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

Smart 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.**
- **It is therefore no longer acceptable to use ordinary plastics for everyday items**
- **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.**
- **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.**
- **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 with the same machinery.**
- **Oxo-biodegradable plastics can be recycled with ordinary plastics if collected during their useful life. Crop-based plastics cannot.**
- **Plastics do not cause oil-depletion, so there is no need to switch to expensive crop-based alternatives, which consume land and water resources as well as fossil-fuels.**
- **Crop-based plastics are the wrong choice if we are concerned about litter – because those that are tested according to EN13432 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 (OBP) is entirely consistent with those principles. We support the redesign of plastics, we support re-use of plastics, and we support recycling of plastics.

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 by Intertek for the UK Government in 2011 put plastic ahead of all the other materials used to make shopping bags. Intertek performed another LCA for shopping bags in 2012 which included the litter metric, and they put the environmental credentials of OBP 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."

However, a study was published on 19th July 2017 in “Science Advances” by researchers at the University of California, Santa Barbara, the University of Georgia, and the Law of the Sea Education Association in Woods Hole, Mass. They found that 60% of all the plastics that have ever been manufactured have been landfilled or remain as litter in the environment.

They noted that rapid increases in the pace of plastic production — half of the plastic made since 1950 was made in the last 13 years — will mean the potential for much more waste as global use increases. They therefore predict that even with big improvements in waste management, the amount of plastics landfilled or littered would double by 2050 because of large increases in the amount of plastic used.

They said “The same properties that make plastics so versatile — durability and resistance to degradation — make these materials difficult or impossible for nature to assimilate.” The researchers concluded that “humans are conducting an uncontrolled experiment on a global scale, in which billions of metric tons of material will accumulate across all major terrestrial and aquatic ecosystems on the planet,”

This is precisely the reason why oxo-biodegradable plastic has been invented. It performs in exactly the same way as normal plastic, and can be made in existing factories at little or no extra cost, but it protects the open environment from the accumulation of plastic waste by converting at the end of its useful life into materials which are no longer plastic. They have then become a food-source for micro-organisms which return the material to nature.

This university study shows that **urgent action is necessary**. Governments must stop dithering and make it mandatory for all short-life products made from polyethylene or polypropylene to be made with oxo-biodegradable plastic. This has already been done in Saudi Arabia, the UAE, and other countries in Asia and Africa, and it is time that the rest of the world followed their example. These countries 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 OBP offers an “insurance policy” if all else fails. Factories and brand-owners will not be able to export to those countries unless their plastic products and plastic packaging are made with OBP technology.

OBP products are tested according to ASTM D6954 to prove that they are biodegradable and non-toxic. They can also be recycled during their useful life, and independent reports proving this are publicly available on the OPA website.

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 disproportionate and not practicable. Nobody doubts that all plastics (OBP, crop-based, and conventional) will fragment as they degrade, but OBP has been designed to convert rapidly at the end of its useful life into low molecular-weight materials in the outdoor environment with access to oxygen. Nobody doubts that this does occur.

Similarly, nobody doubts that the length of time that this process takes will depend on conditions in the environment. It will take longer if (rarely) it is not exposed to any sunlight, but exposure to sunlight is not essential. Equally, nobody doubts that under the same environmental conditions OBP will become biodegradable much more quickly than conventional or crop-based plastic. However, questions are asked as to whether the whole of the plastic will convert to low-molecular-weight materials, but this is well understood and the industry standards for OBP place limits on the formation of non-degradable fractions.

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. Starch is not used in OBP.

- Crop-based hydro-biodegradable plastics (HBP) - (also loosely known as “bio-based plastics” or “bioplastics” or “compostable plastics”). These contain a high proportion of oil-based material, and are 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.

The Eunomia Report (2016) to the EU Commission concluded that “The debate around the biodegradability of OBP plastic is not finalised, but should move forward from the assertion that OBP plastics merely fragment, towards confirming whether the timeframes observed for total biodegradation are acceptable from an environmental point of view and whether this is likely to take place in natural environments.” We agree, and there is no longer any justification for anyone to refer to OBP as “oxo-degradable” or “oxo-fragmentable.” Oxo-biodegradation is defined by CEN/TR 15351:200611 as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively."

