INFORMACION TECNICA DE D2W - SYMPHONY ENVIRONMENTLA

Para: PROMOCIONES FANTASTICAS SAS
860.451.763

De: Sergio Mejía
Gerente General Latin Pack S.A.
Distribuidor y representante de Symphony Environmental Technologies en Colombia

Asunto: Respuesta Circular con numero de radicado 100002024E4000112 del Ministerio de Ambiente y Desarrollo Sostenible.

Conforme a lo dispuesto en la circular en el número 2 “LAS EXCEPCIONES A LA PROHIBICION, ALTERNATIVAS SOSTENIBLES Y SU DESARROLLO A TRAVES DE LA RESOLUCION 803 DE 2024, PROFERIDA POR EL MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE” cogiéndonos al párrafo “ Uso de materias primas biodegradables y/o Compostables, en los términos que establece el articulo 34 de la ley 2232 de 2022, de manera transitoria la verificación de los requisitos estara en cabeza del ministerio de ambiente”.

Se sugiere el uso de la siguiente información en cumplimiento al Anexo VIII y al Formato de Seguimiento y Control para Autoridades Ambientales.

1. Indicar en la factura de venta al consumidor del producto plástico de un solo usos

- Numero de factura emitida por Latin Pack SAS
- Número del informe técnico Intertek de Biodegradación (anexo)
- Numero del lote de Symphony Environmental

Tabla de Lotes de Julio a Diciembre de 2024

Documento #	Fecha documento	Cantidad	UNIDAD	LOTE	LOTE FACTURACION
FM17328	8 de julio de 2024	500	KGM	D42A005-1	FM17328/MUM/000732B1/2020/D42A005-1
FM17557	18 de julio de 2024	500	KGM	D42A005-1	FM17557/MUM/000732B1/2020/D42A005-1
FM18823	16 de septiembre de 2024	500	KGM	D42A005-1	FM18823/MUM/000732B1/2020/D42A005-1
FM19023	23 de septiembre de 2024	475	KGM	D44A056-1	FM19023/MUM/000732B1/2020/D44A056-1
FM19648	17 de octubre de 2024	24	KGM	D44A056-1	FM19648/MUM/000732B1/2020/D44A056-1
FM19865	25 de octubre de 2024	500	KGM	D44A056-1	FM19865/MUM/000732B1/2020/D44A056-1
FM19866	25 de octubre de 2024	500	KGM	D44A056-1	FM19866/MUM/000732B1/2020/D44A056-1
FM20410	15 de noviembre de 2024	500	KGM	D44A056-1	FM20410/MUM/000732B1/2020/D44A056-1
FM20896	2 de diciembre de 2024	100	KGM	D44A056-1	FM20896/MUM/000732B1/2020/D44A056-1
FM21336	16 de diciembre de 2024	1000	KGM	D47A027-1	FM21336/MUM/000732B1/2020/D47A027-1

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I Estándar Americana ASTM- D6954

Puede acceder a la compra de la norma en la pagina web: D6954 Guía estándar para exponer y probar plásticos que se degradan en el medio ambiente mediante una combinación de oxidación y biodegradación (astm.org)

Guía estándar para exponer y probar plásticos que se degradan en el medio ambiente por una combinación de oxidación y biodegradación

Importancia y uso

5.1 Esta guía es un conjunto secuencial de pruebas y prácticas estándar existentes pero inconexas para la oxidación y biodegradación de plásticos, que permitirá comparar y clasificar la tasa general de degradación ambiental de los plásticos que requieren térmica o fotooxidación para iniciar la degradación. Cada etapa de degradación se evalúa de forma independiente para permitir una evaluación combinada del rendimiento ambiental de un polímero en un entorno de laboratorio controlado. Esto permite una evaluación de laboratorio de su rendimiento de eliminación en el suelo, el compost, los vertederos y el agua, y para su uso en productos agrícolas como la película de mantillo sin detrimento de ese entorno en particular.

NOTA 5: Para determinar las tasas de biodegradación en condiciones de compostaje, se utilizará la Especificación D6400, incluidos los métodos de prueba y las condiciones especificadas.

5.2 No se ha determinado la correlación de los resultados de esta guía con los entornos reales de eliminación (por ejemplo, películas de mantillo agrícola, compostaje o aplicaciones de vertederos) y, como tal, los resultados deben usarse solo con fines comparativos y de clasificación.

5.3 Los resultados de la exposición en el laboratorio no pueden extrapolarse directamente para estimar la tasa absoluta de deterioro por el medio ambiente, ya que el factor de aceleración depende del material y puede ser significativamente diferente para cada material y para diferentes formulaciones del mismo material. Sin embargo, la exposición de un material similar de rendimiento conocido en exteriores, un control, al mismo tiempo que las muestras de ensayo permite comparar la durabilidad en relación con la del testigo en las condiciones de ensayo.

Alcance

1.1 Esta guía proporciona un marco u hoja de ruta para comparar y clasificar las tasas controladas de degradación en laboratorio y el grado de pérdidas de propiedades físicas de los polímeros por procesos térmicos y de fotooxidación, así como la biodegradación y los impactos ecológicos en aplicaciones definidas y entornos de eliminación después de la degradación. Los entornos de eliminación van desde la exposición en el suelo, los
vertederos y el compost, en los que puede producirse la oxidación térmica, hasta la cobertura del suelo y el uso agrícola, en los que también puede producirse la fotooxidación.

