What types of biodegradable plastics exist?

The two main types are oxo-biodegradable and hydro-biodegradable. In both cases degradation begins with a chemical process (oxidation or hydrolysis), followed by a biological process. Both types emit CO_2 as they degrade, but hydro-biodegradables (often containing starch) can also emit methane. Both types are compostable, but only oxo-biodegradable can be economically recycled.

Oxo-biodegradable plastics:

- Do not leave fragments of petro-polymers in the soil
- Pass all the standard eco-toxicity tests
- Are safe for long-term contact with food
- Do not contain organo-chlorine, PCBs or "heavy metals"
- Do not emit methane or nitrous oxide, even deep in a landfill
- Can be made from recycled plastic
- Can be safely recycled

Comparison of Oxo-Biodegradable and Hydro-Biodegradable Plastics

OXO	HYDRO
Usually made from a by-product of oil-refining	Made from fossil fuel-derived polymers and starch
Can be recycled as part of a normal plastic waste-stream	Damages recycle stream unless extracted from feedstock
Can be made from recycled plastic	Cannot be made from recyclate
Emits CO_2 slowly while degrading and forms biomass	Emits CO_2 rapidly while degrading
Inert deep in landfill	Can emit methane in landfill
Can use same machinery as for conventional plastic	Needs special machinery
Suitable for use in high-speed machinery	Not suitable
Can be compostable	Compostable
Little or no on-cost	Four or five times more expensive than conventional plastic
Same strength as conventional plastic	Weaker than conventional plastic
Same weight as conventional plastic	Heavier
Leak-proof	Prone to leakage
Degrades anywhere on land or sea	Degrades only in high-microbial environment
Time to degrade can be set at manufacture	Cannot be controlled
Safe for food contact	Safe for food contact
No PCB's Organo-chlorines, or "heavy metals"	No PCB's Organo-chlorines, or "heavy metals"
Can be incinerated with high energy-recovery	Can be incinerated, but lower calorific value
Production uses **no** fertilisers, pesticides or water	Production uses fertilisers, pesticides and water

Recycling

Oxo-biodegradable plastic can be made from recycled plastic, but hydro-biodegradable plastic cannot.

Oxo-biodegradable plastics can be recycled with other clean commercial polyolefin wastes, provided that regard is had to the inclusion rate and the level of degradation, and that stabilizers are added where necessary. Hydro-biodegradable plastics cannot be recycled with other polymer components of waste. They would therefore have to be extracted from the waste stream and treated separately, at prohibitive cost.

It is difficult for recyclers physically to distinguish the two types of plastics so, the more that hydro-biodegradable plastic gets into the waste stream, the greater the problem for recyclers.

The main benefit of hydro-biodegradable plastics is that they can be composted[1] if collected, but they have been called into question by recyclers.[2] Addressing the Local Authority Recycling Advisory Committee conference in November 2006 Recoup's project manager Sarah Dandy warned that bioplastics could have a negative impact on plastics recycling as a whole. "With compostable plastic packaging made from degradable starch-based materials and traditional plastics from oil-based ones, the fear is that bioplastics will increasingly find their way into the plastics recycling stream – impacting on quality and un-doing the work done on raising public awareness of plastics recycling."

1. Some are suitable only for industrial composting
2. Materials Recycling Week 20 Nov 2006

Addiflex Degradable Plastic Additives

ADDIFLEX – The Oxo-biodegradable solution to plastic waste

Is it safe for food-contact?

Yes. Certification has been obtained for Europe and North America.

In September 2007 the Commercial Packaging Manager of the Co-op said "I am happy to say that we are using oxo-biodegradable polythene films for direct food contact applications. We currently use these materials for pre-packed produce, self serve produce, pre-packed bread, frozen vegetables and fresh turkeys as well as for carrier bags. The approval for use has been based on the very strict EU requirements under EU Directives 2002/72/EC and 2004/19/EC relating to plastic materials and articles intended to come into contact with foodstuffs. We have been using these materials for food contact use since 2004."

Oxo-biodegradable bags are also being bought by the UK Soil Association, and used for direct contact with organic food products. ***Addiflex*** is already approved by Normpack in Europe for food contact and has a letter of recommendation from Keller and Heckman for the FDA and is in the process with the CFIA.

Isn't it made from oil?

In North America, most plastic are made from oil and gas by-product, unless the oil and natural gas is left under the ground, carbon dioxide will inevitably be released, but until other fuels and lubricants have been developed for engines, it makes good environmental sense to use the by-product, instead of wasting it by "flare-off" at the refinery and using scarce agricultural resources to make plastics.