If OBP 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

For OBP 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.[2] 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 main reason why campaigners around the world are trying to ban or tax plastic bags[3]. The level of pollution by plastic litter, including 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.

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

[2] Jambrek et al “Plastic waste inputs from land into the ocean.” 347 Science pp 768-771
[3] 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.

To meet this challenge OBP was developed by polymer scientists.

It is important to stress that this is consistent with a circular economy. This is because OBP 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[4] without the need for separation if collected during the useful life of the product. OBP is not designed to be deliberately lost to the economy – but it is there to protect the environment if all else fails.

Micro-beads – used in products such as cosmetics and made from PE, or PP have attracted a lot of attention recently, and it is important to note that they too can be made oxo-biodegradable.

The problem which OBP 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 OBP will not.

Nobody doubts that any type of plastic which has converted to low molecular-weight materials has become accessible to micro-organisms, who can use it as a food source, and that these micro-organisms exist on land and in the sea. The dispute is about how quickly they will bioassimilate the material, and whether they will bioassimilate all of it. However, conventional plastic undergoes the same processes, and low molecular-weight residues of OBP will behave in the same way as low molecular-weight residues of conventional plastic, but will have become capable of biodegradation much more quickly – within months instead of decades.

Once the material has become biodegradable in the open environment it really does not matter how long it takes to biodegrade completely if it has been proved to be non-toxic. This would matter only in the unlikely situation that large quantities of plastic residues had been discarded in the same place, and this is not likely in the case of carrier bags.

Oxo-biodegradation has been studied by scientists for many years, most recently by the Eurofins laboratory in Spain in 2016, who tested specimens according to ASTM D6954 and found that the prodegradant additive reduced the molecular weight of the plastic to the point where it became a low molecular weight material accessible by bacteria as a food-source, and no longer a plastic.[5] 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. They then proved compliance with the eco-toxicity tests prescribed by OECD 207 and 208.

[4] http://www.biodeg.org/recycling.html

[5] for definition of plastic see ASTM D883

Oxo-biodegradation has also been proved in France[6] 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, and it is thus a molecule that is indispensable for microbial life. 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, was published in Vol 96 of the journal of Polymer Degradation & Stability (2011) at pages 919-928. They found 91% biodegradation within 24 months. French academics at the Institut de Chimie de Clermond-Ferrand have also found that fragmentation of polymer lead 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.

OBP has the same tensile 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, 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 particles of ordinary plastic.

The first (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,[7] 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).[8] 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 OBP to bio-degrade.

After the molecular reduction has occurred, the oxo-biodegradable material will be converted into water and humus by naturally-occurring bacteria and fungi, thus completing the cycle from oil, back to 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, OBPs release CO_2 much more slowly, and it can be absorbed by the surrounding vegetation and micro-organisms as a food-source.

If we are concerned about litter 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 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 (See "Fossil Resources" below). By contrast, OBPs 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.

[6] CNEP R2014-222 - May 2014
[7] See reports from Eurofins, LGAI and OWS
[8] See reports from LGAI and OWS

OBP can be used to make mulch films for agriculture, and a reputable supplier will formulate the polymer and additive having regard to the particular circumstances on the particular farm, and to the particular type of crop and its growing-season. Allowance will be made for exposure to UV light on the surface of the field during the growing season. Trials will also be done in situ with a range of formulations before an OBP mulch-film is supplied to a farmer in commercial quantity.

As to whether the micro-organisms will bioassimilate the whole of the low molecular-weight material, biodegradation of 91% has been proved as mentioned above, at the Technical Research Institute of Sweden and the Swedish University of Agricultural Sciences, and of 88.9% in the Eurofins laboratory in Spain. This is complete biodegradation for all practical purposes. (the limit specified for HBP in EN13432 is 90% of the maximum degradation of a suitable reference material, and even this could be less than 90% of the actual material).

