



Biodegradable
Plastics Association

BPA Comment on the EUNOMIA REPORT

This report (Aug 2016) was commissioned by the EU from Eunomia Consultants to examine the impact of the use of Oxo-biodegradable (OBP) plastic carrier bags on the environment. The Report refers throughout to OBP as PAC (Pro-oxidant Additive Containing) plastic.

This report does not recommend a ban of oxo-biodegradable plastics.

The report was completed in August 2016 and the science has moved on since then. See e.g. <https://www.symphonyenvironmental.com/resource/uk-judge-finds-the-case-for-oxo-biodegradable-plastic-proven/> and <https://www.symphonyenvironmental.com/resource/queen-mary-university-london-publishes-positive-study-on-biodegradable-plastic/>

The Eunomia Report introduces the subject as follows:

“The high molecular weight and hydrophobic nature of conventional plastic lends the material high resistance to biological attack. However, for situations where biodegradation is a desirable attribute, the second half of the 20th century saw attempts to develop the first plastics deliberately engineered to age upon the application of heat and light.

Within the current century, the focus has shifted to materials marketed as “oxo-degradable” or “oxo-biodegradable” plastics. These are plastics which contain additives intended to initiate degradation as well as stabilisers (anti-oxidants) intended to delay this effect until it is desired to occur if, and when, an item is discarded in the natural environment. These plastics are intended to go through both abiotic degradation (for instance embrittlement and mechanical damage) and biotic degradation processes (i.e. biodegradation), accelerated by light and/or heat, until they are, ultimately, fully bio-assimilated.

The debate around the biodegradability of PAC plastic is not finalised, but should move forward from the assertion that PAC 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.”

There is no longer any justification for referring 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.”

Landfill

OBP is not designed to biodegrade in landfill. As the Report confirms, “aerobic degradation produces CO₂ whereas anaerobic degradation produces methane—a greenhouse gas 25 times more harmful (on a 100 years’ time horizon) than CO₂.” Plastics which contain a proportion of vegetable-sourced material suffer from this disadvantage. We will refer to these plastics as hydro-biodegradable plastics (“HDP”) - (also loosely known as “bio-based plastics” or “bioplastics” or “compostable plastics”). OBP do not suffer from this major disadvantage.

The Report concludes “Whilst PAC plastic may biodegrade in the upper levels of a landfill in aerobic conditions and therefore produce CO₂, it has already been demonstrated that this happens at a very slow rate, and only if abiotic degradation has already occurred. The limited evidence that is available suggests that deeper in landfill under anaerobic conditions there will be little or no biodegradation taking place. In this case, the carbon is effectively sequestered, avoiding the direct release of GHGs to the atmosphere.”

Composting

OBP is not designed for composting, and it is surprising that the authors of the Report have taken so much time to consider it. By contrast, HDP is marketed as “compostable” but the relevant standard (EN13432 or ASTM D6400) requires it to convert rapidly not into compost but into CO₂ gas, which contributes to climate-change but does nothing for the soil. This process cannot therefore be described as “packaging recoverable through composting” or “organic recycling.”

The main purpose of HDP is to make bags which carry compostable material to an industrial composting plant and which do not 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 does not produce CO₂ 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 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 HDP industry representatives on CEN for their particular technology, and is not relevant to OBP (except that OBP meets the same non-toxicity requirements).

In fact the desirability of this standard must be questioned in an age where great efforts are being made to reduce CO₂ emissions. HDP is also sometimes used for packaging, in the mistaken belief that it is better to make plastic from crops instead of oil – See “Fossil Resources” below.

Recycling

The Report says “The evidence available does not support the suggestion that PAC plastic can be identified and sorted separately by reprocessors with the technology that is currently available. Furthermore, manual sorting would be time-consuming and is unlikely to be economically viable.”

This is a problem with all types of plastic film, and is one reason why post-household plastic film is generally not recycled. 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 reprocess it, so – as the report confirms – this is generally not done in Europe but it is exported as mixed plastic for low grade uses (not for long life uses such as building films or pipes). The separation of OBP film 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, and scientific tests have proved that it can be safely recycled together with conventional plastic, so that separation is not necessary. See <http://www.biodeg.org/recycling.html>

The Report continues “Evidence suggests that the impacts of prodegradant additives on recyclates can under certain circumstances be avoided with the inclusion of stabilisers. The appropriate quantity and chemistry of stabiliser would depend on the concentration and nature of the prodegradants in the feedstock.” However, the report misunderstands the role of stabilisers. 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 exposed to sunlight, in which case the manufacturer 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.

