RecyClass

RECYCLABILITY EVALUATION PROTOCOL

FOR PP FILMS

STANDARD LABORATORY PRACTICE

VERSION 4.0

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RecyClass

CONTENT

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GLOSSARY

A.0	100 % control film flakes
A.25	Blend 75/25 control/innovation flakes
A.50	Blend 50/50 control/innovation flakes
A.100	Blend 100 % innovation film flakes
ASTM	American Society for Testing and Materials
B.0	Film made of 50 % of virgin pellets and 50 % of B.0 pellets
B.25	Film made of 50 % of virgin pellets and 50 % of B.25 pellets
B.50	Film made of 50 % of virgin pellets and 50 % of B.50 pellets
B.100	Film made of 50 % of virgin pellets and 50 % of B.100 pellets
Control Sample	Plain PP film (or PP resin that has already been thermally processed once) used as benchmark
EN	European Standard
Innovation Sample	Film containing the innovative technology
ISO	International Organization for Standardization
MFI	Melt Flow Index
PE	Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
TC	Technical Committee
TGA	Thermogravimetric Analysis
Virgin Material	PP resin that will for the first time be converted to a plastic product (no thermal pre-treatment)
wt%	Weight Percentage

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DISCLAIMER

"RecyClass is an initiative working on enhancing and evaluating the recyclability of plastic packaging through a technical perspective. The Recyclability Evaluation Protocols will promote recyclability by encouraging industry to test new plastic technologies, materials or product before market launch and giving advice and recommendations to the companies.

The Recyclability Evaluation Protocols are available to download on the RecyClass website. Companies providing plastic packaging concepts are encouraged to use them to self-assess the impact of their solutions on recyclability and highlight potential issues. **However, compliance with a Recyclability Evaluation Protocol is not a replacement for an official assessment and may not be used as a marketing tool.** The RecyClass Steering Board, following the recommendations of the Technical Committees, is the decision-maker regarding the compatibility of the innovation with recycling according to the results of the evaluation, granting a Recyclability Approval Letter to the Applicant.

All tests must follow the Evaluation Protocols recommended by the RecyClass Technical Committees and must be conducted by an independent laboratory recognised by RecyClass which has no legal affiliation to the applicant.

More information is reported in the RecyClass Internal Procedures available on the *RecyClass website.*

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1. INTRODUCTION AND PURPOSE OF THE PROTOCOL

The "RecyClass[1] Recyclability Evaluation Protocol for PP Films" referred to in this document as "The Protocol" describes the methodology that must be followed by the applicant at a laboratory scale in order to determine if a plastic packaging innovation is compatible with the post-consumer PP film recycling stream. The Protocol targets companies responsible for introducing a packaging product onto the market. The applicant shall proceed with the Protocol as established in the Assessment Process for Applicants of Recyclability Evaluation in the RecyClass Internal Procedures[2] and "RecyClass Recyclability Approval Quality Management & Procedures document[3].

The Protocol analyses whether an innovation will undergo the necessary pre-treatment, extrusion and conversion steps described in this methodology at a laboratory scale without negatively impacting the recycling process. It aims to prove the recyclability[4] of plastics packaging while encouraging innovation in the PP film market. The overall goal is to maintain the protection of packaged goods and their marketing display functions without obstructing the proper functioning of the PP film recycling process.

This document provides guidance on the testing methodology that shall be followed, including benchmark recommendations to guide the interpretation of the results.

PP film terminology, as it is used in this document, is defined as a flexible plastic whose form changes depending on whether it is filled with a substance or not. It has a thickness of up to 250 µm and at least 90 % of its weight is plastic, with up to 10 % of closely bonded or impregnated material. Printing, coatings, or plastic fillers can classify as closely bonded or impregnated materials. It includes blown, cast and biaxially oriented PP films.

Please note that all units in this protocol are expressed following the International System of Units[5], from the Bureau International des Poids et Mesures.

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1 RecyClass assesses the recyclability of a plastic package providing a ranking from A to F. RecyClass also provides specific indications and recommendations on how to improve packaging design to fit current recycling technologies. More information at https://recyclass.eu/

[2] *RecyClass Internal Procedures*

[3] *RecyClass Recyclability Approval Quality Management & Procedures*

4 Recyclability definition according to PRE & APR: Plastics must meet four conditions for a product to be considered recyclable: 1. The product must be made with a plastic that is collected for recycling, has market value and/or is supported by a legislatively mandated program. 2. The product must be sorted and aggregated into defined streams for recycling processes. 3. The product can be processed and reclaimed/recycled with commercial recycling processes. 4. The recycled plastic becomes a raw material that is used in the production of new products.