1.2 En esta guía, las normas establecidas de ASTM International se utilizan en tres niveles para acelerar y medir la pérdida de propiedades y peso molecular por procesos

térmicos y de fotooxidación y otros procesos abióticos (Nivel 1), medir la biodegradación (Nivel 2) y evaluar el impacto ecológico de los productos de estos procesos (Nivel 3).

1.3 Las condiciones de nivel 1 seleccionadas para la oxidación térmica y la fotooxidación aceleran la degradación que es probable que se produzca en el entorno de aplicación y eliminación elegido. Las condiciones deben incluir un rango de humedad o concentraciones de agua basadas en el entorno de aplicación y eliminación en mente. La tasa de degradación medida a temperaturas de oxidación típicas es necesaria para comparar y clasificar los polímeros que se evalúan en la aplicación elegida para alcanzar un peso molecular que constituya un residuo biodegradable demostrable (utilizando pruebas de biómetro de ASTM International para CO2 evolución adecuada al entorno elegido). A modo de ejemplo, los datos de oxidación acelerada deben obtenerse en rangos de temperatura y humedad típicos en el entorno de aplicación y eliminación elegido, por ejemplo, en suelos (20 a 30 °C), vertederos (20 a 35 °C) e instalaciones de compostaje (30 a 65 °C). Para aplicaciones en suelos, se deben considerar las temperaturas locales y los rangos de humedad, ya que varían ampliamente con la geografía. Al menos una temperatura debe estar razonablemente cerca de la temperatura de uso final o de eliminación, pero bajo ninguna circunstancia debe estar a más de 20 °C de distancia de la temperatura eliminada. También debe establecerse que el polímero no sufre un cambio de fase, como la temperatura de transición vítrea (Tg) dentro del rango de temperatura de prueba.

1.4 A continuación, los residuos resultantes de las oxidaciones se exponen a entornos apropiados de eliminación o uso en métodos de ensayo biométricos normalizados para medir la velocidad y el grado de biodegradación (nivel 2).

1.5 Los datos generados en el marco de la evaluación del Nivel 1 y el tiempo determinado para la biodegradación en el entorno elegido (Nivel 2) permiten clasificar en relación con otros polímeros evaluados en condiciones ambientales similares con esta guía. El grado y el tiempo de biodegradación deben ser consistentes con los métodos de ASTM International, y se debe demostrar que cualquier residuo de la etapa intermedia de oxidación y de biodegradación es ambientalmente benigno y no persistente (Nivel 3).

NOTA 1: El uso previsto de esta guía es para la comparación y clasificación de datos para ayudar en el diseño y desarrollo y la reducción de los impactos ambientales de polímeros que no requieren más de 24 meses para oxidarse y biodegradarse en las opciones de uso y eliminación previstas y no crear residuos nocivos o persistentes en las condiciones de eliminación apropiadas (por ejemplo, dos temporadas de condiciones de cultivo en el suelo).

1.6 Se advierte que los resultados de cualquier exposición de laboratorio en esta guía no se pueden extrapolar directamente a los entornos reales de eliminación; En última instancia, se requiere la confirmación de la exposición al mundo real, como ocurre con todas las normas de ASTM International.

1.7 Los valores indicados en unidades SI deben considerarse estándar.

NOTA 2: No existe ninguna norma ISO que sea equivalente a esta guía de normas.

1.8 Esta norma no pretende abordar todos los problemas de seguridad, si los hubiera, asociados con su uso. Es responsabilidad del usuario de esta norma establecer

prácticas apropiadas de seguridad, salud y medio ambiente y determinar la aplicabilidad de las limitaciones reglamentarias antes de su uso.
1.9 Esta norma internacional se elaboró de conformidad con los principios de normalización internacionalmente reconocidos establecidos en la Decisión sobre los principios para la elaboración de normas, guías y recomendaciones internacionales emitida por el Comité de Obstáculos Técnicos al Comercio (OTC) de la Organización Mundial del Comercio.

II. Certificación Astm-D6954 Intertek

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Report No: MUM/000732B1/2020
Sample No.: 12097077

FINAL REPORT

SYMPHONY ENVIRONMENTAL LTD

Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation ASTM –D6954

ENVIRONMENTAL DIVISION LABORATORY, MUMBAI

INTERTEK INDIA PRIVATE LIMITED

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Report No: MUM/000732B1/2020
Sample No.: 12097077

Client: SYMPHONY ENVIRONMENTAL LTD

Sample registration date: 04/03/2020

Analysis completed on: 02/12/2021

Name of product: Borealis RB707CF PP with 1% D2W 93208

Quantity received and packing: - 1 roll

Sample details: Borealis RB707CF PP with 1% D2W 93208

Test Required: ASTM –D6954 - Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation

Sampling done by: Sample not drawn by Intertek

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Test Method:

ASTM D6954 standards are used in three tiers for accelerating and measuring the loss in properties and molecular weight by thermal and photo oxidation processes and other abiotic processes (Tier 1), measuring biodegradation (Tier 2), and assessing ecological impact of the products from these processes (Tier 3). **(Figure 1)**

Description of three Tiers:

1) **Abiotic Degradation (Tier 1):** Using either accelerated or real time conditions, samples are subjected to a combination of oxygen, heat and/or light to reduce the molecular weight and/ or mechanical properties. Tier 1 measures the rate and extent of molecular weight loss resulting from oxidation that is indicative of losses in physical properties from oxidation. ASTM D 5208 covers the specific procedures applicable for fluorescent Ultraviolet (UV) exposure of photodegradable plastics

2) **Biotic Degradation (Tier 2):** The residues from Tier 1 are retrieved from biodegradation testing using the environment in which the material is intended to end up after disposal (compost, soil, water, and landfill). In most cases, the amount and rate of CO_2 production (aerobic degradation). In Tier 2, after the test samples are exposed to the abiotic degradation process described in Tier 1, the entire test material is subjected to biodegradation tests as per ASTM D5988. The time profile of carbon dioxide evolution is recorded and the time to reach the appropriate thresholds are noted.