Evaluation of degradation can be done in the open environment, as was done in seawater at Bandol[9] but the evaluation of biodegradation has to be done under laboratory conditions (as is also the case with HBP) – it cannot be done in a field or an ocean or a compost heap. These tests are very expensive and are not done for the amusement of scientists. They are designed to replicate conditions in the real world, and there is no reason to think that in the open environment the micro-organisms will stop before they have consumed all of the available material. It is for those who think so to provide credible reasons.

When comparing the performance of OBP with conventional plastic, the conventional plastic will not biodegrade at all until it has acquired biodegradability after exposure for very many years, and then its performance will be much the same as the degraded residues of OBP. The purpose of OBP is therefore to reduce very significantly the period of time that the plastic is lying or floating around, and accumulating in the environment before it becomes biodegradable.

PROPENSITY TO LITTER

It is often claimed that biodegradable plastics are likely to encourage littering, but this is rarely advanced as an objection to HBP. The Eunomia Report says, “rather than speculation, objective behavioural research is required to move this topic forward in a constructive manner.” We agree.

In our view, even if there were a label describing a product as oxo-biodegradable, it is unlikely that the people who cause litter will look for the label before deciding to throw a plastic item out of a car window. Further, 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 years or even months, or 100 plastic items which will lie or float around for decades?

A Life-cycle Assessment by Intertek shows that when the litter metric is included OBP is actually the best material for making carrier bags. See http://www.biodeg.org/New%20LCA%20by%20Intertek%20%20-%20Final%20Report%2015.5.12(1)%20(1).pdf

OBP products, like all other plastic products, should be labelled to advise consumers that the product should be disposed of responsibly. However, it is not acceptable to continue debating this speculative proposition any longer, while thousands of tonnes of conventional plastic are getting into the environment every day, which will accumulate and pollute the environment for decades into the future.

MARINE ENVIRONMENT

According to Dr. Jean-François Ghiglione[10] “OBP will float and be at almost all times subjected to UV light, which accelerates the abiotic phase of degradation. This is not always the case on land, where plastic pieces are often covered by soil, leaves etc. and are less exposed to UV light.

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[9] See note 14 below

[10] Directeur adjoint de l'Observatoire Océanologique de Banyuls

He points out that there are specific bacteria living in the "seasurface microlayer" (the top millimetre of the ocean surface), where bacteria are different from those further below the surface. The bacteria in the sea-surface microlayer are particularly adapted to a hydrophobic environment (e.g. where oil materials are floating) and these bacteria are known to present a high capability for hydrocarbon degradation. These bacteria are therefore potential OBP-degraders, and such an environment does not exist at the surface of soil. These bacteria are probably less abundant and less diverse in the ocean than in soil, but probably more effective to degrade OBP."

If abiotic degradation of OBP is found to generate biodegradable material at a rate that cannot be immediately consumed by marine microorganisms, the process will contribute materials which closely resemble products of organic materials naturally present in the environment (e.g. fragments of seaweed), and are recognisable to microorganisms as an accessible source of food - not fragments of plastic.

Some marine bacteria, such as Alcanivorax borkumensis and R. rhodochorous are noted for their ability to biodegrade hydrocarbons and they are ubiquitous in the oceans. They occur in low concentrations in unpolluted seas, but are observed to accumulate in waters polluted by oil spills. When presented with a source of carbon which is recognisable to the microorganisms as food, it seems therefore that they will respond with increased populations. The relatively low concentrations of microorganisms found in unpolluted oceans is not therefore a reason for expecting slow biodegradation of OBP.

Evidence is available - from tests done in real time at Bandol[11] on the coast of France that OBP will degrade to low molecular-weight materials under natural conditions in water, and samples aged under those conditions have been studied at Queen Mary University London where the abiotically degraded plastic was presented as the only source of carbon available to the bacteria. The samples were proved to be biodegraded by bacteria commonly found in the oceans, and separate samples by bacteria commonly found on land. The degraded plastic was also proved to be non-toxic to those bacteria.

