www.biodeg.org

Oxo-Biodegradable Plastics Association
A not-for-profit Association Limited by Guarantee.

EU registration no. 370641927438-79

OPA COMMENTS

-on-

"The Identity of Oxo-Degradable Plastics and their Use in Switzerland"

March 2020

Project Report commissioned by the Federal Office for the Environment (FOEN)

GENERAL POINTS

1. This is yet another literature review. Unfortunately it will be misleading for those who have to decide whether to use oxo-biodegradable plastics or not.
2. It is remarkable that the authors did not engage with the OPA. The only contact we received was from someone posing as a student.
3. The very first sentence indicates that the authors do not know the difference between oxo-degradable and oxo-biodegradable plastics.
4. In para. 2.1 on page 6 they say that their investigation "focused only on plastics that have been marketed as 'oxo-degradable.' However, nobody adds pro-oxidant additive to plastic and markets it as oxo-degradable.
5. "Oxo-degradation" is defined by CEN (the European Standards authority) in TR15351 as "degradation identified as resulting from oxidative cleavage of macromolecules." This describes ordinary plastics, which abiotically degrade by oxidation in the open environment and create microplastics, but do not become biodegradable except over a very long period of time.
6. By contrast, "oxo-biodegradation is defined by CEN as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively". Oxo-biodegradable plastics contain a pro-oxidant additive, which catalyses the natural process of oxidation until the molecular weight of the material is low enough to be accessible to bacteria and fungi, who then recycle it back into nature.
7. It is clear that the authors are discussing oxo-biodegradable plastic (which they insist on calling oxo-degradable plastic) and we will comment on their paper accordingly. We will refer to oxo-biodegradable plastic as OBP.
8. In the Introduction they say "Oxo-degradable plastics are plastics containing pro-oxidant additives that allegedly promote fragmentation and subsequent biodegradation." However, this is not an accurate description of the process of oxo-biodegradation, which is described by Professor Ignacy Jakubowicz as follows: "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." http://www.biodeg.org/Reply%20to%20Ellen%20MacArthur%20Foundation%20from%20Prof%20Ignacy%20Jakubowicz%20-%2021-8-17.pdf

9. The authors of the Swiss report continue "in practice, ODP do not fully biodegrade under environmental or industrial composting conditions, and thus may serve as a source of microplastics in the environment."
10. They are clearly not aware that on 30th October 2018, after studying oxo-biodegradable plastic for ten months, the European Chemicals Agency advised that they were not convinced that microplastics are formed.
11. The authors cite a report which was published in 2017 by the Ellen MacArthur Foundation (EMF) and endorsed by some of the world's largest producers of the very plastic packaging which is polluting the oceans. The Report claimed that oxo-biodegradable plastics (which they also insist on calling "oxo-degradable" plastics) simply fragmented into tiny pieces of plastic - but having engaged with OPA scientists they no longer say that.
12. They now admit in their May 2019 report (which the authors of the Swiss report have not cited) that these plastics are manufactured so that they can degrade faster than conventional plastics and that they do become biodegradable.
13. EMF continue that "it is not yet possible accurately to predict the duration of the biodegradation for such plastics" and for that reason a broad indication only can be given as to timescale. It is however possible to say with certainty that at any given time and place in the open environment an oxo-biodegradable plastic item will become biodegradable significantly more quickly than an ordinary plastic item.
14. It is not important how long a particular piece of plastic in a particular place will take to biodegrade – the importance of oxo-biodegradable technology is that it will quickly reduce the overall burden of plastic in the environment.
15. The authors of the Swiss report offer no reason why, once the molecular weight has been reduced and the material has become biodegradable, it would not fully biodegrade under environmental conditions. The only "environmental conditions" required are the presence of oxygen (for the abiotic degradation) and bacteria (for the biotic degradation) both of which are always available. Sunlight and heat will accelerate the process but they are not essential. However, plastic litter on land and floating on water will usually have access to both. Moisture is not necessary for the abiotic process of converting plastic into biodegradable materials.
16. It is easy to prove that the molecular weight of material exposed under natural conditions has reduced so that the material has become biodegradable, and this has been done at Station d'essais de Vieillissement Naturel de Bandol on the Mediterranean coast of France. It is less easy to prove biodegradation, as this cannot be done in a field or a compost heap or floating on the ocean. It has to be done by testing in a laboratory according to ASTM D6954 and comparable Standards, (it is the same for testing "compostable" plastic according to EN13432 or ASTM D6400). It has been done by Eurofins laboratories, who found 88.9% biodegradation in 121 days. Further, in a report published in February 2020 https://www.biodeg.org/wp-content/uploads/2020/02/published-report-11.2.20.pdf researchers at Queen Mary University London found the biodegradation of oxo - LDPE was 90 times greater than that of ordinary LDPE after 35 days. See also the report of Peter Susman QC, https://www.biodeg.org/uk-judge-find-the-case-for-oxo-biodegradable-plastic-proven/ which reviews the scientific evidence.
17. The Swiss report then says "In addition, ODP can negatively impact recycling processes." This is a broad statement which cannot be justified. See https://www.biodeg.org/recycling-and-waste/ and is in conflict with their own findings at