3) **Eco- toxicity (Tier 3):** By using of different species of plant, the effect of the residues from Tier 2 on the growth and survival can be determined. Tier 3 involves considerations of the ecological impacts in the final disposal medium such as soil, as in all biodegradation testing methods, which is basically a comparison of the test medium before and following oxidation and biodegradation.

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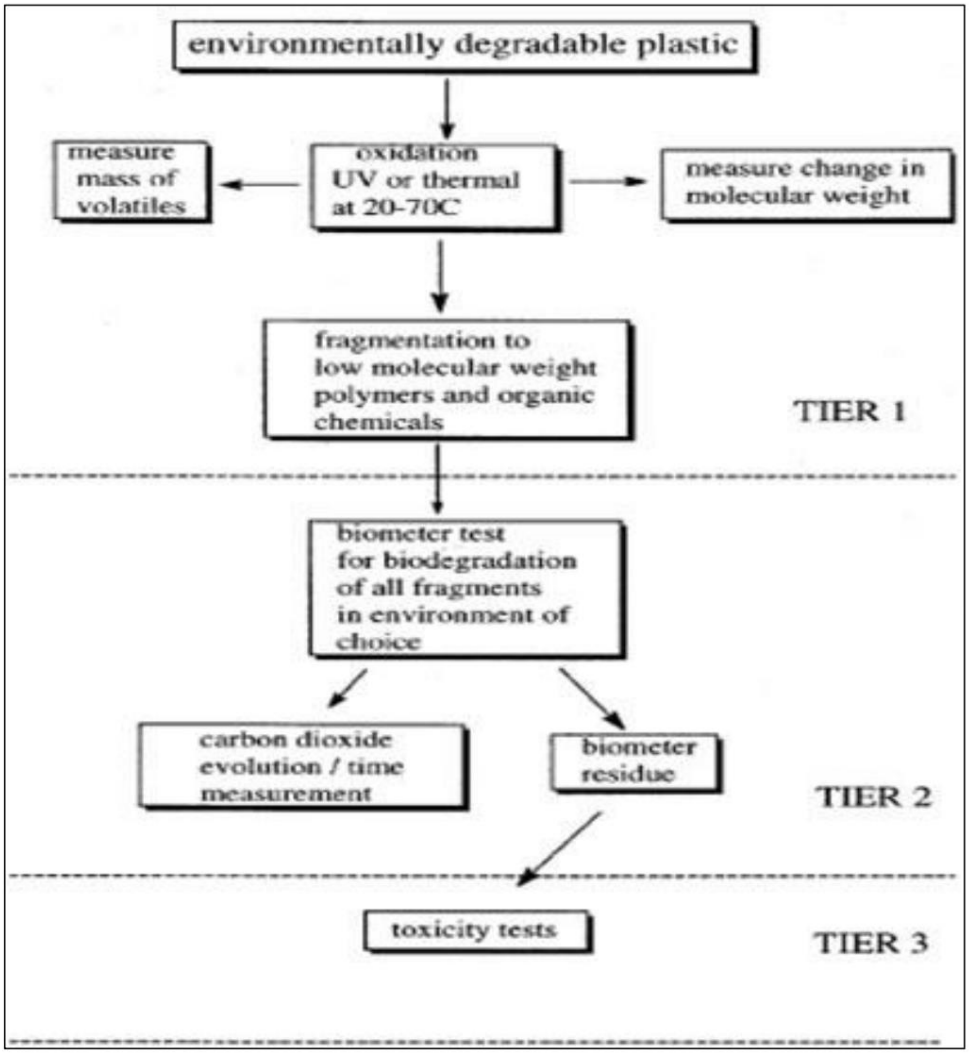

Figure 1: Protocol for analyzing Plastics that degrade in the Environment by a Combination of oxidation and Biodegradation- ASTM D6954

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SAMPLE DESCRIPTION:

One sample were submitted by SYMPHONY ENVIRONMENTAL LTD
1. PP Borealis RB707CF – Laboratory reference No. 12097077

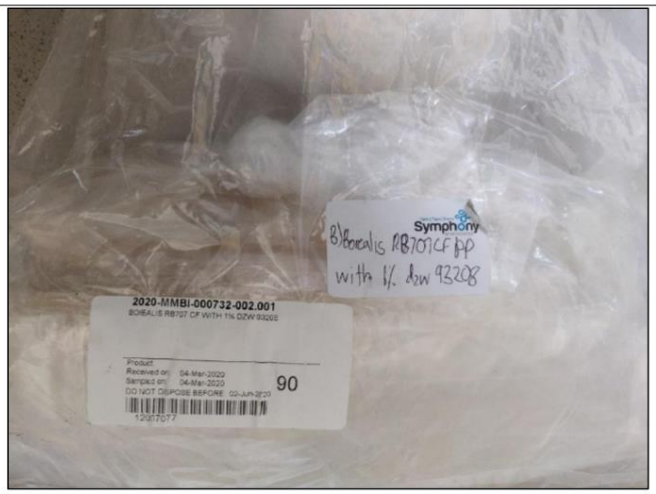

Figure 2: Test Sample

Abiotic Degradation (Tier 1) Methodology:

As mentioned in ASTM D5208, Cycle C - continuous UV with uninsulated black panel temperature controlled at 50°C is used for the study. Use Cycle C for materials that will be used for toxicity testing after exposure. This is essential because cycles that use condensation can wash away by-products of photochemical degradation. For thin films, the exposure period would be the time required for the film to reach 5 % or less elongation to break (Practice D3826) and the fragmented film to reach a recorded average weight-average molecular weight (MW) of 5000 or less.

