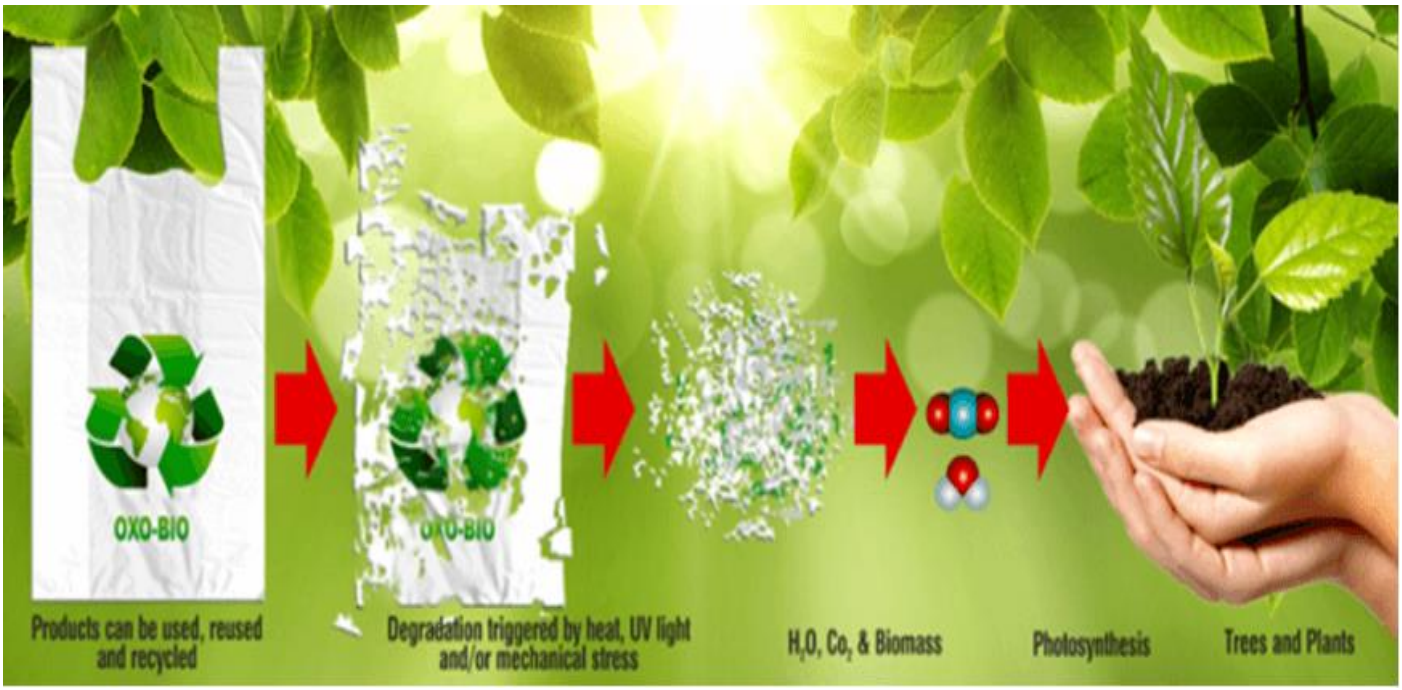
# OXO-BIODEGRADABLE PLASTIC PACKAGING




EP Tech Ltd.

