OXO-BIODEGRADABLE PLASTIC

There is no simple solution to plastics in the open environment. Recycling is important, and if all the plastic could be collected for recycling there would not be a problem, but this is unlikely for the foreseeable future, even in the developed world.

Waste management in Switzerland is among the most efficient in the world, but the Swiss Federal Office for the Environment says:

“Plastics have no place in the environment. Nevertheless, around 14,000 tonnes of plastics end up in Switzerland’s soil and waters every year – primarily due to the abrasion and decomposition of plastic products and improper disposal of plastic waste. Plastics then accumulate in the environment because they only degrade very slowly.”

This is the reason why oxo-biodegradable plastic was invented. It is used in a wide variety of packaging and other products made from polyethylene or polypropylene, which are among those most likely to be littered. It is also very useful in agriculture. It tackles the problem at the molecular level by ensuring that the plastic does not just break up into smaller pieces. It dismantles the molecular chains *within* the polymer so that it ceases to be a plastic and becomes a biodegradable material which is consumed by bacteria and fungi and cleaned out of the eco-system by them.

Oxo-biodegradable plastic is *not* designed to end up in nature, but it is the only way to prevent plastic in the open environment from accumulating there for decades. It is designed to be used and recycled and disposed of in the same way as ordinary plastic, and there is no need to label the product as biodegradable. It is designed to biodegrade only if at the end of its useful life it escapes into the open environment deliberately or by accident. It will also biodegrade if disposed of in landfill, though that is not its primary purpose.

Many people, including the European Parliament, have confused this technology with oxo-degradation, and there is no dossier from the EU technical experts, the EU Chemicals Agency, providing any justification for any ban on oxo-biodegradable plastic.

DEFINITIONS

The scientific definitions are in CEN (European Committee for Standardisation) TR 15351 as follows: "Oxo-degradation" is 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. Nobody puts additives into plastic and markets it as “oxo-degradable.”

By contrast "oxo-biodegradation" is "degradation resulting from oxidative and cell-mediated phenomena either simultaneously or successively." This means that the plastic degrades by oxidation until its molecular weight is low enough to be accessible to bacteria and fungi, who then recycle it back into nature by cell-mediated phenomena. These plastics are marketed as “oxo-biodegradable.”

Confusing these two technologies hinders the wider adoption of oxo-biodegradable technology and perpetuates the pollution of the environment, because if ordinary plastic continues in use for products most likely to be littered they will accumulate in the environment, and especially the oceans and watercourses, for decades instead of quickly biodegrading, leaving no microplastics or harmful residues.

MICROPLASTICS

Microplastics are caused by the disintegration of ordinary plastics when exposed to sunlight and stress, but they do not become biodegradable except over a long period of time. Oxo-biodegradable technology deals with this by making the plastic biodegrade. In December 2017 the European Chemicals Agency (ECHA) were asked to study oxo-biodegradable plastic and on 30th October 2018 they informed the BPA (Biodegradable Plastics Association) that they were not convinced that microplastics were formed. There is no Report from ECHA because the Commission terminated the study when it became apparent that ECHA were not going to agree with them about microplastics.

Oxo-biodegradable plastic degrades in the presence of oxygen. Heat and UV light will accelerate the process, but neither they nor moisture are necessary. It is not therefore correct to say that it requires special conditions which may not be available in the open environment. The type of plastic which *does* require special conditions is the type marketed as compostable.

Oxo-biodegradable plastic has been compulsory in the Middle East since 2009 for a wide range of plastic products

RECYCLING

Oxo-biodegradable plastic can be recycled and made from recyclate. It has been in use for 25 years, and for the past 15 years it has been used by Grupo Bimbo for their plastic bread-wrappers. They are the largest bread manufacturers in the western world, and have a policy of recycling this plastic. Much of it has been recycled and no problems have been reported.

STANDARDS

For the purpose of testing and certifying plastic which Degrades in the Environment by a Combination of Oxidation and Biodegradation, an international standard has been developed by ASTM in accordance with internationally recognized principles on standardization established by the World Trade Organization. This Standard has been replicated in many jurisdictions around the world, including the UK.