Plastic fragments are not the final products of abiotic degradation of OBP. The inclusion of a prodegradant additive will accelerate the observable fragmentation of plastic in the environment, compared to an equivalent non-degradable plastic product, but degradation continues beyond fragmentation until the material has become low molecular weight oxidised materials which no longer resemble a polymer. These are water soluble and biodegradable, and this abiotic degradation will proceed without the involvement of microorganisms. By contrast, conventional plastics can be observed to fragment in a relatively short time-frame, but will remain in the environment for a long period of time as high molecular-weight microplastics.

In the 2012 study published in the Marine Pollution Bulletin "Occurrence of micro-plastics in gastrointestinal tracts of pelagic and demersal fish from the English Channel" it was shown that the majority of plastic particles consumed by the fish were rayon (57.8%) and polyester fibres. These are derived from clothes, hygiene products and nappies. Micro-plastics are not therefore necessarily derived from plastic bags nor even from packaging of all types- which normally use polyethylene and polypropylene. Nor have they been shown to absorb toxins to any greater extent than other particles in the sea such as particles of seaweed.

Several studies have been done, including those by Pascall et al, Takada et al, Mato et al and Teuten et al, which demonstrate that conventional polymers such as polyethylene and polypropylene will readily adsorb PCB and other toxins. This is because the polymers are inherently non-polar and hydrophobic in nature, and with a low Tg (glass transition temperature), their nature allows for greater segmental mobility, pore-size, free volume, diffusion and partition coefficients. This means that hydrophobic organic toxins such as PCB can in theory adsorb to the polymers (through Van der Waals attractive forces) from the aqueous environment.

The increased pore-size and free volume also means that if the toxin is adsorbed to the conventional polymer, it will not readily desorb, and thus over long periods of time the polymer will break down by shear, friction and weathering, and the potential for the plastic material to adsorb toxins increases.

[11] Station d'essais de Vieillissement Naturel de Bandol

Takada et al demonstrated in a field experiment in Tokyo Bay that conventional plastic fragments collected from the bay had adsorbed up to 892 ng/g. This suggests that the plastic had persisted in that area for at least twenty-seven years (assuming a linear uptake profile).

Pascall et al included polyvinyl chloride and polystyrene in their study. The results from their experiments demonstrated a significantly lower adsorption uptake of PCB toxin. The difference in chemical structure resulting in differing polarity of the polymer, more rigid packing (demonstrated by higher Tg) resulting in restricted segmental mobility, and restricted pore size explains the reduced adsorption observed. This information helps to build a picture of what would be expected for oxo-biodegradable polymer materials in the oceans.

Under the action of oxygen, UV light, and ambient heat, polyethylene and polypropylene which contains oxo-biodegradable additives will change their molecular structure and break down. Hydroperoxy intermediates are readily formed in the initial phase of degradation, and immediately there is a change in chemical structure and increase in polarity. The formation of these oxygenated species already makes the polymer less susceptible to adsorption of PCB and related hydrophobic toxins.

Lower diffusion and partition coefficients result from increased cohesive forces, reducing segmental mobility and pore-size. The highly polar functional groups that are formed will not interact with the non-polar toxins, either through chemical reaction or intermolecular interaction.

The second stage of degradation is the molecular-weight reduction of the hydroperoxy intermediates (with the Vicinal form proceeding more rapidly) to intermediate and short-chain aldehydes, ketones, esters, and hydroxyl and hydrocarbon radicals. These will proceed further to carboxylic acids which will be readily bioassimilated by micro-organisms.

In summary, the constantly progressing chemical breakdown of the oxo-biodegradable polymer, results in species with increased hydrophilic character that will readily solubilise and emulsify in the ocean environment. It would, therefore, not be possible for hydrophobic toxins such as PCB to accumulate on OBP materials

STANDARDS

The main Standards which have been written for testing OBP are ASTM D6954 (USA); BS8472 (UK); AFNOR AC T51-808 (France); and SPCR 141 (Sweden). Variants of these standards have also been adopted in other countries. There is no European standard for OBP because the technical committees of CEN are dominated by representatives of the HBP industry who do not wish to see a standard which might increase competition from OBP. Accordingly the OBP industry has worked at its own expense in the other standards organisations around the world to develop new and better standards.

