

econic™

High Barrier Compostable Packaging

Composting Study at Daltons

February - May 2010



Andrew Sheerin
Convex Plastics Ltd



Contents

Executive Summary	03
Background	04
Protocol	05
Composting Study Diary	07
Results - Temperature	15
Strength	16
Mineralisation	17
Moisture Content	18
Visual Photographs of Breakdown	19
Conclusion	20
Discussion	21
Further Investigations	22



Executive Summary

Convex Plastics has developed a compostable coffee bag for the packaging market called Econic[®]. Traditional fossil fuel based packaging materials have been replaced with materials which have higher renewable* content derived from corn (starch) and wood plantations (cellulose)

The base materials used to create Econic[®] are accredited to British standard EN13432 and the American ASTM6400 for biodegradability in a composting environment.

Over the period of 17 weeks Convex monitored the breakdown of 8 Econic[®] compostable bags at a bark composting facility, near Matamata, New Zealand.

Econic[®] was successfully monitored to break-down in a bark composting windrow. On average 49.4% of a bag have been mineralized by micro-organisms within 105 days. This would indicate 100% mineralization would take 212 days of windrow composting in bark.

It is important to note that the windrow was turned over each fortnight, so the bags had to be uncovered and then buried again.

A second composting study was conducted on an Econic[®] bag disposed of in a food-waste composting bin in Auckland, New Zealand. This compost included food waste as well as spent coffee grinds.

It was concluded that there was sufficient heat, moisture and micro-organism activity to compost the Econic[®] bag in 50 days in this environment.

Through two composting studies Convex has seen the compostable Econic[®] bags breakdown. Depending on the available heat, moisture and micro-organisms in a compost Econic[®] bags will breakdown and provide an alternative to traditional non-degradable packaging being placed in landfills.

* the current average percentage of renewable content in Econic[®] is 60%. The actual % varies depending on the thickness and materials used. Contact Convex to discuss this further. Convex are constantly striving to increase the renewable content by sourcing new raw materials as they become available.



Econic[®] Compostable Coffee Packaging

Convex Plastics has developed a compostable coffee bag for the packaging market called Econic[®]. Traditional fossil-fuel based packaging materials have been replaced with materials which have higher renewable* content derived from corn (starch) and wood plantations (cellulose) Compostable cellulose has been laminated together to produce high barriers to oxygen and moisture ingress. A compostable cornstarch sealant layer on the inside of each bag provides good sealing properties through and around dry granular products.

Each of the base materials have been certified internationally to the EN13432 standard for biodegradability through composting . The materials also conform to the American testing standard ASTM6400.

MVTR barrier = 5.3 g/m²/day 38°C 90% RH* *Both Tested from non-vented area of bag.

O₂ barrier = <0.2 cc/m²/day 23°C 0% RH*

A vent strip can be incorporated into the bags to allow CO₂ gases to be vented through the bag. This relies on a positive pressure inside the bag to drive venting.

Convex has studied the breakdown and composting of the compostable Econic[®] bags at a bark composting facility, near Matamata, New Zealand. The first fortnightly inspection discovered bags to have softened with moisture and heat exposure. The study was run for 15 weeks.

* the current average percentage of renewable content in Econic[®] is 60%. The actual % varies depending on the thickness and materials used. Contact Convex to discuss this further. Convex are constantly striving to increase the renewable content by sourcing new raw materials as they become available.



Compostable Coffee Bag Trial Protocol - Daltons

Convex has provided 8 compostable Econic® bags to Daltons to evaluate their composting performance. These bags are suited to the size required for 1kg of coffee beans. The purpose of this study is to evaluate the natural breakdown of Econic® bags in a bark composting windrow.

Protocol.

3 month Composting study at Daltons

8 bags should be filled at Daltons with composting growing media.

These bags should be buried in a windrow and clearly marked for finding later.