Page 11 – finding 3, and page 15 Finding 3.4; page 19 4A

18. They then say "Recently, the Single-Use Plastics Directive has been adopted in the European Union, stating that the placing on the market of all plastics containing additives, which through oxidation lead to fragmentation (i.e. ODP), will be prohibited." The reasons for this prohibition are given in Recital 15, and it might be justified for oxo-biodegradable plastic and a wide range of ordinary plastics (see Page 11 – finding 3) but for the reasons mentioned above it is not justifiable for oxo-biodegradable plastics. The EU have no scientific support for any restriction of oxo-biodegradable plastic from their own scientific experts, the European Chemicals Agency.
19. In para. 1.1 on page 2 the authors do not mention that in Denmark the courts in Ellepot a/s v Sungrow A/S (BS-44586/2018-SHR) have held that "compostable" plastics cannot be described as biodegradable – because they are tested according to EN13432 for biodegradation in the special conditions found in a composting facility, not in the open environment.
20. Nor do they mention that in Germany, in the case of Güthoff v Deutsche Umwelthilfe (15 U 28/14/ 28 O 116/13) it was held that plastic should not be described as compostable. This is because in many areas "compostable" plastic is not sent to an industrial composting unit. It is either sent to landfill or for incineration, or it escapes into the open environment as litter.

IRRELEVANT ISSUES

21. There are three irrelevant issues which always find their way into a discussion of oxo-biodegradable plastic, and which cause confusion. It would therefore be useful to clarify:

A. Composting

22. Oxo-biodegradable plastic was not invented for composting. It was invented to deal with plastic waste which escapes into the open environment. It does this by converting the plastic in aerobic conditions into biodegradable materials, and it is tested according to ASTM D6954.
23. "Compostable" plastic is an entirely different product, which is not relevant to the problem of plastic which has escaped into the open environment. This type of plastic is tested according to EN13432 or ASTM D6400 to biodegrade in an industrial composting facility, where it turns into CO2 – not into compost. Actually there is no place for plastic of any kind in the composting process. See https://www.biodeg.org/composting/

B. Landfill

24. Oxo-biodegradable plastic will degrade in a landfill where oxygen is present, but it is not necessary. This is because if plastic is in landfill it has already been responsibly disposed of. Also anything which biodegrades deep in landfill generates methane, which is a much more powerful greenhouse gas than CO_2. Oxo-biodegradable plastic has therefore been designed so that it will not degrade in anaerobic conditions. See https://www.biodeg.org/landfill/

C. Recycling

25. This is not really relevant to the type of plastic for which oxo-biodegradable technology is used. See https://www.biodeg.org/recycling-and-waste/

SPECIFIC POINTS

Page 9 Finding 1.3 – the Agricultural Sector

26. OBP can be used to make mulch films for agriculture, but it is a bespoke product. A reputable supplier will formulate the polymer and masterbatch having regard to the climatic conditions on the particular farm, and to the particular 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 trials will be done in situ with a range of formulations before an OBP mulch-film is supplied to a farmer in commercial quantity. Crop-based plastic is not as useful for this purpose, because the time for degradation cannot be controlled.
27. A leading OPA member – Symphony Environmental, has conducted successful field trials at a farm in Wales https://www.biodeg.org/wp-content/uploads/2020/06/pembroke-mulch-film-trial-report-30.09.13.pdf

