they are not otherwise biodegradable. 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 at all.

Starch is not used in oxo-biodegradable plastics.

Oxo-biodegradable plastic masterbatches are produced in many locations worldwide, including Europe, and are already used around the world. Oxo-biodegradability is actually mandatory in some countries 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 have followed their example, most recently Saudi Arabia. Factories and brand-owners will not be able to export to those countries unless their plastic products are made with oxo-bio technology.

A public-opinion poll by You Gov in the UK in July 2015[4] showed that 85% of people thought that all plastic carrier bags should be both recyclable and biodegradable in case they accidentally get into the open environment. A similar result was found in Mexico.

For oxo-biodegradable plastics generally see www.biodeg.org

There are four issues of particular concern:

- LITTER
- RESOURCE DEPLETION
- RECYCLING
- FOOD WASTE

LITTER

It is well known that millions of tonnes of plastic waste end up in the environment every year.[5] Plastic packaging is estimated to represent the highest share, as its weight, size and low-value make it prone to uncontrolled disposal. Plastic pollution of the open environment is a worldwide problem, and that is the principal reason why campaigners around the world are trying to ban or tax plastic bags[6]. The level of pollution by plastic litter and microplastics is alarming, and almost all of it is conventional plastic, which can persist in the environment for decades. It is necessary to move away from conventional plastic as a matter of urgency.

[4] http://www.symphonyenvironmental.com/wp-content/uploads/2015/11/YouGov-Results-23.7.15.pdf
[5] J.R. Jambrek et al "Plastic waste inputs from land into the ocean." 347 Science pp 768-771
[6] http://www.biodeg.org/bagbansandtaxes.html

In an ideal world, all the used plastics would be collected, but we don't live in an ideal world. In some countries government strategy aims at improving the economics, quality and uptake of plastic recycling and reuse, and reducing plastic leakage into the environment, and we agree with this. However, there is nothing in this strategy for dealing with the thousands of tons of plastic which (despite the strategy) will for the foreseeable future still escape into the open environment, endangering wildlife and clogging up waterways. Somehow, we have to make sure that it does not lie or float around for decades.

In order to meet this challenge oxo-biodegradable plastic was developed by polymer scientists. 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. Oxo-biodegradable plastic is almost identical with conventional plastic, except that it will quickly degrade and then biodegrade, leaving no fragments of plastic if it gets into the open environment as litter. It is important to stress that this is consistent with a circular economy. This is because oxo-biodegradable plastic items can be redesigned, they can be re-used unless and until they get into the open environment as litter, and they can be recycled[7] without the need for separation if collected during the useful life of the product. Oxo-biodegradable plastic is not designed to be deliberately lost to the economy - it is there to protect the environment if all else fails.

Primary Microplastics – used in products such as cosmetics and made from PE, or PP can be made oxo-biodegradable.

The problem in the open environment which oxo-biodegradable plastic is designed to address has nothing to do with landfill. 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 landfilled at all, and soon it will not be allowed in Europe – because plastic which has been collected is useful for its calorific value and for recycling. Some landfills are designed to capture methane but how do you know at the point of manufacture whether your plastic item will end up in one of them? A crop-based "compostable" plastic will generate methane in anaerobic conditions in landfill, but an oxo-biodegradable plastic will not.

Oxo-biodegradation is officially defined by CEN[8] as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively." It has been studied by scientists for many years, most recently by the Eurofins laboratory in Spain in 2016, who found that the prodegradant additive reduced the molecular weight of the material to the point where it became a low molecular weight material accessible by bacteria as a food-source. At that point they tested for the presence of metals, and found that there were none exceeding the limits prescribed in Annex A.1.2 of EN13432. They then subjected the degraded material to biodegradation testing, and found that the bacteria generated a quantity of CO_2 which showed that they had consumed the residual material to the extent of 88.9%, at a rate which produced that consumption in 121 days.

Oxo-biodegradation has also been proved in France[9] by an entirely different methodology set out in AFNOR AC T51-808, which uses bacteria which are found in soil and in marine environments. Adenosine triphosphate (ATP) is the energy-transfer molecule for all living organisms. It is thus a molecule that is indispensable for microbial life and its quantity is directly related to the quantity of active cells. This French test-method makes it possible to determine the total ATP quantity of the cells in suspension in the culture medium, as well as those attached to the polymer material fragment or flask surfaces on the one hand, and the ratio of the concentration of adenosine diphosphate (ADP) to the concentration of ATP on the other.