The BPA will certify OXO-biodegradable plastic which conforms to the international Standard ASTM D6954 for testing degradability, biodegradability, and non-toxicity. This Standard contains pass/fail criteria, and oxo-biodegradable plastic has been tested to this Standard many times by independent international test houses such as Intertek and Eurofins. The Standard has been replicated in many other countries, including the UK, Saudi Arabia, and Mexico.

One of the authors of ASTM D6954, Dr. Graham Swift, explained the Standard in his evidence to the UK Government, and explained why it contains a caveat, recognising that laboratory environments are isolated, unlike the dynamic natural environment - in which degradation and therefore biodegradation is likely to proceed more quickly.

The EN13432 Standard does not require testing of compostable plastic in a compost heap and ASTM D6954 does not require oxo-biodegradable plastic to be tested in a field or in the ocean. In both cases they are tested according to test methods designed by scientists to replicate the conditions in the environment where they are expected to biodegrade. The Standards also require eco-toxicity testing to ensure that they will be safe in the environment.

THE SCIENCE

Oxo-biodegradable technology has been studied by scientists for more than 50 years since it was invented not by marketeers and salesmen but by Professor Gerald Scott and other distinguished polymer scientists, in the 1970's. See his textbooks "Polymers & the Environment" (ISBN 9780854045785); "Degradable Polymers; Principles & Applications" (ISBN 1-4020-0790-6); and "Programmed-Life Plastics from Polyolefins: A New Look at Sustainability"

The most recent scientific publication is the report of a four-year study called "Oxomar" which was sponsored by the French government at their marine laboratory. The scientists reported (at C6) "We have obtained congruent results from our multidisciplinary approach that clearly shows that Oxo-biodegradable plastics biodegrade in seawater and do so with a significantly higher efficiency than conventional plastics. The oxidation level obtained due to the d2w prodegradant catalyst was found to be of crucial importance in the degradation process." Note the six peer-reviewed publications cited on page 12 and the further authorities cited on pages 17 and 18.

They continued "in relation to oxo-biodegradable plastic our study shows evidence of biodegradation of OXO-bio after artificial ageing, which correspond to a service life of approximately one year under natural light. However, our study could not comment on its complete degradation in marine environment after periods classically used in actual norms." That is because having demonstrated biodegradation in seawater with a significantly higher efficiency than conventional plastics they did not continue the experiment.

However 95.05% biodegradation has been found in Standard tests by Intertek, and 88.9% by Eurofins.

The scientists also confirmed (C6) that "accelerated artificial aging (UV, temperature) which was perfectly mastered in this project, is a tool of choice which is particularly well suited to the study of the fate of OXO-bios in the marine environment. Accelerated artificial ageing does not invalidate the results."

See also the study at Queen Mary University London; the evidence given by scientists in response to the Call-for-evidence by the European Chemicals Agency; and the evidence given by Intertek

The American National Standards Institute says: "Using oxo-biodegradable technology can prevent future contributions to the accumulation of plastic waste that has escaped into the environment. Oxo-biodegradable plastic serves as a solution to littered plastic because it is recyclable and will degrade without releasing methane."

ANSI continues “It is important to note that oxo-biodegradable plastic is *not* the same as oxo-degradable plastic. Oxo-degradable plastic does not biodegrade but breaks into microplastics which are then released into the environment and cause significant harm, especially to ocean life. They quickly fragment into smaller and smaller pieces (i.e., microplastics) that do not break down at the molecular or polymer level like biodegradable and compostable plastics. The resulting microplastics are left in the environment indefinitely until they fully break down over a very long period of time.”

“By contrast, oxo-biodegradation means degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively. [CEN TR15351] The plastic degrades by oxidation until its molecular weight is low enough to be accessible to bacteria and fungi, who then recycle it back into nature. These plastics are tested for degradation, biodegradation, and ecotoxicity according to ASTM D6954-24.”

There is another paper, from the US Environmental Protection Agency, which says that it is possible to eliminate persistence of plastics by adding a safe pro-oxidant to make a low-cost biodegradable plastic.

For further reading by those who are not polymer scientists there is a briefing note called “Why Biodegradable” which explains the technology and deals with the arguments which are made against it, including those made by the EU. In making the SUP Directive the EU Parliament circumvented the REACH Regulation 2006/1907 (Arts 68-72) and acted without advice from their own scientific experts, the European Chemicals Agency, who have never produced a dossier recommending any restriction of oxo-biodegradable plastic.