Recently, interest has been shown in manufacturing sugar derived polyethylenes. These, like oil-derived PE, are not biodegradable, but they can be made oxo-biodegradable in the same way as the latter, by the addition of a pro-degradant additive.

Does it leave any harmful residues?

No. Oxo-biodegradable plastic passes all the usual ecotoxicity tests, including seed germination, plant growth and organism survival (daphnia, earthworms) tests carried out in accordance with ON S 2200 and ON S 2300 national standards.

ADDIFLEX – The Oxo-biodegradable solution to plastic waste

Does it contain "heavy metals"?

No. ***Addiflex*** contains only minerals typically found in mineral supplements and plants.

How long does it take to completely degrade?

An important advantage of oxo-biodegradable plastic is that it can be programmed to degrade in whatever timescale is required. The average useful life of a carrier bag is approximately 18 months. During that time bags are often re-used for shopping or for use as bin-liners etc.

The plastic does not just fragment, the process continues until the material has biodegraded to nothing more than CO_2, water, humus, and trace elements. The time can vary depending on the conditions.

Isn't it better to use paper bags?

No. The process of making paper bags causes 70% more atmospheric pollution than plastic bags. Paper bags use 300% more energy to produce, and the process uses huge amounts of water and creates very unpleasant organic waste. When paper bags degrade they emit methane and carbon dioxide.

A stack of 1000 new plastic carrier bags would be around 2 inches high, but a stack of 1000 new paper grocery bags could be around 2 feet high. It would take at least seven times the number of trucks to deliver the same number of bags, creating seven times more transport pollution and road congestion.

Also, because paper bags are not as strong as plastic, people may use two or three bags inside each other. Paper bags cannot normally be re-used, and will disintegrate if wet.

Can it be marketed as Biodegradable or Compostable?

Products containing an oxo-biodegradable additive are 100% degradable. According to the FTC guidelines you cannot state they are biodegradable/compostable unless it biodegrades in the normal method of disposal, which for shopping bags is mostly in landfill.

ADDIFLEX – The Oxo-biodegradable solution to plastic waste

What happens to it in a landfill?

Oxo-biodegradable plastics fragment and partially biodegrade to CO_2 and water in the surface layers of the landfill, but the residues are completely inert deeper in the landfill in the absence of oxygen. They do not emit methane.

By contrast, hydro-biodegradable plastics will degrade and emit CO_2 in the surface layers of a landfill if there is enough microbial activity. However, in the depths of a landfill, in the absence of air, hydro-biodegradable plastics can generate methane, which is a powerful greenhouse gas.

Can it be composted?

Oxo-biodegradable plastics do not degrade quickly at low temperatures but ***Addiflex*** has a version of additive that can be used in most windrow and in-vessel composting systems.

But aren't the hydro-biodegradable plastics renewable?

No. Because hydro-biodegradable plastics are made from polyester, which is fossil fuel - derived, such as Ecoflex and sometimes starch. Fossil fuels are burned in the machines used to clear and cultivate the land, and in the manufacture and transport of fertilizers and pesticides and in transporting the crop itself. Energy is also used by the autoclaves used to ferment and polymerize material synthesized from biochemically produced intermediates (e.g. polylactic acid from carbohydrates etc). When the material biodegrades it emits CO_2 and methane, so the total fossil fuels used and greenhouse gases emitted are more than for conventional or oxo-biodegradable plastic.

ADDIFLEX – The Oxo-biodegradable solution to plastic waste

What national or international standards exist?

Oxo-biodegradable plastic can be tested according to American Standard ASTM D6954-04 for Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation.

Until recently there was no standard designed to certify oxo-biodegradable plastic.

However, In July 2007 the French Standards Organisation, AFNOR, published XP T 54-980, which is a Standard for oxo-biodegradable plastics in agriculture.

A draft Standard 8472 capable of measuring oxo-biodegradation was published by the British Standards Institution in 2007.

European Standard EN 13432 applies only to plastic packaging, and was written before oxo-biodegradable plastics became popular. It is not appropriate for testing oxo-biodegradable plastics because it is based on measuring the emission of carbon dioxide during degradation. Hydro-biodegradable plastic is compliant with EN 13432, precisely because it emits CO_2 (a greenhouse gas) at a high rate.

Another unsatisfactory feature of EN 13432 is that it requires almost complete conversion of the carbon in the plastic to CO_2, thus depriving the resulting compost of carbon, which is needed for plant growth, and wasting it by emission to atmosphere.