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A sample from Tier 1 residue is dissolved in an appropriate nonreactive solvent and the gel phase, if any, separated by filtration, the gel dried, and the amount of gel reported as weight fraction of total sample. This is regarded as non-degradable fraction of polymer. For measuring the extent of disintegration/fragmentation, a sieve test is performed. For products consisting of a single polymer (homopolymers or random copolymers), 60 % of the organic carbon must be converted to carbon dioxide before ending the test, and the gel content generated in Tier 1 must be no higher than 10 %. For products consisting of more than one polymer (block copolymers, segmented copolymers, blends, or addition of low molecular weight additives), 90 % of the organic carbon must be converted to carbon dioxide, before ending the test.

In Tier 1, the loss in weight of the sample is measured. The molecular weight and/or tensile elongation of the samples before and after the exposure are determined and recorded, along with % gel. This practice is intended to induce property changes associated with conditions that might be experienced when the material is discarded as litter, including the effects of sunlight, moisture, and heat.

For thin films, the pass Tier 1 requires reaching 5 % or less elongation to break and the fragmented film to reach a recorded average weight-average molecular weight (MW) of 5000 or less.

RESULTS:

The PP Borealis RB707CF become brittle after exposure for 1500 hrs. The percent elongation decreased which can also be correlated to the FTIR graphs as shown in Graph 3 & Graph 4. This may occur due to chemical changes such as trapped free radical or charge species within the polymer structures.

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FIGURE 3: Sample AFTER 1500 HRS

FTIR Spectra:

FTIR spectra of PP Borealis RB707CF shown in **Graph 1 to Graph 4** shows the IR bands characteristics - the stretching vibration of Carbon-Hydrogen (CH) group of the main chain at 2800–3000 cm−1, the wagging and rocking vibration of methylene (CH_2) at 1440–1490 cm−1, bending of CH at 1367-1363 cm−1, the S ring stretching at 1325 cm−1, CH_2 rocking vibrations at C_6 at 1313 – 1300 cm−1, C_C, C-OH,C-H ring side 990 – 950 cm−1, COC, CCO and CCH deformation with stretching at 895 - 850 cm−1 group at vibrations 700–750 cm−1, respectively.

Degradation of polymers is mainly due to photooxidation and thermo oxidation causing the chain scission and cross-linking of polymer backbone, the formation of carbonyls (C=O) and vinyl (CH2=CH) groups, and, finally, changes in the conformation and crystallinity of the polymer.
Different peak in the spectra indicates the presence of different chromophoric groups such as carbon-carbon double bonds (C=C) and carbonyl groups (C=O), which are capable of absorbing UV energy. **Graphs 2 and Graphs 3** shows the Infrared spectra of Irradiated film.

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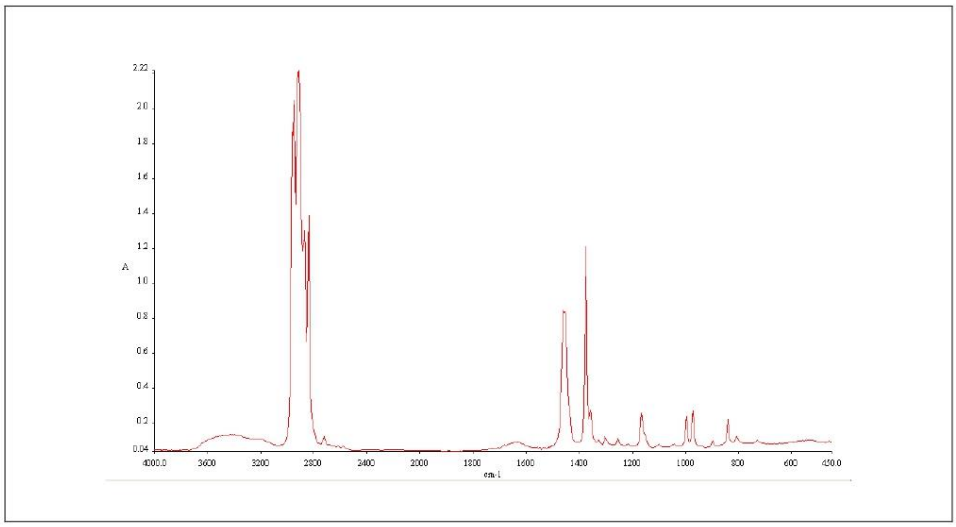
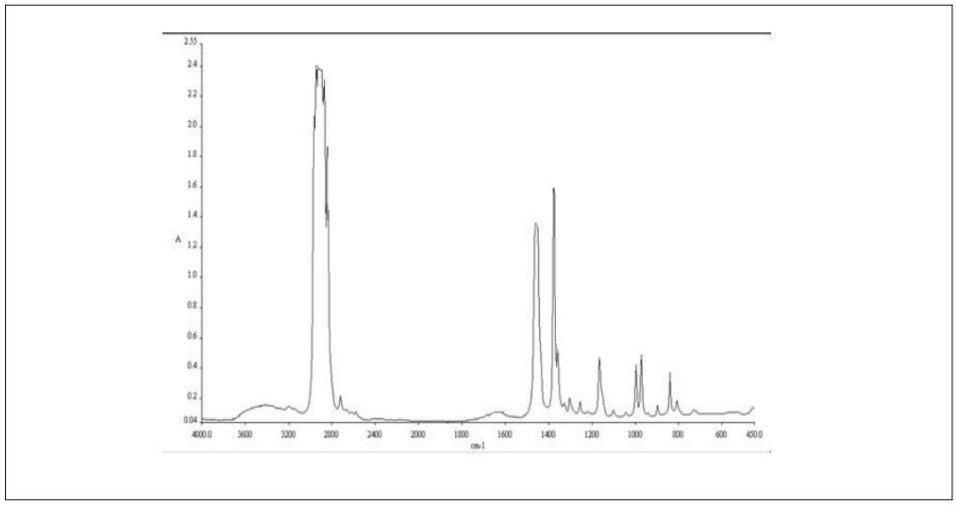