Each Bag should be numbers 1 through 8, and should be spaced along the windrow, to allow for easy unearthing later. Every two weeks the windrow should be inspected for signs of the bags degrading, a new bag can be unearthed every two week period as not to disturb other bags. An A4 sample of film should be collected by cutting it from the inspected compostable bag and returned to Convex for Tensile Strength testing (a measure of film embrittlement). The windrow and unearthed bag should be photographed.

At each inspection the temperature of the growing media should be recorded, and the ambient environment temperature. Weather conditions such as sun, rain etc should be recorded.

One traditional non-compostable plastic bag, should also be buried as an experiment 'control' to reference against. This bag should not breakdown.

Planned inspection timeline (Thursdays at 10am).

Week 0 - 4th Feb - Setup trial.

Week 2 - 18th Feb - inspect bag 01, photograph, record mix temp and air temp.

Week 4 - 4th Mar - inspect bag 02, photograph, record mix temp and air temp.

Week 6 - 18th Mar - inspect bag 03, photograph, record mix temp and air temp.

Week 8 - 1st Apr - inspect bag 04, photograph, record mix temp and air temp.

Week 10 - 15th Apr - inspect bag 05, photograph, record mix temp and air temp.

Week 12- 29th Apr - inspect bag 06, photograph, record mix temp and air temp.

Week 14 - 13th May - inspect bag 07, photograph, record mix temp and air temp.



Example Record sheet.

Week 2 - 18th Feb - inspect bag 01, photograph, record mix temp and air temp.

Time: 10.30am Inspected by: Andrew S Air Temp: 22°C

Date: 24-01-2010 Weather: Overcast Windrow Temp: 45°C

Non-Compostable "Control" bag Comments: Tough plastic, very stretchy. Looks like new. No visible signs of degrading or softening. Bag still in one piece.

Compostable "Econic®" bag Comments: Bag 01 inspected today, film starting to soften, becoming fragmented, big pieces of plastic breaking up into smaller pieces when touched. , Plastic feels thick / thin. Plastic feels moist / dry. Plastic colour is becoming lighter/darker/ transparent. Weather is , Sunny/Raining/Windy/Overcast.

Photographs taken of: 1: Windrow before unearthing of bag..... Yes

2: Bag number XXX when unearthedYes

Cut off an A4 sized sample from Bag number XXX, and return to Convex for Tensile Strength Testing. This is a measure of how brittle the film has become as the plastic chains become broken.

Regards

Andrew Sheerin

Convex Plastic



Diary of Composting Study of Coffee Bags.

Week 0 - 4th Feb - Setup Trials., photograph, record mix temp and air temp.

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 28°C

Date: 04-02-2010 Weather: Sunny / Hot Windrow Temp: 55.0°C

Non-Compostable "Control" bag Comments: Daltons Grow bag set as control for experiment.

Compostable "Econic®" bag Comments: 8 silver compostable coffee bags were buried alongside the control "Daltons Grow in" bag. . 4 bags were filled with compost, the remaining 4 were left unfilled.

Moisture content of Windrow = 57.5%. Temperature at depth of 30cm = 52.2°C.



Week 0 - Econic bags being buried.



Week 2 - 18th Feb - inspect bag 01, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 25°C

Date: 18-02-2010 Weather: Sunny / Hot Windrow Temp: 55.0°C East side, 47°C on West

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: The 4 bags filled with compost all showed signs of softening and wrinkling. The 4 unfilled bags also showed the same appearance. Samples felt like 'soggy paper'.

Moisture content of Windrow = 50.9%

One unfilled (no compost inside) Coffee bag was returned to Convex for Elongation testing.

Original films strength = 65.2 MPa, Original elongation = 41 % , = 20.5 mm

At 2 weeks composting strength = 29.3 MPa, Original elongation = 25 % , = 12.5 mm

This equates to a film elongation reduction of 39 %.



Filled bag tore on handling



Week 4 - 4th March - inspect bag 02, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 21°C

Date: 04-03-2010 Weather: Sunny Windrow Temp: 51.0°C (both sides)

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: All the bags filled with compost continued to show signs of softening and wrinkling. Samples felt like 'soggy paper'. The filled bags also showed signs of tearing and rips in multiple directions.