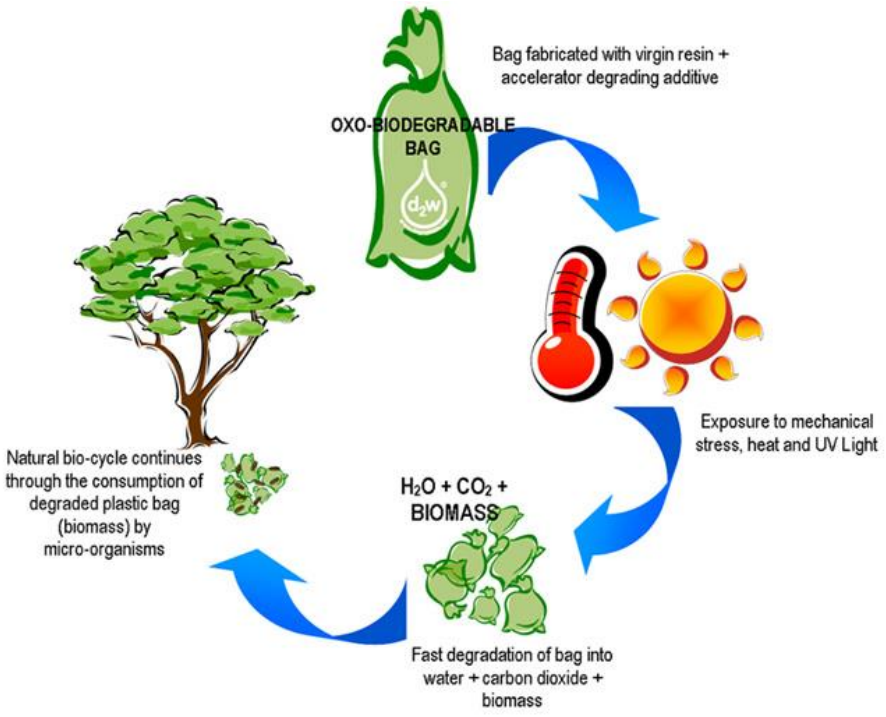
PO Box 15598

Tauranga 3110

www.eptech.co.nz

melody@eptech.co.nz

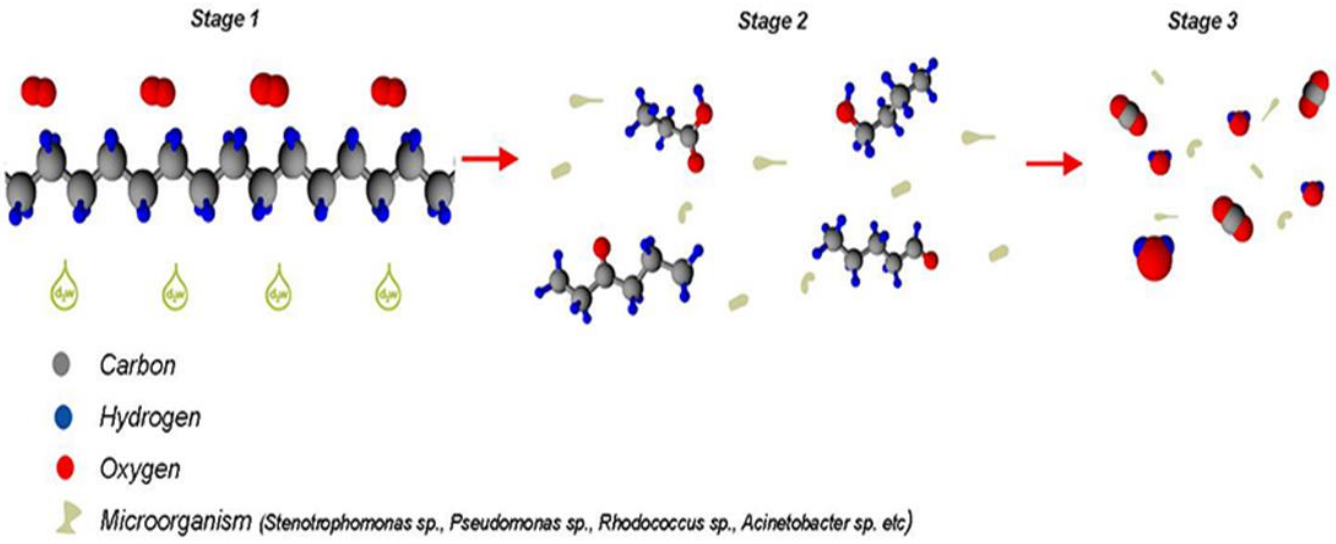
# HOW IT WORKS




**Stage 1:** D2w added to the polymer during the manufacturing stage at a 1% inclusion rate

**Stage 2:** Abiotic (Degradation) Stage: This is where the d2w additive breaks the strong molecular chains of the plastic to enable the product to degrade by a process of oxidation. The speed of this process is accelerated by heat, light and stress. At the end of this first stage the product is invisible to the naked eye and is no longer a plastic

**Stage 3:** Biotic (Biodegradation): This non plastic material is ingested by microorganisms and converted into biomass and compost.