Page 11 – finding 3

28. The authors acknowledge the importance of the two main components of an OBP masterbatch: stabilizers and pro-oxidants. The balance of these components is critical if you want to control the useful life and the degradation rate of the plastic material.
29. It is well known in polymer science that unsaturated organic compounds are prone to abiotic degradation and will destabilize the polymer if exposed to outdoor factors. We agree that "other broad substance categories such as unsaturated organic compounds are found in ordinary commercial plastics." And that "Many of the identified substances may be used for other functionalities in polymers, and thus a much larger fraction of plastics might unintentionally oxo-degrade."
30. They continue at p15 "Conventional plastics may contain pro-oxidant additives that were added for different intended functionalities. Moura et al. (1997) described that colorants in general can act as pro-oxidants. If they partake in the creation of radicals or reactive oxygen species, such as singlet oxygen (1Δg), they can trigger photo-degradation of the polymer matrix." "Conventional plastic products (n = 23) were found to regularly contain Fe, Ba, Ti, Zn, Cu and V. Some individual conventional plastic bag samples also contained Cr and Pb."
31. This is an important point, because users of recyclate cannot therefore assume that the recyclate does not contain pro-oxidants, and will have to add stabilisers if they are making a long-life product, whether the feedstock contained oxo-biodegradable plastic or not. The normal commercial stabilisers will neutralize any residual prodegradants in the recyclate.
32. The authors quote the definition of ODP in Article 3 of the Single-use Plastics Directive 2019/904 as follows: "'Oxo-degradable plastic means plastic materials that includes additives which through oxidation lead to the fragmentation of the plastic material into micro-fragments or to chemical decomposition" The authors then correctly point out that "a potentially much higher number of plastics on the market may match the current legal definition of oxo-degradable plastics without being advertised or intended as such…" and they could therefore all be banned.

Page 12 – finding 3.2

33. It is correct that the list of transition metal carboxylic salts is longer than Mn, Fe and Co.

Practically all transition metal organic compounds where the metal can exist in two different states of oxidation (valence) and can "jump" from one level to the other and back to the initial state, will act as an oxidation catalyst. But it doesn't mean that all these compounds may be used commercially. For example, Ni-based compounds are toxic.

34. With regard to the organic unsaturated compounds (even some polymers), these are used on a limited basis, as their heat stability and other properties are relatively low, and their volume on the market is not high. We would be surprised to learn about an effective commercial prodegradant which wasn't based predominantly on Mn/Fe/Co carboxylates. There are other salts that would be effective – but are not widely used
35. The organic functional groups (e.g. benzophenones) have specific use (e.g. as stabilizers, or other applications), but again their use is limited compared to other chemical compounds in the plastics industry.
36. The authors are mixing up "enzymatic" masterbatches with oxo-biodegradable masterbatches, but the mechanism of the two technologies is completely different. We are not convinced that “enzymatic” masterbatches are effective, and including these additives, in a discussion about OBP causes confusion.
37. Other components might be added to an oxo-biodegradable masterbatch with claims to "boost" a degradation/biodegradation response, but these are added simply to differentiate the product in the marketplace or to try to make it patentable.
38. A copolymer cannot be described as a pro-oxidant additive. Modifying the polymer may enhance degradation (such as in ethylene carbon monoxide co-polymers), but this is not the addition of a prodegradant catalyst – it is simply modifying the polymer or blend.
39. "Commercial importance" can only be determined by asking the industry. If the OPA had been asked we would have been happy to provide information about the commercially important components.

Pages 12-15 Tables

40. These look like lists of possibilities - not actual formulations.
41. The authors tried to list as many additive/masterbatch suppliers with patents or not. But they mix the enzymatic additive suppliers with OBP MB suppliers, and unknown products/technologies. It is difficult to use this database in an objective way as a source of useful technical information.
42. A range of products claiming enhanced biodegradability e.g. EcoPure have been conflated with prodegradant catalysts. It is claimed that these chemicals attract microbes which perform the degradation - not to make the plastic biodegradable via oxidation of the main chain.
43. P-Life mentions various organic sensitizers, but its product is dependent on a traditional metal salt prodegradant catalyst.

Page 15 Finding 3.4

44. It is correct that some pigments and dyes may act as prooxidants. But these products are not advertised and labeled as "OBPs" and they may generate microplastics. These pigments and dyes have been used for many years and they will continue to be used.
45. It is known that if polymers existed in a perfectly pure state they would last perhaps for centuries. However, we observe degradation in the environment because polymers contain carbonyl/peroxide groups and some unsaturation (double bonds); and/or impurities, often metallic, which can act as photosensitisers (absorb light energy and transfer it to the polymer as vibrational energy (heat).
46. This is uncontrolled and usually sufficient to cause fragmentation, but not to cause

substantial biodegradability.