Samples have been retained for elongation and strength reduction testing.

Moisture content of Windrow = 54.6%

One unfilled (no compost inside) Coffee bag was returned to Convex for Elongation testing.

Original films strength = 65.2 MPa, Original elongation = 41 % , = 20.5 mm

At 4 weeks composting strength = 22.0 MPa, Original elongation = 13 % , = 6.5 mm

This equates to a film elongation reduction of 68 %.



Filled bags very brittle to touch



Week 6 - 18th March - inspect bag 03, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 17°C

Date: 18-03-2010 Weather: Overcast / Grey Windrow Temp: 57°C East side, 50°C west side.

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: Upon trying to lift the bags this time. Large sections of each bag were now fracturing into smaller parts, fingers would penetrate through the brittle material. The unfilled bags also showed the same appearance. Samples continue to feel like 'soggy paper'. Samples have been retained for elongation and strength reduction testing.

Moisture content of Windrow = 45.1%

One unfilled (no compost inside) Coffee bag was returned to Convex for Elongation testing.

Original films strength = 65.2 MPa, Original elongation = 41 % , = 20.5 mm

At 6 weeks composting strength = 22.0 MPa, Original elongation = 13 % , = 6.5 mm

This equates to a film elongation reduction of 68 %.



Bags fracturing upon contact



Week 8 - 1st April - inspect bag 04, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 20°C

Date: 01-04-2010 Weather: Overcast / broken cloud Windrow Temp: 58.0°C East side

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: The bags filled with compost showed signs of softening and wrinkling. Upon trying to lift the bags this time fingers would penetrate through the brittle material. Large sections of each bag were now fracturing into smaller parts, . The unfilled bags also showed the same appearance. Samples continue to feel like 'soggy paper'.

Samples have been retained for elongation and strength reduction testing.

Moisture content of Windrow = 48.4%

One unfilled (no compost inside) Coffee bag was returned to Convex for Elongation testing.

Original films strength = 65.2 MPa, Original elongation = 41 % , = 20.5 mm

At 8 weeks composting strength = 9.8 MPa, Original elongation = 20 % , = 10.0 mm

This equates to a film elongation reduction of 51 %.



Bags Fracturing into smaller parts



Week 10 - 15th April - inspect bag 05, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 19°C

Date: 15-04-2010 Weather: Clear / broken cloud Windrow Temp: 42.0°C

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: No unfilled bags were available for testing today. All compost filled bags have fragmented into small brittle pieces. It was estimated that less than 33% of the full bag were left as fragments.

With Autumn starting to set in with lower ambient temperatures, and windrow temperatures were observed ~10°C lower than previous visit. Smaller fragments are now more prevalent.

Moisture content of Windrow = 56.8%

One compost filled Coffee bag was returned to Convex for Elongation testing. It was later determined that this film was too brittle to be tested.



Small fragments prevalent



Week 12 - 29th April - inspect bag 06, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 23°C

Date: 29-04-2010 Weather: Clear / broken cloud Windrow Temp: 42.0°C

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: All compost filled bags have fragmented into small brittle pieces.

When placed in the palm of your hand and rubbed the fragments crumbled into powder.
No samples were returned for tensile and elongation testing as they were too fragile.

Moisture content of Windrow = 46.6%



Remains of 2 compostable bags, as fragments



Week 15 - 21st May - inspect bag 07 & 08, photograph, record mix temp and air temp

Time: 10.00am Inspected by: Andrew S / Geoff B Air Temp: 12°C

Date: 21-05-2010 Weather: Grey / Raining Windrow Temp: 42.0°C

Non-Compostable "Control" bag Comments: Daltons Grow bag showed no sign of deterioration.

Compostable "Econic®" bag Comments: The two remaining bags 07 and 08 were gathered along with the remaining compost and taken back to Convex to be dried and sifted to remove the composted bark material.