# BIODEGRADATION

Oxo-biodegradation of polymers has been studied and acknowledged since the 1970's. One of the earlier studies done was by a Professor James Guillet at Toronto University in 1976. His work showed that carbon derived from oxidised polyolefin could be sequestered by plants. He took polymers and irradiated them in a UV accelerometer. He accelerated the degradation process of the regular polymer with the UV accelerator and then tested the degraded polymer in both garden soil and activated sewage sludge and he studied them over a period of three months exposed outdoors in Toronto. The results show that a degraded polymer is considerably more easily and rapidly biodegraded than an undegraded polymer. This work was further developed by Paul Kostyniak in 1977 and Ann-Christine Albertsson in the early 90's.

In the 90's, when plastic became increasingly unpopular due to its inability to biodegrade readily and the damage plastic litter was causing in the environment, pro-degradant additives were being researched as a means to alleviate the damage of plastic as litter based on the findings of Guillet and others. Pro-oxidant additives were developed in this decade and there have been many scientific papers written since then to confirm their ability to speed up the process of biodegradation of polymers.

One of these pro-degradants was is the one used by EP Tech, d2w. d2w is a manganese salt based additive which weakens the molecular structure of the finished plastic product, enabling degradation to occur.

Biodegradation of EP Tech products happens in two stages. The first stage is the abiotic or oxidation and degradation phase. The d2w additive in the bag when exposed to oxygen (oxidised), weakens the Hydro Carbon chains within the plastic to allow the film to break down. This break down and fragmentation is the oxidation phase. The degradation phase is a free radical chain reaction that completely changes the molecular structure of the material. Once the plastic get to below a certain molecular weight (40,000 daltons), it is no longer plastic, but a non toxic material capable of being ingested by micro-organisms. It is this stage that is the important stage when it comes to litter, as at the end of this stage, the material is no longer plastic. It is non-toxic, it is invisible to the naked eye and it is safe to be consumed.

The second stage is the biodegradation stage which is where the resulting material is ingested by micro-organisms and converted to biomass.

The technology has been tested using the protocol of American Standard D6954 which is the Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation.

A real life study done by Professor Telmo Ojeda published in 2008 shows HDPE and LDPE formulated with the d2w additive being exposed to natural weathering. The abiotic degradation was measured by measuring the molar mass and mechanical properties of the samples. As mentioned, once a polymer gets below a molecular mass of 40,000 it is no longer considered a polymer or plastic. At this weight the material becomes oxygen containing molecules that are able to be ingested by microorganisms. This study shows that this happened between the 80 – 136 days of exposure. The film was exposed in optimum conditions so this three month timeframe cannot be guaranteed. Experts predict that this stage can take 3 months to 3 years.

For his biodegradation tests, he placed the degraded samples in compost. The biodegradation rates were measured by their mineralisation into CO2. After three months in the compost, the film had mineralised 12% of the original carbon in the degraded plastic. The study does not follow biodegradation beyond 90

days. It should be noted here that this technology has shown to have a much slower rate of biodegradation in compost than it does in soil and the open environment.

Professor Ignacy Jacubowicz published his findings in 2011 on biodegradation of an oxo-biodegradable polymer made containing manganese salt like d2w. The testing was conducted in soil and in compost in accordance with International Standards ISO 17556 and ISO 14855-1. The findings of this study showed that oxo-biodegradable plastic film will biodegrade in soil within two years. He used mineralisation into CO2 as a measurement of biodegradation. This is a popular and widely accepted method for measuring biodegradation and is incorporated into a wide variety of Standards. It should be noted that this timeframe may be overestimated as this measurement of biodegradation only takes into account mineralisation into CO2 and doesn't measure the conversion into biomass which is also an indicator of biodegradation. The author admits to this in his report. The speed of biodegradation in compost was significantly slower. Based on these these findings, biodegradation of EP Tech's product as litter will happen quickly, but disposal in Industrial Composting Facilities is not suggested.