[5] SI Brochure - BIPM

2. SCOPE OF THE PROTOCOL

The scope of the Protocol covers any innovation introduced to the existing packaging solutions for PP films. Prior to initiating the evaluation, the applicant shall review the Design for Recycling Guidelines for clear PP films or coloured PP films[1] in order to confirm that the PP innovation film is compatible with these requirements.

The following packaging solutions and/or innovations are covered by the scope of this Protocol:

1. Non-PP layers and coatings, including PE, nylon, EVOH, and others not specified.
2. Rigid PP and non-PP attachments to the PP film tested packaging.
3. Mineral fillers and other additives that alter the density of PP film.
4. Paper and filmic labels
5. Inks and pigments, including direct, reverse, laminated, and other printing technologies.
6. Compatibilizers and other additives otherwise not specified.
7. Adhesives in laminated mono-PP-structures

Following the RecyClass Recyclability Methodology[2], packaging containing aluminium, metal, degradable plastics, black carbon surface, as well as PVC and PVDC and PET layers are considered as disqualifying criteria for PP films recyclability. Consequently, packaging containing any of these features does not fall under the scope of this Protocol.

3. DISCLAIMER

A PP film recycling process is not yet established. The Protocol aims to represent as accurately as possible how the PP recycling process should work at an industrial scale to allow PP films to get recycled in high quality products. RecyClass Technical Committee reserves the right for further testing, if necessary, to issue a final opinion on the recyclability of the tested packaging. Note that, the Recyclability Evaluation Protocol establish some benchmark recommendations to guide the decision-making process. However, not all the properties listed in the protocol are provided with a benchmark recommendation, being the evaluation also based on the technical expertise of the Technical Committee (TC).

Within RecyClass, “easy-to-empty” and “easy-to-access” indexes are important factors when considering the recyclability of a package. Washing operations at state-of-the-art PP film mechanical recycling facility uses mild conditions, no detergents nor strong chemicals. Consequently, any food or product residue constitutes an impurity for the recycling stream. RecyClass encourages testing to verify that the package is “easy-to-empty” and therefore ensures the minimum amount of residue material at the end of its useful life. Nonetheless, this factor is beyond the scope of this Protocol.

4. LABORATORY TEST METHODOLOGY

This methodology aims to reproduce the recycling process at laboratory scale to determine the suitability of an innovation for the PP film recycling stream. The methodology described below shall be followed precisely and any modifications or problems must be noted during the testing phase. A Laboratory Evaluation Report compiling objectively all the results obtained shall be prepared to report to the RecyClass PO films Technical Committee (TC)