“Evidence suggests that oxidised PAC plastic can significantly impair the physical qualities and service life of the recycled product.” However, if an OBP carrier bag is going to be collected for recycling at all it is likely to be collected during its useful life (typically 18 months). If collected later and the plastic had oxidised it would be falling apart and would not be used for recycling. Oxidised OBP would in any event have to form a substantial proportion of the feedstock to have any effect at all.

“Recyclate made from mixtures containing unknown PAC plastic should not be used for long-life products, due to the lack of evidence surrounding the long-term impact in secondary products.” There is no lack of evidence. The TCKT report dated 27th July 2016 considered this very issue, and concluded that “provided a UV-stabiliser has been included (which as demonstrated 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 the plastic, where oxygen is not available.” (The authors of the Report have read the 17th March 2016 TCKT report, but have not cited the 27th July 2016 report)

The position of the OBP industry is based on scientific reports by specialist researchers.

The Report is concerned with plastic film used to make carrier bags, not with PET bottles, for which OBP is not sold.

Anyone who wants to promote recycling should certainly be concerned about HDP, 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 but we are not aware of any proposal to restrict the marketing of HDP for that reason.

The best option for recycling is conventional plastic, but this has a serious disadvantage if it gets into the open environment as litter. Thousands of tons of conventional plastic are getting into the open environment every day, where they will lie or float around and will accumulate for decades, and this is no longer acceptable.

Degradation

One of the key findings of this report is that, “without exception, the scientific evidence suggests that the conditions present during the abiotic stage (which in most studies is simulated by some form of accelerated pre-treatment) of degradation will have a significant impact on the materials’ ability to subsequently biodegrade.”²

Nobody doubts that all plastics (OBP, HDP 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, and the Report quotes Loughborough University who concluded that “There is no question that oxo-degradable products do degrade and fragment when exposed to sunlight and/or heat for an extended period of time. The mechanism by which this happens is well researched and reported.”

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 it is not correct to say that exposure to sunlight is essential. Equally, nobody doubts that under the same environmental conditions OBP will convert to low molecular-weight materials much more quickly than conventional plastic. However, questions have been raised as to whether the whole of the plastic will convert to low-molecular-weight materials, but this is well understood and the standards for OBP place limits on gel-formation.

The Report is meant to be concerned with carrier bags, but it also mentions plastic mulch films for agriculture at some length. These can be made from OBP but 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, and it is not therefore relevant to consider degradation times for unexposed material. Trials will also be done in situ before an OBP mulch-film is supplied in commercial quantity.

Biodegradation

Nobody doubts that any 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 types of micro-organisms exist on land and in the sea. The dispute is how quickly they will bioassimilate the material, and whether they will bioassimilate all of it.

Conventional plastic undergoes the same process, 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 or years 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, provided it has been proved to be non-toxic. This would matter only in the unlikely situation that there were large quantities of plastic residues in the same place, and the Report acknowledges that this is not likely in the case of carrier bags.

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

The Eunomia Report comments on the Swedish study that “with the results of the laboratory study showing over 91% conversion to CO₂, the [Swedish] author contends that the “risk of plastic fragments remaining in soil indefinitely is very low.” Nowhere is such a claim for complete bio-assimilation proven in practice though.” “Although it can be believed that biodegradation can be facilitated by careful engineering of the chemical package in PAC plastic, evidence is not available to definitively conclude that this will happen in real world situations with PAC plastic products being placed on the market.”

The opinion of the distinguished academic team in Sweden cannot be so easily dismissed, having regard also to the scientific studies in Spain and elsewhere. What does the author of the Report mean by “proven in practice?” Evaluation of biodegradation has to be done in laboratory conditions (as is also the case with HDP) – 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. 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, and it is for those who think so to prove it.