In 2007 Professor Emo Chiellini published a study showing the results of a oxo-biodegradable polyethylene in an aqueous medium using river water. The film was thermally oxidised prior to being put into laboratory testing flasks. The results concluded that oxo-biodegradable PE can biodegrade in a water media.

These reports are included in this booklet:

- *James Guillet – Tab 1*
- *Telmo Ojeda – Tab 2*
- *Ignacy Jacubowicz – Tab 3*
- *Emo Chiellini – Tab 4*

# SOIL TOXICITY

There are concerns among some that the end result of biodegradation of a polymer will cause toxins or leachates to be left behind in the soil. An oxo-biodegradable plastic which has been tested according to ASTM D6954 or BS 8472 will have had to have passed tests to ensure there are no heavy metals or toxicity.

This technology has been tested in accordance with these standards and is shown to have no heavy metals or toxicity.

The degradation of these products is a reflection of molecular weight loss and not as some may think a reduction in size due to friction. It is a chemical reaction altering the very molecular structure of the material. These fragments cease to be petropolymers when their molecular weight has descended to 40,000 daltons or less during the degradation or abiotic phase. In the Ojeda real life study mentioned earlier, this molecular weight was reached after around 80-136 days.

Independent eco-toxicity tests have also been done to International Standards OECD 207 and 208 on degraded fragments and also on composting residues and all studies found there is no eco-toxicity, no heavy metals and no danger of harmful leachate.

Copies of these studies are included in the booklet – *Tab 5*

# RECYCLING:

Typically the recycler is not a polymer expert. They collect waste plastics, the material is mixed together and the recyclate produced. This is then sold to converters who make the plastic mixed with virgin plastics or co mixed with other compatible plastic into products. The converter processes the recyclate which is mixed with virgin material into a finished product. As mentioned EP Tech bags are made from regular PE with the d2w additive included at a 1% inclusion rate. When these bags are mixed with other plastics to form a recyclate, that 1% is obviously reduced and when the recyclate is then mixed with virgin material, it is reduced even further. The converter will also need to include stabilisers and anti-oxidants. Recyclers always add anti-oxidants as a matter of course; this overcomes the activity of the prodegradant in the blend. Because of this, studies have concluded that plastic products made with oxo-biodegrdable technology may be recycled without any significant detriment to the newly formed recycled product. Recyclers both in NZ and throughout the world are successfully recycling this type of product.

The recycler for the soft recycling scheme adopted by big businesses in NZ such as Foodstuffs and the Warehouse is an Australian company called Replas. EP Tech has spoken with them and they accept our type of product in their recycling processes.

Studies on the recycling of our product are included in this booklet – *Tab 6*

# LANDFILL

Because this technology was initially created to deal with the issue of plastic when it becomes litter, not a lot of research was done with regards to its behaviour in a landfill. The initial school of thought and expert opinion was that our product would degrade in the upper levels of a landfill and then once it reached the anaerobic (no oxygen) conditions deep in a landfill, degradation would stop and the bag would become inert. However, a few years ago, EP Tech met a Polymer expert in the US called Dr Swift who believed that this technology would biodegrade deep in the anaerobic conditions of a landfill and advised us that there was a standard that we could test our product against to find out if this was the case. In 2015, EP Tech film was tested against the internationally accepted ASTM D5511 Standard Test Method for Determining Anaerobic Biodegradation of Plastic Materials Under High-Solids Anaerobic-Digestion Conditions. It was tested over a period of two years and the study has concluded that EP Tech oxo-biodegradable plastic will biodegrade in a landfill. Dr Swift is currently writing a report on the findings and has estimated time for biodegradation in a landfill to be between 2-5 years depending on exposure prior to being buried. This report will be published this year.