ASTM D6954 contains no less than six pass/fail criteria. 1.for the abiotic phase of the test (6.3 - 5% e-o-b and 5,000DA) 2. the tests for metal content and other elements (6.9.6), 3. Gel content (6.6.1), 4. Ecotoxicity (6.9.6 -6.9.10), 5. PH value (6.9.6) and 6. for the biodegradation phase, (for unless at least 60 % of the organic carbon is converted to carbon dioxide the test cannot be considered completed). It is for customers and governments to decide what timescales are acceptable to them.

NON-TOXICITY

The OBP industry is as much concerned as anyone that its products should not introduce toxicity into the environment, and for this reason the standards for OBP require testing, to confirm that the residues are harmless.

Essentially OBP are made from the same materials as conventional plastics, with the addition of only 1% of a masterbatch (most of which is ordinary polymer), and they have to pass the same tests in EN 13432 as HDP to ensure that there is no toxicity and no metals exceeding the limits prescribed in Annex A.1.2 of EN 13432 (and Art 11.1 of EU Packaging Waste Directive 94/62/EC). Other ingredients which manufacturers may wish to include in plastic products, or which may be generated by the manufacturing process of plastic products, are not the responsibility of the OBP industry, and should be specifically regulated by government.

The Eunomia Report says "it does appear that the OBP industry can create products that have minimal toxic impact on flora and fauna. … and it is encouraging that almost all existing test standards for OBP plastic specify some form of toxicity test using established methods (such as germination and earthworm survival tests)."

The Report continues, "this does not mean that all products on the market avoid negative toxic effects, as there is no regulatory control currently exercised in this regard. Problems remain that (a) accreditation is not mandatory for products on the EU market, and (b) some of the standards do not have pass/fail criteria for the toxicological test results."

This is a criticism not of the OBP industry, but of CEN, and the regulatory authorities in Europe[12] who have not sought to ensure that OBP is supplied only by reputable manufacturers, who can produce evidence that their products have been tested by recognised laboratories according to well established standards such as ASTM D6954, and of regulatory authorities who have not specified what test results they would and would not find acceptable. They have so far done so only for the testing for metals, by specifying in Art 11.1 of 94/62/EC the maximum Concentration allowed.

FOSSIL RESOURCES

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

OBP and other oil-based plastics do not cause fossil resource-depletion. This is because they are made from ethylene – 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, buildings, and factories, it makes sense to use this by-product instead of consuming large amounts of fossil fuel in the agricultural production, transport, and polymerisation of "crop-based" plastics. See http://www.biodeg.org/biobased.html

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

RECYCLING

The best option for recycling is conventional plastic, but this has a serious disadvantage if it gets into the open environment as litter.

Separation of the different types of polymer is a problem with all types of plastic film, and is one reason why post-household plastic film is not attractive to recyclers. Other reasons are that the material is often contaminated and it would not be cost-effective to clean it, given that the material from which it is made is inexpensive and readily available.

It is also too costly in financial and environmental terms to collect it, transport it, sort it, bail it, store it, and then reprocess it, so it is generally exported as mixed plastic for low grade uses (not for long-life uses such as building films or pipes, which are normally made from virgin polymer or used-plastics of known type and provenance). The separation of OBP film derived from carrier bags is therefore a non-issue, but a marker could easily be included if separation were desired.

OBP has however been designed to be recyclable during its useful life, so that separation is not necessary. Specialist laboratories in Austria and in South Africa have carried out detailed tests[13] and concluded that plastics made with oxo-biodegradable technology can be safely recycled in a post-consumer waste stream without the need for separation.

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[12] This is not the case in countries such as Saudi Arabia and the UAE who audit the laboratories and production facilities of the suppliers and will authorise only those suppliers who pass the audit.
[13] http://www.biodeg.org/recycling.html

These findings apply to thin plastic films, as well as to long life plastics including garden furniture and plastic lumber.

It is clear from the scientific reports that it is not necessary to add stabilisers unless the recyclate is being used to make long-life products, in which case the manufacturer of those products would be adding stabilisers anyway. These stabilisers are in a quantity and with a chemistry which he would normally use, and no special arrangements are necessary for recyclate containing OBP.