Minimal fragments remain, a good indication of the composting environment being rich in micro-organisms, heat, oxygen and moisture.

The composting study was concluded today, as the land area occupying the windrow was needed for other business as well as the composted bark was being put to further use.

Moisture content of Windrow = 58.5%

No samples were returned to Convex for Elongation testing, as the samples were very brittle.



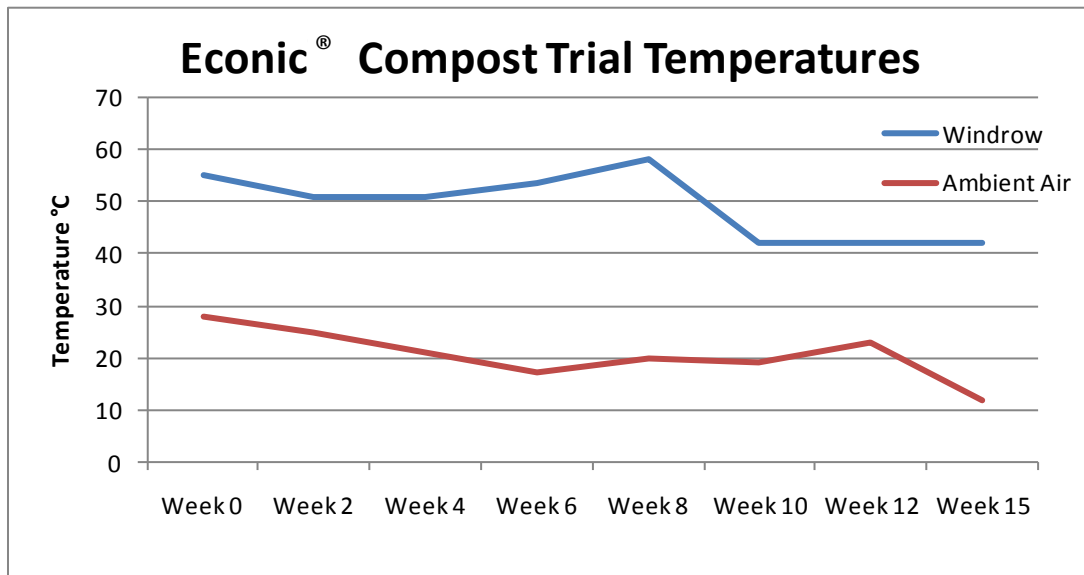
Minimal fragments remain



Results

Temperature Variation

Econic[®] Compost Trial Temperatures			
		Windrow Temperature °C	Ambient Air Temperature °C
4/02/2010	Week 0	55	28
18/02/2010	Week 2	51	25
4/03/2010	Week 4	51	21
18/03/2010	Week 6	54	17
1/04/2010	Week 8	58	20
15/04/2010	Week 10	42	19
29/04/2010	Week 12	42	23
21/05/2010	Week 15	42	12