Graph 1: FTIR Spectra of initial unexposed PP Borealis RB707CF (12097077)



Graph 2: FTIR Spectra of irradiated PP Borealis RB707CF sample (12097077) for 1000 hrs

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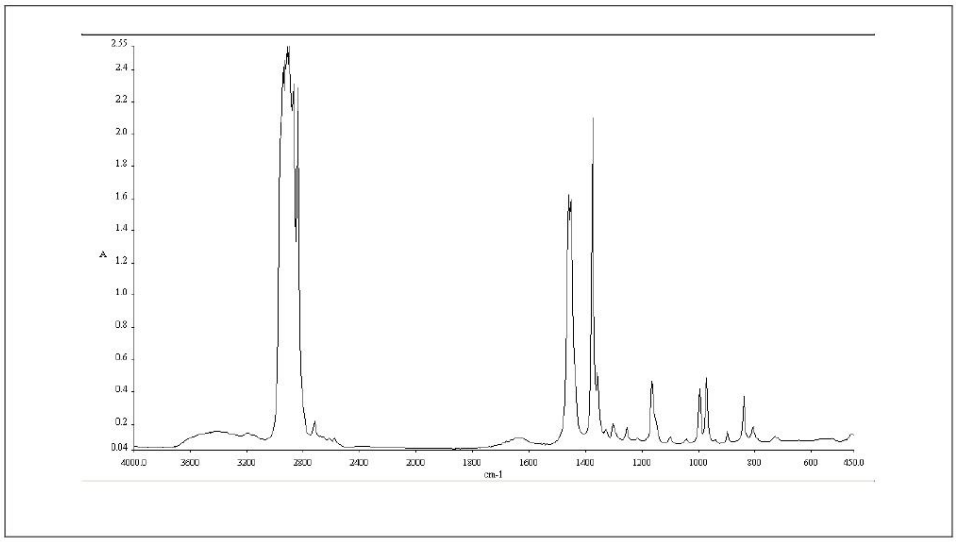
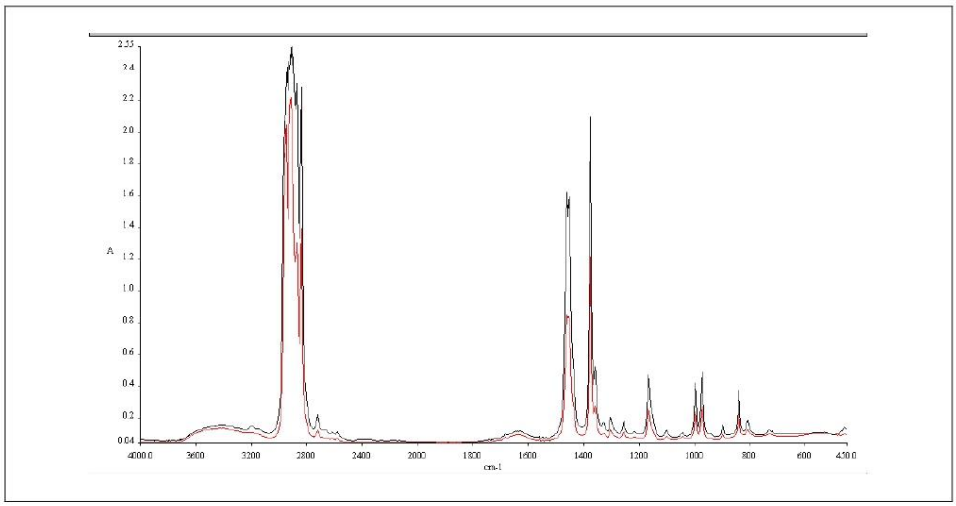


Graph 3: FTIR Spectra of irradiated PP Borealis RB707CF sample (12097077) for 1500 hrs



Graph 4: FTIR Spectra of unexposed and exposed PP Borealis RB707CF sample after 1500 hrs (12097077)

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Sample No.: 12097077

Molecular Weight Determination of Aged and Unaged Polyethylene Films Using High Temperature Gel Permeation Chromatography.

The aged and unaged samples were sent to Intertek Wilton by Symphony Environmental Ltd for Molecular weight analysis. The average molecular weight of unexposed sample was 3,60,667 g/mol while after 1500 hrs. of UV ageing 98 % reduction in molecular weight i.e. 6900 g/mol was observed in reports IWTN/W000012110BRL001.