The Report refers to the work being done at Queen Mary University London which shows that “small levels of biodegradation were observed which if left to continue at the same rate would lead to full biodegradation in around 2 years.” The Report continues “It is, however, unclear how these results can be translated to behaviour in the real world. One strain of bacteria is used in the test whereas in the open environment there may be many more, as well as fungi which may also attack and break down the plastic—and therefore it may biodegrade quicker.” “From the information studied, the authors of this report can believe that it is possible for a PAC plastic to fully mineralise in an open environment, with the prodegradant additives encouraging this action, and thus the polymers and entrained substances can be assimilated into the natural environment.”

The chemical package in OBP is indeed carefully engineered, and that is a skill acquired as a result of tests and experiments carried out over twenty years by reputable suppliers. If the Report is suggesting that only OBP placed on the market by reputable manufacturers can be relied upon, we would agree, and this is the same in any industry and for any product.

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 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.

Marine environment

The Report says, “Evidence is not available to properly understand the fate of PAC plastic in marine environments, and thus there remains a risk that plastic fragments may remain either indefinitely, or for long enough to cause significant environmental damage.” Actually, although conventional plastic fragments will remain in the marine environment for a very long time, nobody thinks that plastic fragments of any kind will remain in the environment indefinitely.

Evidence is certainly available that conventional plastic may remain in the marine environment for long enough to cause significant environmental damage, and this is the reason why OBP was invented.

The Report acknowledges that abiotic degradation of OBP occurs in the natural environment, but speculates that if marine biodegradation does not occur rapidly enough, this will result in an increase in fragments of plastic in a given area. The comparison with soil environment is very speculative. It is true that bacterial biomass and diversity are lower in seawater compared to soil, but it does not follow that biodegradation will be less efficient in marine waters.

According to Dr. Jean-François GHIGLIONE³ “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 in soil, where plastic pieces are often covered by soil, leaves etc and are less exposed to UV light. There are specific bacteria living in the “seasurface microlayer” (the top millimetre of the ocean surface), where bacteria are different from further below the surface. The bacteria in the seasurface microlayer are particularly adapted to a hydrophobic environment (eg 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 than in soil, but probably more effective to degrade OBP.”

Therefore, 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, and are recognisable to microorganisms as an accessible source of food - not fragments of plastic. Some marine bacteria, such as *Alcanivorax borkumensis* and *R. rhodochorus* 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 microorganism as food, it seems therefore that they will respond with increased populations. The relatively low concentrations of microorganisms found in the oceans is not in itself justification for expecting slow rates of biodegradation of OBP.

Evidence is available - from Station d'essais de Vieillissement Naturel de Bandol on the coast of France that oxo-biodegradable plastic 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 under conditions where the abiotically 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 separate samples by bacteria commonly found on land. The degraded plastic was also proved to be non-toxic to those bacteria.

Commenting on these two pieces of work the Report notes that “during pre-ageing under water, PAC plastic is much more susceptible to UV degradation than conventional plastic (as demonstrated by the large difference in molecular weight). The biodegradation tests also indicate that bacteria can feed off plastic measured with a higher molecular weight than the 5,000 limit often used to characterise this.”

The Report says that “should full biodegradation on land occur, this would reduce the quantity that may otherwise transfer to the marine environment.” We agree, and this will be the case at a much earlier stage after abiotic degradation, even before biodegradation ensues.

The Report continues “It is not possible to conclude whether PAC plastic would increase or decrease absolute quantities of plastic in marine environments.” We think it is perfectly possible to conclude that degradation which is much more rapid than for conventional plastic, and biodegradation which proceeds at the same rate as conventional plastics after they have become biodegradable, would decrease absolute quantities.

The “ocean garbage patches” have been accumulating for decades, and this would not have happened had all the plastics been OBP. The problem is getting worse every day while Europe debates, but countries in other parts of the world have already made OBP mandatory.

A piece of OBP which degrades and becomes fragmented might be carried more easily into the sea by rainwater if it is near the sea or a watercourse, but an undegraded piece of conventional plastic is more likely to be blown into the sea. If it remains on the land it will eventually behave in the same way as OBP.

The Report continues “It seems likely that the fragmentation behaviour of PAC plastics will exacerbate issues related to microplastics.” However, microplastics have become a problem because conventional plastic has been eroding and fragmenting for decades, and the fragments are still fragments of plastic because their molecular weight has not reduced to the point where the material is available to microorganisms. This is not the case with OBP.