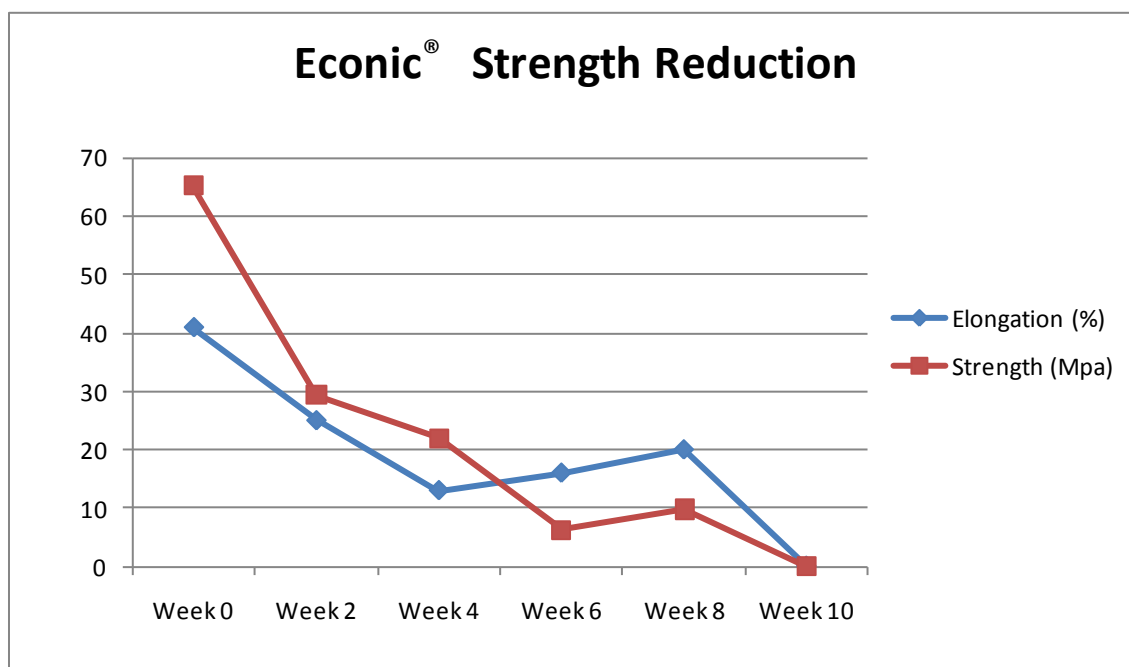
Here are the results measured for the temperature of the windrow using a depth probe, and ambient air using a thermometer.



Film Strength Reduction

Compostable Econic [®] Coffee Bag			
Date		Elongation (%)	Strength (Mpa)
		MD	MD
4/02/2010	Week 0	41	65.2
18/02/2010	Week 2	25	29.3
4/03/2010	Week 4	13	22.0
18/03/2010	Week 6	16	6.2
1/04/2010	Week 8	20	9.8
15/04/2010	Week 10	*	*
29/04/2010	Week 12	*	*

* Samples too small and splitty to test



Tensile testing results of the Econic[®] film over the trial period have shown the film to become more brittle (less elongation) and weaker (lower strength) numbers. This would be consistent with the polymer carbon chains being broken into shorter and shorter chain lengths under the action of moisture, heat and micro-organisms.



Bag Mineralisation

Bag 7 & 8 were returned to Convex for sifting / drying and weighing. The samples were air dried in an oven at 90°C for 2 full days.

The combined bag 7 & 8 start weight was 30.22 g, remaining weight after drying and sifting 15.28 g.

The weight change = 14.94 grams = 49.4% mineralized. 50.6 % remaining by weight

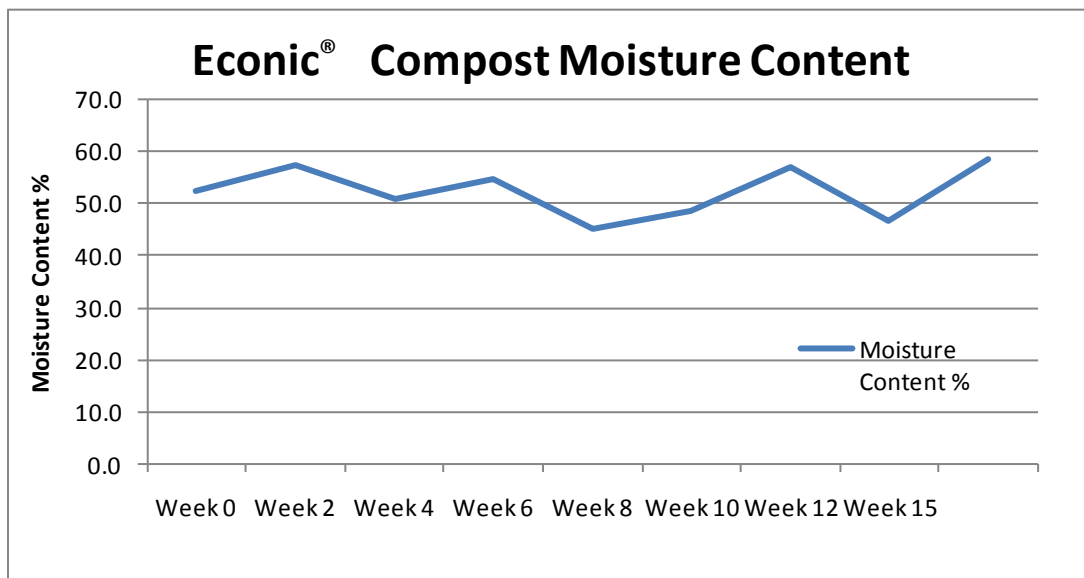
Average percentage mineralised 49.4% within 105 days. Based on this calculation, and extrapolation it would take 212 days for 100% mineralization / composting to occur in this bark composting facility.