CONTROVERSY

There are publications which question this technology, such as the Ellen MacArthur (EMF) paper, written by a non-scientist in 2017. In 2019 it was amended after complaints regarding its accuracy. Also, The BPA pointed out that many of the organisations shown as endorsing this paper aggressively promote a rival bio-plastic technology, while many of the others whose logos appeared in the document were themselves producers of the very plastic items that get into the open environment as litter. There is no evidence that any of them had done their own research.

The EMF paper's conclusion was also rejected by Professor Ignacy Jakubowicz, one of the world’s leading polymer scientists, who had advised EMF that the degradation process was not merely a fragmentation, but a change from a high molecular weight polymer to a material that can be bio-assimilated.

The BPA has also commented on the 2018 Report of the EU Commission; the Eunomia report, the HSAC Report, the Plymouth University Report, the Michigan State University Report, the Hutton Report, the UCL Report, the US Plastics Pact, the WWF Position Paper, the Sustainable Packaging Coalition Position Paper, the BBAI letter, the UNEP Report, etc.

There are in addition many peer-reviewed papers purporting to show that oxo-biodegradable technology does not work. They look impressive but they usually contain a fundamental error. For example the authors (a) have not followed the procedure described in ASTM D6954 or have not followed any standard at all. (b) have followed the wrong standard eg ASTM D6400 or EN13432 (c) did not characterise the sample before starting the test, and therefore have no idea whether it contains an oxobiodegradable masterbatch at the correct concentration or at all.

(d) did not continue important parts of the test for a sufficient length of time (e) used a sample so heavily laden with stabilisers that it would take a very long time before the material became biodegradable. (f) failed to understand that oxo-biodegradable plastic is not intended to degrade immediately, but is stabilised to have a useful life and to be re-used (g) exposed the sample under conditions unlikely to be experienced by plastic litter in the open environment eg buried or submersed instead of lying or floating on the surface.

The problem is that this faulty research then gets cited and repeated in literature-reviews and leads policymakers to make the wrong decisions.

Oxo-biodegradable plastic products will biodegrade much more quickly in the open environment than conventional plastic, and nobody has given any reason why degradation once commenced should stop before it is complete. Even if it did not fully biodegrade it would be better than conventional plastic, which would not have biodegraded at all except over a very long period of time.

COMPOSTING

Oxo-biodegradable plastics are not designed to be compostable in open industrial composting facilities, according to ASTM D6400 or EN13432, so they do not need to biodegrade in the 180 day timescale required by the industrial composters and included in those standards. However, they can be satisfactorily composted in an in-vessel process, and have been proved to be compostable in actual composting facilities, and in laboratories according to ISO 14855 [Eurofins Laboratories 6.11.16].

Oxo-biodegradable plastics should not therefore be confused with plastics intended to biodegrade in the special conditions found in an industrial composting unit. These plastics use an entirely different technology, but confusion is caused by the fact that they are so often referred to intentionally or by mistake in discussions about oxo-biodegradable plastic.

In fact, plastics which comply with ASTMD6400, EN13432, Australian 4746, and ISO 17088 cannot properly be described as 'compostable' because those standards require them to convert into CO_2 gas within 180 days. They cannot therefore be made into compost - only into CO_2 gas. This contributes to Climate Change, but does nothing for the soil.

CONCLUSION

The evidence for and against oxo-biodegradable plastic was reviewed in November 2018 by Peter Susman KC, a deputy judge of the High Court of Justice in England, who had over 25 years' experience of adjudicating cases in the technology and construction branch of the court, involving the evaluation of expert evidence. He declared the scientific case in favour of oxo-biodegradable plastic to be "clear and compelling".

Susman concluded, in a 15-page written opinion that "It is no longer tenable to conclude that there is 'no firm evidence either way' whether oxo-biodegradable is effective.

I consider that recent research provides clear and compelling evidence that oxo-biodegradable plastic is indeed effective in facilitating very significantly speedier degradation than is the case when that technology is not used ....[I] cannot imagine that such significantly speedier final degradation occurs later than 'within a reasonable time', however that the expression might be defined. ...I regard the idea that biodegradable plastics might encourage littering as "fanciful and unreasonable" and **I find the case for oxo-biodegradable plastic proved."**