Work has also been done 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 pages 919-928. They found 91% biodegradation within 24 months. See also the statement by French academics at the Institut de Chimie de Clermont-Ferrand that fragmentation of polymer leads to the formation of a complex mix of small compounds that are readily water soluble and totally assimilated by bacteria.

None of these tests mentioned above were designed to prove biodegradation in the laboratory only, but were designed to show what would be likely to happen under real-world conditions, just as tests done on "compostable" plastic are done in a laboratory according to EN13432 or ASTM D6400.

[7] http://www.biodeg.org/recycling.html
[8] the European Standards Organisation - TR 15351
[9] CNEP R2014-222 - May 2014

In addition, tests at Station d'essais de Vieillissement Naturel de Bandol[10] on the Mediterranean coast of France have proved that oxo-biodegradable plastic will degrade to low molecular-weight materials under natural conditions in water. Samples aged under those conditions were studied at Queen Mary University London[11] under conditions where the degraded plastic was the only source of carbon available to the bacteria. The samples were proved to be biodegraded by bacteria commonly found in the oceans, and separately by bacteria commonly found on land. The degraded plastic was also proved to be non-toxic to those bacteria.

Oxo-biodegradable plastic has the same strength as ordinary plastic, but it automatically converts in the presence of oxygen into $C0_2$, water, and biomass if discarded into the open environment. 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[12], and has become soluble in water. 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 metals beyond the prescribed limits. It does not therefore leave microplastics behind - and the particles of plastic which have been found in the oceans by NGOs and scientists are mostly particles of ordinary plastic.

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 *bio*degradability in ASTM D6954, BS8472 and AC T51-808.

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. The residues are completely harmless, as proved by the OECD eco-toxicity tests[13] required by the international standards, and it is proved that they do NOT include any metals exceeding the limits prescribed in Annex A.1.2 of EN 13432 (and Art 11.1 of the EU Packaging Waste Directive 94/62/EC).[14] 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 take much longer than oxo-biodegradable plastic to bio-degrade.

After the molecular reduction has occurred, the oxo-biodegradable material will be converted into water and humus by commonly-occurring bacteria and fungi, thus completing the cycle from oil, back into nature.

When anything degrades in aerobic conditions CO_2 is released, and in the case of bio-based plastic this has to occur very rapidly to satisfy EN13432 or ASTM D6400. By contrast, oxo-biodegradable plastics release CO_2 much more slowly, and it can be absorbed by the surrounding vegetation and micro-organisms as a food-source.

It is sometimes said that making plastic biodegradable encourages people to litter, and this is an argument which applies to bio-based as well as oxo-biodegradable plastics. There is however no evidence that these types of plastic are actually littered any more than conventional plastic.

It is impossible to tell the difference between oxo-biodegradable and conventional plastic by appearance, touch, or smell, but it is easy to tell the difference between conventional and bio-based plastic. Even if there were a label describing a product as oxo-biodegradable, the type of people who cause litter are not likely to look for the label before deciding to throw a plastic item out of a car window.

Even if it were true that biodegradability encourages littering, and supposing that there would be 10% more litter, is it preferable to have 110 plastic items which will degrade and biodegrade in a few months, or 100 plastic items which will lie or float around for decades? It is not acceptable to continue worrying about this speculative proposition any longer, while thousands of tonnes of conventional plastic are getting into the environment every day, which will pollute the environment for decades into the future.

If we are concerned about litter in the environment on land and sea which cannot realistically be collected, there is no point in choosing "compostable" plastics, which obviously have to be collected before they can be

[10] http://www.biodeg.org/marineenvironment.html

[11] Report dated February 2016

[12] ASTM D883-11 defines a plastic as "a material that contains as an essential ingredient one or more organic polymeric substances of **large molecular weight** ….."

[13] See attached reports from LGAI and OWS

[14] See attached reports from LGAI and OWS

composted, and no point in choosing the type of crop-based plastic (sometimes called "drop-in plastic") which is no more biodegradable than conventional plastic. By contrast, oxo-biodegradable plastics can be re-used and recycled during their useful life, and only if they do not get collected would they ultimately degrade and biodegrade in the open environment.

RESOURCE DEPLETION

Oxo-biodegradable and other oil-based plastics do not cause fossil resource-depletion,[15] because they are made from ethylene – a necessary by-product of oil which used to be wasted. The oil is extracted to make fuels and lubricants, and the same amount would be extracted even if oil-based plastics did not exist. Therefore, until other fuels and lubricants are found for vehicles, ships, aircraft and factories, it makes sense to use this by-product instead of consuming large amounts of fossil fuel in the agricultural production and polymerisation process of "crop-based" plastics.[16]

It would therefore be misleading to describe crop-based plastics as "renewable."