Most conventional waste plastics will have been exposed to UV radiation, in particular agricultural film, and may have oxidised to some extent. Recyclers of mixed plastic wastes have no way of knowing which have been exposed and for how long, and it is also known that printing inks, and other chemicals will affect the recycling process. Therefore, the industry already has the problem of identification when dealing with post-consumer plastic films, and deals with it by using those materials for low-value/short-life applications such as carrier bags and garbage sacks, or by adding fresh stabilisers if used for long-life applications.

If an OBP carrier bag is going to be collected for recycling at all it is likely to be collected during its useful life. During that time it will be unlikely to have oxidised. Also, the stabilisers in the OBP masterbatch are designed to ensure a minimum useful life (typically 18 months) before oxidation commences, even with exposure to sunlight during use. If collected very late and if the plastic had oxidised, it would have a strong odour and would be falling apart, and would not be used for recycling. Oxidised polymer would in any event have to form a substantial proportion of the feedstock to have any effect at all.

As to whether recyclate made from mixtures containing OBP plastic should be used for long-life products, the Austrian TCKT report of 27th July 2016[14] considered this very issue, and concluded that provided a UV-stabiliser has been included (which they note should always be the case with plastic products intended for outdoor use) there will be no negative effects from the inclusion of oxo-biodegradable recyclate. These studies also demonstrate that even without UV stabiliser the presence of oxo-biodegradable recyclates has no effect within the body of thick cross-section plastic, where oxygen is not available, nor when the plastic is buried or otherwise enclosed with no access to oxygen

The specialist researchers also found that crop-based 'compostable' plastics cannot be safely recycled with oil-based plastics.

The position of the OBP industry is therefore based on scientific reports by specialist researchers, and we have seen no evidence of any deleterious effect on any product made from recyclate containing OBP.

In the last four years alone, enough masterbatch has been sold by one OPA member to make nearly 600,000 tonnes of OBP products from polyethylene and polypropylene.[15] We know that OBP 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 OBPs.

It is time for a much better dialogue between the recyclers and the OBPs 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.

[14] http://www.biodeg.org/recycling.html

[15] Oxo-biodegradable additive is not suitable for PET

Anyone who wants to promote recycling should certainly be concerned about HBP, because it cannot be recycled together with oil-based plastic waste, and separation would be required. Some of it will get into the plastic waste recycling stream – especially as it is now being promoted for carrier bags and packaging.

COMPOSTING AND 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 be OBP.

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

The main purpose of HBP is to make bags which are used to carry compostable material to an industrial composting plant and which do not therefore have to be emptied there. OBP has in fact been trialled for this purpose in the UK and was found satisfactory by industrial composters, but it is not marketed for composting for the bizarre reason that it does not produce CO_2 gas quickly enough to pass EN13432, (which makes no allowance for the period of useful life during which OBP is designed NOT to degrade). The carbon in OBP residues therefore remains as a nutrient for the soil until it is returned to nature by the action of micro-organisms.

EN13432 is a standard written by the HBP industry representatives on CEN for their particular technology, and is not relevant to OBP (except that OBP meets the same non-toxicity criteria). In fact the desirability of this standard must be questioned in an age where great efforts are being made to reduce CO_2 emissions. HBP is also sometimes used for packaging and carrier bags, in the mistaken belief that it is better to make plastic from crops instead of oil – See "Fossil Resources" above.

ANNEX

HYDRO-BIODEGRADABLE (HBP) 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 become plastics.

1) HBP 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 and contaminate it.

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 will absorb CO_2, but that would be true of the vegetation which was there before.

12) It is not really suitable for agricultural mulch films, because (unlike OBP) 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) HBP will not comply with the laws of the United Arab Emirates, Pakistan, Saudi Arabia 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 have a better LCA than crop-based plastic or paper bags.

16) A consortium consisting of Friends of the Earth, Surfrider Foundation, Zero Waste Europe, Ecos, and the European Environmental Bureau published a paper in 2017 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.”