Table 1: Molecular Weight Determination of Aged and Unaged Borealis RB707CF PP with 1% D2W 93208 sample (12097077)

Sample Description	Exposure Time (Hours)	Mw ($\bar{x}$) (g/mol)	Reduction (%)
Borealis RB707CF PP with 1% D2W 93208 Unaged	0	3,60,667	98%
Borealis RB707CF PP with 1% D2W 93208 Aged	1500	6900	

Thermal aging was performed as per ASTM 5510 420 hours (2.5 weeks) at 70°C. The aged and unaged samples were sent to Intertek Wilton by Symphony Environmental Ltd for Molecular weight analysis. The average molecular weight of unexposed sample was 3,60,667 g/mol while after 1500 hrs. of UV ageing 99 % reduction in molecular weight i.e. 2100 g/mol was observed in reports IWTN/W000012787ARL001.

Table 2: Molecular Weight Determination of Aged and Unaged Borealis RB707CF PP with 1% D2W 93208 sample (12097077) as per ASTM 5510 for 420 hrs.

Sample Description	Exposure Time (Hours)	Mw ($\bar{x}$) (g/mol)	Reduction (%)
Borealis RB707CF PP with 1% D2W 93208 Unaged	0	3,60,667	99%
Borealis RB707CF PP with 1% D2W 93208 Aged	420	2100	

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Measuring the extent of disintegration/fragmentation by studying the physical properties:

The extent of disintegration was studied using Tinius olsen H10KS with 500 N Load cell for Tensile strength & Percent elongation test. Sample was subjected for Tensile strength & Percent elongation test after every exposure.

Table 3: Different physical properties of Borealis RB707CF PP with 1% D2W 93208 sample (12097077) at different duration of UV exposure

Duration / Sample	'0' Hrs.	'1000' Hrs.	'1500' Hrs.
Percent elongation (%)	104.3	42.1	3.3
Tensile strength (N)	20.1	9.7	4.6

The % elongation Biodegradable of **Borealis RB707CF PP with 1% D2W 93208 sample** was found to be less than 5% at 1500 hrs. The sample was broken into small pieces.

Measuring the Gel content:

Gel content of the of Borealis RB707CF PP with 1% D2W 93208 sample from Tier 1 were used to study the percentage of gel formation due to oxidative degradation of polymers. After 1500 hrs. The sample showed 2.2% gel formation.

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Measuring the extent of disintegration/fragmentation by conducting sieve test:

A **Borealis RB707CF PP with 1% D2W 93208 sample** after 1500 hrs exposure was used to perform Sieve test. 50 gms sample was passed through 2 mm sieve. The retained was used to calculate the degree of disintegration.

$$\% \text{ retained} = \frac{\text{Weight of sample in the sieve}}{\text{Total weight of sample}} \times 100$$

% passing = 100 % retained

The degree of disintegration is equal to the % of sample passed through the sieve. The degree of disintegration of **Borealis RB707CF PP with 1% D2W 93208 sample** using 2mm sieve was found to be 4.2%.

Elemental Analysis

The aged samples were sent to Intertek Wilton by Symphony Environmental Ltd for restricted element analysis. The restricted Element content in mg kg-1 or ppm is mentioned below as reported in IWTN/W000012110ARL001 and 0-016807-0-BLG-001-00.

Table 4: Restricted Element Content (mg kg-1 or ppm) of Borealis RB707CF PP with 1% D2W 93208 sample (12097077)

Restricted Element Content (mg kg^{-1} or ppm)											
Cd	**Pb**	**Hg**	**Cr**	**Mo**	**Se**	**As**	**Co**	**Zn**	**Cu**	**Ni**	**F**
0.5	***50***	***0.5***	***50***	***1***	***0.75***	***5***	***-***	***150***	***50***	***25***	***100***
<0.1	<0.2	<0.2	0.69	<0.1	<0.4	<0.2	0.64	2.59	<0.2	0.20	0.2

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BIOTIC DEGRADATION (TIER 2) METHODOLOGY

It followed Standard D6400-12 specified for labelling plastics designed to be aerobically composted in municipal or industrial facilities, where thermophilic conditions are achieved.
It has three basic provisions that govern how a product must perform in a simulated compost environment:

1. **Disintegration during composting:** The product must physically disintegrate to the extent that it cannot be "readily distinguishable" from the finished compost product.

2. **Biodegradation:** The product must actually biodegrade (be consumed by microorganisms) at a rate comparable to known compostable materials.

3. **No impact on plant growth:** Finally, the product cannot have adverse impacts on the ability of the compost to support plant growth. Additionally, the material should not introduce unacceptable levels of regulated metals or hazardous substances into the environment, upon sample decomposition.

Principle of Biodegradation:

Biodegradability of the entire fragmented product from Tier 1 under lab- scale conditions is done using Test methods ASTM D5338-15. This method determines the degree and rate of aerobic biodegradation of plastic materials on exposure to a controlled composting environment under laboratory conditions, at thermophilic temperatures. The samples were exposed to an inoculum that is derived from compost from municipal solid waste. The aerobic composting takes place in an environment where temperature, aeration and humidity are closely monitored and controlled. The percentage of biodegradability is obtained by determining the percentage of carbon in the test sample that is converted into CO2 during the duration of the test.

Apparatus Setup:

A series of 09 composting vessels of 5 liter volume (1 blank i.e. compost, 1 positive i.e. cellulose mixed with compost, and 1 test plastic sample mixed with compost, all in 3 replicates). The entire composting

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vessel were kept in Incubator capable of maintaining the temperature of composting vessels at 58± 2° C (Figure 3). Pressurized air system that provides CO_2 free, H_2O saturated air to each of the composting vessels at accurate aeration rate. CO_2 evolved will be absorbed by 0.024 N $Ba(OH)_2$ and the amount of CO_2 will be determined by titrating with 0.05 N HCl.