Compost Windrow Moisture Content

Econic[®] Compost Moisture Content

		Moisture Content %
4/02/2010	Week 0	57.5
18/02/2010	Week 2	50.9
4/03/2010	Week 4	54.6
18/03/2010	Week 6	45.1
1/04/2010	Week 8	48.4
15/04/2010	Week 10	56.8
29/04/2010	Week 12	46.6
21/05/2010	Week 15	58.5



Visual Photographs of Breakdown

Week 0			Week 2	
Week 4			Week 6	
Week 8			Week 10	
Week 12			Week 15	

Conclusion

Econic® has successfully been monitored to break-down in a bark composting windrow.

On average 49.4% of the remaining two bags have been mineralized by micro-organisms within 105 days.

This would indicate 100% mineralization would take 212 days of windrow composting in bark.

It is important to note that the windrow was turned over each fortnight, so the bags had to be uncovered and then again buried.

Starting on 24th January 2011, an Econic® bag was composted in a food-waste composting bin in Auckland.

This compost included food waste as well as spent coffee grinds.

By the 15th of March the Econic® bag could not be found through turning the compost over. It was concluded that there was sufficient heat, moisture and micro-organism activity to compost the Econic® bag in 50 days.

The temperature of this test was not monitored, but through visual observations was sufficient to ensure compostability.



Discussions

Econic® has successfully broken down in the real world environment of Dalton's bark composting windrow. As the bags have been uncovered each fortnight, is it not known if this has slowed down the natural rate of decomposition should the bags have been left un-handled.

Temperature, Moisture and the presence of micro-organisms all play an important part in the rate of biodegradation. Further studies will need to be entered into to fully understand the reasons for on average 49.4% of the remaining 2 bags having been mineralized by micro-organisms within 105 days.

The base films used in Econic® Compostable Bags have been tested in the laboratory and biodegrade in a composting environment to British Standard for testing EN13432. This test indicates 90% of the product must be mineralised within 180 days. From the field work conducted through Summer/Autumn with varying temperatures the measured breakdown was 49.4%. The EN testing standard is further classified as the controlled aerobic composting test ISO 14855 : 1999. There are differing testing methods for aerobic (with air) and anaerobic (without air) composting.

The Econic® bags were also buried as a whole bag, when in the future the bags may be shredded into smaller parts. Shredded Econic® film with its increased surface area will breakdown more rapidly.



Further Investigations

Shredding of the Econic® bags should be investigated to determine if the biodegradation rate is increased and mineralization is greater than 49.4%. Some samples should also be left buried and not rotated each fortnight to check if non handled bags break down quicker. Smaller plastic pieces with greater area will biodegrade more quickly.

Convex is currently working with a number of Australasian Coffee roasters to confirm the real world composting of Econic® compostable bags.

As temperature, water content, and compost heap contents change this will influence the rate at which Econic® compostable bags will break-down.

This testing so far has all been positive and product decomposing has been observed.

A big thank you to the Geoff, Jason, Graeme, Colin and the Team at Daltons for their time and input into this study.

Andrew Sheerin
Technical Manager
Convex Plastics Ltd