Page 15 Finding 4

47. In our opinion, the portable XRF equipment is useful for front-line OBP analysis. We use XRF as a quick screen for a known formulation and follow that up where necessary with testing in the laboratory.
48. The examples given are not relevant to OBP plastics. From all materials tested we see no Co, Mn or Ce. The examples may refer to pigments and dyes (product made in Indonesia, may still use pigments and inks based on Cd, Cr, etc.).

Page 16 "handheld XRF is not a feasible method for identifying ODP."

49. This is an issue with the fundamental premise of identification (by any method, not specific to XRF) of a transition metal species present in a plastic bag and forming a conclusion as to oxo-biodegradability.

Page 19 4A "An unequivocal definition of ODP is needed."

50. CEN has already defined oxo-degradation and oxo-biodegradation in TR15351 – See above.

Page 19 Recommendation 4 B "Simple methods for identifying ODP in practice need to be developed." A portable xrf device is already available for making an initial test in a shop or warehouse. There is no comparable method for identifying "compostable" plastic.

51. Page 19 Recommendation 4C "Regulating the labeling of degradable products may contribute to a proper disposal." The OPA agrees with this. There are strict requirements for testing and labelling in countries where OBP is mandatory eg Saudi Arabia and the UAE; and the OPA would support similar requirements in Europe.
52. We would agree that degradability is an environmentally favorable property for "products which are likely to be disposed of when having residues of a substance containing nutrients attached (e.g. food packaging), and it is for that type of product that OBP is predominantly used.
53. If we collect an unknown/unmarked bag from the street and find 25-80 ppm of manganese or cobalt in it, it is more than likely that that bag is oxo–biodegradable but it is not proof of performance.
54. Iron is found in almost any plastic product, particularly if it is filled or coloured. Though an additive based entirely on iron would not make the product oxo-biodegradable, it would make it photodegradable and would promote fragmentation.
55. It happens rarely, but we do see products with a correct level of prodegradant catalyst, which do not degrade because of the inadvertent inclusion in the polymer of a powerful stabiliser such as HALS.
56. XRF does have some specific issues, namely some line overlaps are fairly common (say 5-10% of cases). The presence of certain pigments (lead chromate) or impurities (barium sulphate, present in some calcium carbonate) lead to false positive results.
57. However, just because XRF is not perfect, does not mean it is not useful - clearly not since we get valuable information from it every day. While false or misleading positives are possible, absence is absolute evidence of no catalyst if you know what element(s) you are looking for.

Page 19-20 Recommendations

58. As mentioned above, the point re "unintended ODP" and the SUP Directive is an important one. It means that most plastics are oxo-degradable, and are therefore banned. The definition in Art. 3(3) of the Directive is a careless piece of work. It also fails to distinguish between oxo-degradable plastic (which fails to biodegrade but instead creates microplastics) and oxo-biodegradable plastic which does not
59. The identity of OBPs should be determined by their performance, not just their composition. This can be demonstrated by manufacturers (via masterbatch suppliers) in advance, by producing test reports according to ASTM D6954 and comparable Standards. The OPA standard http://www.biodeg.org/wp-content/uploads/2018/09/opa-standard-specification-oxo-biodegradable-pe-pp-film-finished-products-aug-2018.pdf offers a way to quickly check the performance of oxo-biodegradable products, which can be policed by sampling the market.
60. Recommendation C acknowledges that degradability is desirable for certain product types. We agree that OBP products should be properly labelled and that the public should be advised to dispose of them responsibly. Oxo-biodegradability is intended as a fail-safe mechanism if all else fails.
61. The example with industrial and home composting is positive and real. A material biodegradable in industrial composting may not biodegrade in home composting. Home composting is not done under regulated conditions and it is unlikely that most householders will ever read a standard which prescribes those conditions. This is also unrealistic – why would a householder buy an expensive plastic bag to transport kitchen waste to a home compost, when he could use a bucket? For composting generally see https://www.biodeg.org/composting/
62. The example of ODP labelled as OBP and being a cause of littering is pure speculation, and would apply equally to all biodegradable plastics. OBPs were invented to solve the litter problem, not to generate litter. Further, the biodegradation of OBPs, once proved by testing in a laboratory to industry standards such as ASTM D6954 is as valid as the "compostability" of plastics, tested in a laboratory to industry standards such as EN13432.

OXO-BIODEGRADABLE PLASTICS ASSOCIATION

London 4th August 2020 www@biodeg.org