We find it difficult to understand the trend towards replacing conventional oil-based plastics with plastics derived partly or fully from crops.

A consortium consisting of Friends of the Earth, Surfrider Foundation, Zero Waste Europe, Ecos, and the European Environmental Bureau published a paper in 2017[17] in which they say "The bioplastics industry use their green-sounding credentials to position themselves as helping to speed the reduction in fossil fuel use and solving the ever-growing plastic pollution and marine litter issues. However, there is clear evidence that bioplastics do not solve many of these problems and in fact may create new ones."

RECYCLING

Specialist laboratories in Austria and in South Africa have carried out detailed tests[18] and they concluded that plastics made with oxo-biodegradable technology can be safely recycled in a post-consumer waste stream without the need for separation. These findings apply to thin plastic films as well as to long life plastics, including garden furniture and plastic lumber.

They also found that crop-based 'compostable' plastics can not be safely recycled with oil-based plastics.

In the last four years alone, enough masterbatch has been sold by one OPA member to make nearly 600,000 tonnes of oxo-biodegradable plastic products from polyethylene and polypropylene.[19] 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 specialist reports, that oxo-bio plastic can be safely recycled, and recyclers have presented no technical evidence and no actual experience, to the contrary. They do have cause to be worried about crop-based plastics but not about oxo-biodegradable plastics.

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

FOOD WASTE

In the first place, we need to protect food from wastage by damage and contamination, and for this purpose plastic is necessary. 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

[15] Except for any fossil-derived energy used in the polymerisation process (which also applies to bio-based plastics).
[16] See Infographic at http://www.biodeg.org/files/uploaded/Hydro-biodegradable%20Plastic%20Production%20Process.pdf
[17] http://www.biodeg.org/FoE%20paper_Jan-2017.pdf
[18] http://www.biodeg.org/recycling.html
[19] Oxo-biodegradable additive is not suitable for PET

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.

HYDRO-BIODEGRADABLE PLASTIC

(Sometimes known as “bioplastic” “bio-based” “crop-based” or “compostable” plastic)

This type of plastic is designed to be taken to an industrial composting or anaerobic digestion unit, and to biodegrade in the special conditions found in those industrial processes. It does not address the problem of plastic litter in the open environment because the original vegetable materials have been polymerised and have therefore become plastics.

1. Bioplastics cannot be recycled with ordinary plastics, so anyone who is in favour of recycling should be against them. Even if intended for industrial composting, some of this plastic will get into the oil-based plastic recycling stream.
2. They are 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 and there is no justification for subsidising it out of taxpayers’ money.
3. When something is described as compostable an ordinary person would think that it can 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 six months. 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.
4. It should not be described as “biodegradable” because although it will fragment in the open environment it is tested for biodegradation only in the special conditions found in industrial composting or anaerobic digestion.
5. It is not suitable for shopper bags because they need to be strong and inexpensive, and to be capable of re-use many times before final disposal.
6. 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.
7. It is not "renewable" as it contains up to 70% oil-based polyester. 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.
8. Deep in landfill it can generate methane, which is a greenhouse gas much more powerful than CO_2.
9. 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 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 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.”
10. There is not nearly enough available arable land and water to grow crops to make enough crop-based plastic to replace ordinary plastic, even for shopping bags.
11. It is sometimes claimed that the crops being grown to make crop-based plastics absorb CO2, but that would be true of the vegetation that was there before.
12. It is not really suitable for agricultural mulch films, because (unlike oxo-biodegradable plastic) the degradation time cannot be controlled in line with the growing cycle.
13. It is thicker and heavier for the same strength, so it needs more trucks to transport it, using more road space, consuming more fuel, and emitting more CO_2 and other forms of pollution to atmosphere.
14. 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.

15. An LCA by Intertek, published by the UK Government in 2011 and a further LCA by Intertek in 2012 found that ordinary plastic and oxo-bio plastic has a better LCA than crop-based plastic or paper bags.

16. There is no type of plastic suitable for home-composting. There is no Standard for this and it would be dangerous to try to create one, because composting has to be carefully managed to create and maintain the conditions prescribed by a Standard, and this cannot be expected from home composters, most of whom will not even read the Standard. The result will be that fragments of plastic will get into the compost and into the food-chain. 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. There is in any event no need for an expensive plastic bag for conveying organic waste to the bottom of the garden when a bucket would serve the purpose equally well. As mentioned at 3 above “compostable plastic” does not convert into compost.