A copy of the raw data is included in the booklet – *Tab 7*

# STANDARDS

Our d2w bags have been proven in accordance with the following standards:

- ASTM 6954-04 - Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation
- ASTM D5510-94(2001) - Standard Practice for Heat Aging of Oxidatively Degradable Plastics
- UAE 5009/2009 - Standard & Specification For Oxo-Biodegradation Of Plastic Bags And Other Disposable Plastic Objects
- BS8472:2011 - Methods for the assessment of the oxo-biodegradation of plastics and of the phyto-toxicity of the residues in controlled laboratory conditions
- ASTM D5511 Standard Test Method for Determining Anaerobic Biodegradation of Plastic Materials Under High-Solids Anaerobic-Digestion Conditions


# COMMERCE COMMISSION CASE

In 2010, our company was prosecuted by the Commerce Commission under Acts 10 and 13 of the Fair Trading Act. They claimed that EP Tech product was not degradable, oxo-biodegradable or biodegradable and that it wouldn't work in the real world. They claimed that EP Tech product is not recyclable as it contaminates the recycling stream. They claimed that EP Tech product would not biodegrade in a landfill. They claimed that EP Tech product was not compostable and not environmentally friendly. Section 13 of the Act states that a companies claims are false and misleading. Section 10 of the Act states that a companies claims are liable to mislead.

EP Tech proved in the High Court of NZ that their product is biodegradable, degradadble and oxo-biodegradable and were found not guilty of all Section 13 charges, as their claims were not false and misleading. EP Tech were found guilty under Section 10, because by using the word biodegradable, degradable or oxo-biodegradable without a qualifying statement with regard to timeframe for biodegradation, consumers can be misled into thinking it will happen faster than it actually will. The products now have a qualifying statement explaining this.

EP Tech proved in a High Court that our product is recyclable and were found not guilty of all these charges.

EP Tech never claimed that their products were compostable as they do not meet the composting standard that requires a bag to compost within 180 days. Because they never made this claim, they were found not guilty under Section 13. However, because they did not have a qualifying statement explaining that their bags are not suitable for compostig, they were found guilty under section 10.

As the landfill study had not been done at the time of the trial, they were unable to prove convincingly that their product would biodegrade in a landfill, The judgement on these charges was that "whilst an oxo-biodegradable bag may literally biodegrade in a landfill, it is not evidentially realistic". EP Tech currently have an advisory note on their products stating that biodegradation in a landfill is unlikely due to the Court Case, but once the report (explained in the landfill section) is published and legal advise taken, this will change.

For the environmentally friendly charges, EP Tech were found not guilty under Section 13, but guilty under Section 10. Again, this is due to not having an advisory note for the above charges.

Please see overleaf for Summary of Charges. The ones highlighted in yellow are the ones they were found guilty of.

**Representations on plastic bags**

| Representation | Number of charges | |
|---|---|---|
| | Section 13 | Section 10 |
| "Biodegradable plastics" and "Here today ... gone tomorrow" | 11 | 1 |
| Eco-Pal plastic bags are more environmentally friendly than other plastic bags - the frog logo and the slogan "Here today ... gone tomorrow" | 2 | 1 |
| Eco-Pal bags are more environmentally friendly than other plastic bags | 7 | |
| Eco-Pal bags are "oxo-biodegradable" | 3 | 1 |
| Eco-Pal bags are recyclable | 5 | 1 |

**Representations on the brochure and website**

| Representation | Brochure Number of charges | | Website Number of charges (one for each date) | |
|---|---|---|---|---|
| | Section 13(a) | Section 10 | Section 13(a) | Section 10 |
| Environmentally friendly | 1 | 1 | 2 | 2 |
| Oxo-biodegradable | 1 | 1 | 2 | 2 |
| Degradable | 1 | 1 | 2 | 2 |
| Biodegradable | 1 | 1 | 2 | 2 |
| Compostable | 1 | 1 | 2 | 2 |
| Landfill | 1 | 1 | 2 | 2 |
| Recyclable | 1 | 1 | 2 | 2 |