Result:

After 180 days of incubation under dry (58 °C ± 2 °C), aerobic controlled compositing conditions using test method ASTM D 5338-15, the reference (Positive control), **PP Borealis RB707CF** sample were gradually biodegraded. The reference sample was degraded more than 100 % after 180 days while the **PP Borealis RB707CF** sample showed 95.05 % after 180 days.

Table 5: Percentage Biodegradation of Positive control and Test samples

Day	% Biodegradation	
	Positive Control	Test samples
0	0.00	0.00
3	6.78	1.74
6	12.85	2.68
9	18.92	3.32
12	31.05	5.21
15	42.83	8.05
20	50.68	11.37
25	59.24	14.84
30	63.53	21.16
35	68.88	24.47
40	69.59	25.74
45	75.31	28.89
50	78.87	31.89
55	82.09	33.95
60	82.80	35.21
66	83.13	37.58
72	83.66	40.97
80	84.91	45.47
85	85.27	49.10
90	86.34	53.21

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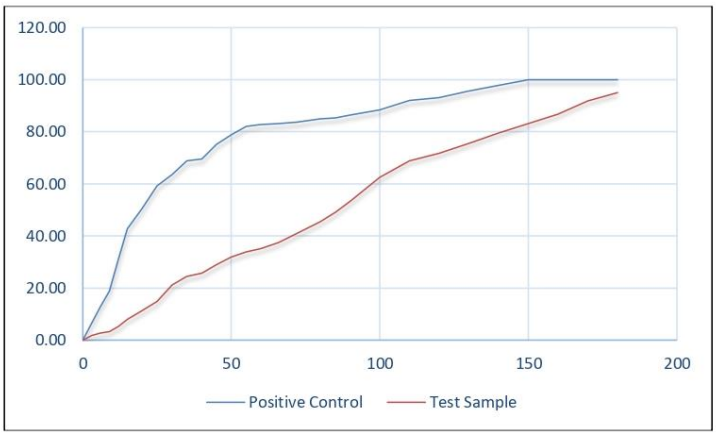
100	88.48	62.52
110	92.05	68.84
120	93.12	71.84
130	95.62	75.63
140	97.76	79.57
150	100.00	83.21
160	-	86.84
170	-	91.89
180	-	95.05



Graph 5: Percentage biodegradation of Test sample under aerobic composting

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Eco- toxicity (Tier 3):

Tier 3 is a Phytotoxicity test by OECD 208 test method which involves the assessment of the seedling Emergence and seedling Growth of higher plants following the exposure to the test substance in the soil and OECD 207 which involves earth worm toxicity test. It is used to confirm that biodegraded and composted materials do not introduce toxic components into the compost.

Principle of OECD 208:

Seeds of *Brassica Juncea* and *Triticum aestivum* are placed in contact with soil treated with the test substance and evaluated for effects following 14 to 21 days after 50% emergence of the seedlings in the control group. Endpoints measured are visual assessment of seedling emergence, biomass (fresh or dry shoot weight, or shoot height) and visual detrimental effects (chlorosis, mortality, plant development abnormalities, etc.). Measurements are made at least weekly or more often when recording the emergence of the seeds and compared to those of untreated control plants.

In order for the test to be considered valid, the following performance criteria must be met in the controls:

- the seedling emergence should be at least 80% for crop and 65 % for non-crop species;
- the mean control seedling growth does not exhibit visible phytotoxic effects (e.g. chlorosis, necrosis, wilting, leaf and stem deformation);
- the mean control survival is at least 90% for the duration of the study;
- for any species, all organisms in a test must be from the same source;
- all test chambers or rooms used for a particular species should be identical and should have same conditions and contain same amount of soil matrix, support media, or substrate from the same source.

Principle of OECD 207:

Similarly, Eisenia foetida species of earthworm are used for earthworm toxicity testing. The artificial soil test involves keeping earthworms in samples of a precisely defined artificial soil to which a range

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of concentrations of the test substance has been applied. Mortality is assessed 7 and 14 days after application. Control are used to assure that effects observed are associated with or attributed only to the test substance exposure. The earthworm is brought from Vermicomposting beds.

The mortality in the controls should not exceed 10 per cent at the end of either test.

Results:

Metal analysis of compost of test **PP Borealis RB707CF** was done to check the toxic levels after biodegradation (Table 3). Seeds grown in compost prepared from samples showed more than 90% germination rate as compared to control. Root and shoot length of plant was similar or slightly more than controls (Table 4). There was no visual injury found in the roots and shoot of the plant due to the test substance.
After 7 days and 14 days, 100% earthworm survival was observed in both 50% and 25% concentration of compost (Figure 7).

Table 6: Metal analysis of residue collected after biodegradation

PARAMETERS	UNIT	PP Borealis RB707CF
pH	-	7.72
Mg	PPM	5033
Ca	PPM	10710
P	PPM	1802
Mn	PPM	710.10
Cu	PPM	55.13
Zn	PPM	166.80
Ni	PPM	27.47
Cd	PPM	<0.10

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Pb	PPM	25.79
Hg	PPM	<0.10
Se	PPM	<0.10
As	PPM	<0.10

As per the Environmental Protection Agency (EPA) the metal concentrations in the sample are well within the prescribed limit

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Table 7: Germination Rate and Biomass of *Brassica Juncea* and *Triticum aestivum* seeds after 21 days.