Plastic fragments are not the final products of abiotic degradation of OBPs. 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.

The process is explained by Professor Ignacy Jakubowicz as follows:⁴ “The degradation process is not only a fragmentation, but is an entire change of the material from a high molecular weight polymer, to monomeric and oligomeric fragments, and from hydrocarbon molecules to oxygen-containing molecules which can be bioassimilated.”

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.

“Working under the assumption that PAC plastic in marine environments will be more fragmented, the effect may be to reduce the impacts on wildlife in some respects (such as entanglement).” Correct

4: <http://www.biodeg.org/Reply%20to%20Ellen%20MacArthur%20Foundation%20from%20Prof%20Ignacy%20Jakubowicz%20-%202021-8-17.pdf>

“but to increase the impacts in others (such as physical ingestion of microplastics).” Thousands of tonnes of microplastics formed from conventional plastics are already being ingested. If these are causing harm as they pass through the digestive system, the response must be to ban plastics of all kinds – but this is clearly impracticable and disproportionate.

“The PAC plastic is more likely to fragment quicker so the impacts associated with microplastics are concentrated within a shorter period of time.” “this could ultimately be worse than spreading out the impacts over a longer period of time due to an increase in the proportion of individuals, species and habitats affected, as well as the burden of impacts for an individual of a species.” In our view the opposite would be the case. Fragments of conventional plastic will be a problem for decades, but once OBP has reached the fragmentation stage it is no longer a plastic (for definition see ASTM D883) and has become a food source for micro-organisms.

Standards

The principal Standards which have been written for testing OBP are ASTM D6954 (USA); BS8472 (UK); and AFNOR AC T51-808 (France); and SPCR 141 (Sweden). Variants of these standards have also been adopted in other countries. There is no CEN standard for OBP because the technical committees of CEN are dominated by representatives of the HDP industry. If this obstruction could be overcome, the Oxo-biodegradable Plastics Association undertakes to draft a suitable European Standard and present it to CEN, and to establish a scheme similar to that operated by Vincotte for “compostable” plastic. In the meantime the American, British French and Swedish standard test methods are suitable for providing the information which customers and governments need to know.

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).

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, according to the OECD eco-toxicity tests.

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 as HDP in EN 13432 to ensure that there are no toxicity and no 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). Other ingredients which manufacturers may wish to include in plastic products (eg Bisphenol A), or which may be generated by the manufacturing process, are not the responsibility of the OBP industry, and should be specifically regulated by government.

The Report says “it does appear that the PAC plastics industry can create products that have minimal toxic impact on flora and fauna. ... and it is at least encouraging that almost all existing test standards for PAC 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, 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 for all relevant tests what test results they would and would not find acceptable. They have however done so in the case of testing for metals by specifying in Art 11.1 of 94/62/EC the maximum concentration allowed.

The report also says that “there remains uncertainty surrounding real world toxicological impacts.” This is also true of compostable plastic but nobody is trying to place restrictions upon it. Again, evaluation of toxicity has to be done in laboratory conditions (as is also the case with HDP) – it cannot be done in a field or an ocean or a compost heap.

Propensity to litter

It is often claimed that biodegradable plastics are likely to encourage littering, but this is seldom seen as an objection to HDP. 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, 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. 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?

OBP products, like other plastic products, should be labelled to advise consumers that the product should be disposed of responsibly.

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 accumulate and pollute the environment for decades into the future.

Fossil Resources

We find it difficult to understand the trend towards replacing conventional oil-based plastics with plastics derived partly or fully from crops. Although the Report does not deal specifically with this issue we think it is important to understand it when considering the materials from which carrier bags and packaging could be made.

OBP and other oil-based plastics do not cause fossil resource-depletion. This is because they are made from ethylene – an inevitable 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, transport, and polymerisation of “crop-based” plastics. See <http://www.biodeg.org/biobased.html>

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

Life-cycle Assessments show that when the litter metric is included OBP is 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](http://www.biodeg.org/New%20LCA%20by%20Intertek%20%20-%20Final%20Report%2015.5.12(1)%20(1).pdf)

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.”

There are 19 reasons why bio-based plastics have very limited utility. See <http://www.biodeg.org/wp-content/uploads/2019/04/opa-19-reasons-why.pdf>