	Plant species	Dose	Germination Rate (%)	Shoot Length (cm)	Root Length (cm)
Control	*Brassica juncea*	25%	99	10	8
		50%	98	10	8
	Triticum aestivum	25%	98	20	14
		50%	98	18	16

	Plant species	Dose	Germination Rate (%)	Shoot Length (cm)	Root Length (cm)
PP Borealis RB707CF	*Brassica juncea*	25%	98	12	10
		50%	97	10	8
	Triticum aestivum	25%	97	16	14
		50%	97	14	12

The above study was conducted at 25˚C ± 4 ˚C temperature, 65% ± 10% humidity with 16 hours of light. The above results showed that the **PP Borealis RB707CF** showed no effect on the plant growth and showed no visible damage to the plants.

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Control 25%	**Control 50%**
	
Test 25%	**Test 50%**

Figure 4: Effect of compost PP Borealis RB707CF sample on Triticum *aestivum* growth

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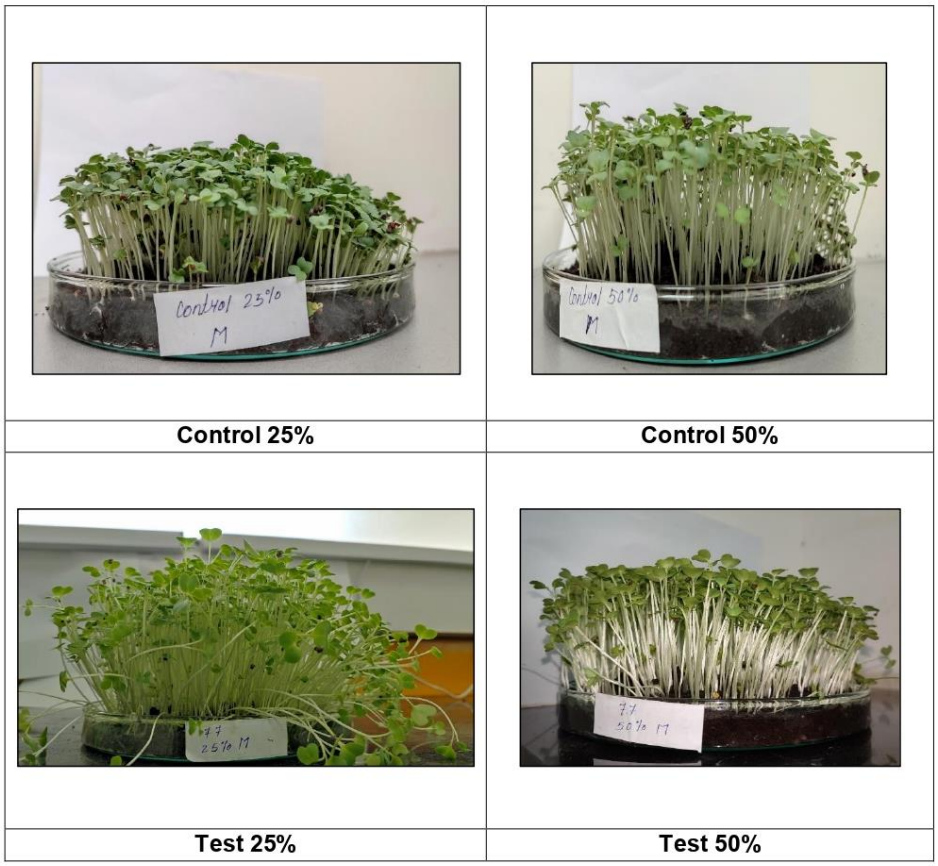

Figure 5: Effect of compost PP Borealis RB707CF sample on *Brassica Juncea* growth

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Earthworm Toxicity

The earthworm toxicity study was conducted as below-
Artificial soil was prepared using 10% sphagnum peat, 20% kaolin clay and 70% industrial sand with final pH 6.32, moisture content 37.8%. the study was conducted at 20˚C± 2 ˚C in continuous light with light intensity approximately 580Lux

Average weight of 10 earthworms before and after study.

Initial

Particulars	25%	50 %	25%	50%
Control (g)	0.3215	0.3151	0.3363	0.3287
PP Borealis RB707CF Sample(g)	0.3632	0.3785	0.3655	0.3278

Final

Particulars	25%	50 %	25%	50%
Control (g)	0.3366	0.3325	0.3652	0.3455
PP Borealis RB707CF Sample(g)	0.3899	0.3941	0.3885	0.3652

The mortality rate was found to be 0%. The average weight of earthworms in increased as compared to contr

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Figure 6: Earthworm before exposing it to the compost containing plastic residues

Figure 7: Earthworm After exposing it to the compost containing plastic residues

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CONCLUSION:

SYMPHONY ENVIRONMENTAL LTD PP Borealis RB707CF passed the Tier 1 in accordance to the conditions set forth in ASTM D6954. The residue from tier 1 was subjected to tier 2 for Biodegradability study. The PP Borealis RB707CF passed the Tier 2 in accordance to the conditions set forth in ASTM D5338. The PP Borealis RB707CF did not show effect on the seedling emergence, seedling growth and passed the earthworm toxicity.

---------- **End of Report** ----------

Authorized Signatory

Dhanashree Bhelose
Business Development Manager

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has met the requirements of AC89, *IAS Accreditation Criteria for Testing Laboratories*, and has demonstrated compliance with ISO/IEC Standard 17025:2017, *General requirements for the competence of testing and calibration laboratories*. This organization is accredited to provide the services specified in the scope of accreditation.

Effective Date December 25, 2023

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Alejandro Giraldo
Director Ejecutivo