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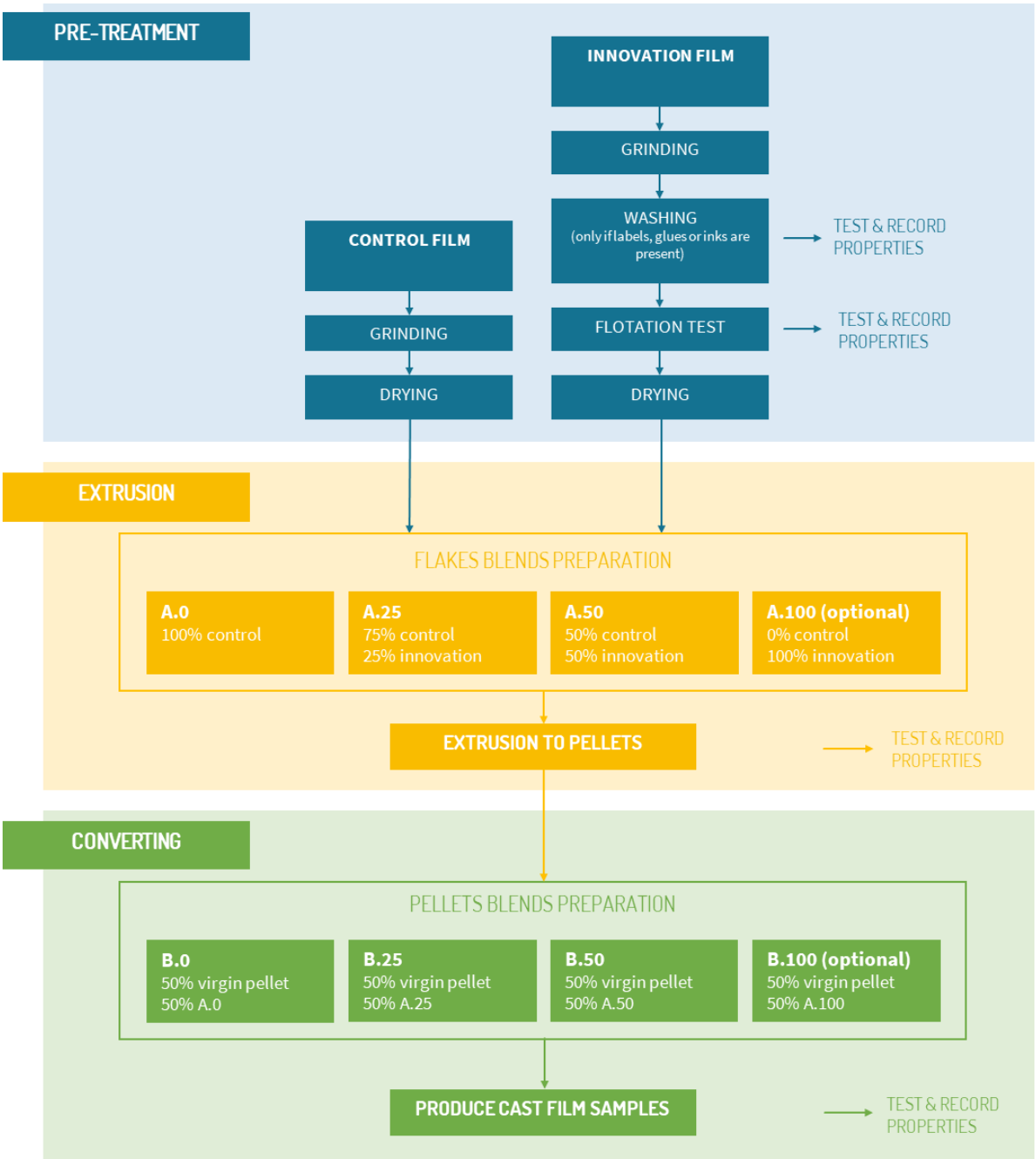
1 Design for Recycling Guidelines

[2] RecyClass Methodology

which will interpret the final results. Any remarks during the laboratory tests described in the Protocol shall be also noted down.

See below in Figure 1 a diagram where the flow of the methodology is described.

Figure 1: Methodology diagram



4.1 CONTROL SAMPLE SELECTION

The control PP film sample for the purpose of performing the Protocol can be selected:

- **Option 1:** If there is a PP film known to be recyclable, consisting of the same base PP resin as the Innovation, except/apart from the specific ingredient/feature being evaluated, it can be selected as the control for this Protocol, with the approval of the RecyClass PO films TC.
- **Option 2:** The applicant can select a PP virgin with the typical MFI for cast film applications and copolymers structure as the innovation article, ± 10 % MFI and ± 0.005 density can be used as control for this Protocol, upon the approval of the RecyClass PO Films TC (see Annex 1). The selected PP resin must be extruded at 230 °C to obtain the control sample. The same physical form as the innovative material should be preferred.

These options are to be used to make both the control flakes and the blends with innovation flakes that will contain the innovative feature(s) (barrier, adhesive, additive, coating, label, multilayer resin, etc.) for the recyclability study.

Since control material is used as reference to evaluate the impact of the innovation, A.0 and B.0 (see Figure 1) needs to fulfil some minimum requirements to make the Recyclability Evaluation valid. RecyClass recognised testing facilities are aware of these minimum requirements and will inform both the Applicant and RecyClass in case of deviations.

For the purpose of the tests, the amount of material that the Applicant should provide will depend upon the equipment and scale used in each laboratory. Usually, at least 10 kg of innovation material (as packaging) and 25 kg of control material (as packaging) will be requested to prepare blends of at least 8 kg. More innovation sample could be requested in case optional tests are required by the RecyClass PO Films TC. It is worth pointing out that the protocol should be used to test innovations as specific parts of a packaging, meaning that all the decorations or elements of the packaging do not need to be present. The objective is to evaluate the impact of a specific innovation on the recyclability of PP Films. Note that full packaging (with labels, decoration, closures, etc.) can also be assessed according to the present protocol.

4.2 VIRGIN SAMPLE SELECTION

The virgin PP sample to be used in this Protocol can be selected from the PP resins listed in the Annex 1 and used as it is (i.e. without applying any thermal pre-treatment). In the case the control material selected has an MFI out of 3 to 8 g/10min, the virgin material should be selected as homopolymer : copolymer blend that can lead to an MFI for B.25 and B.50 blends in the range of 3 to 8 g/10min (230°C, 2.16 kg). A 90/10 homopolymer : copolymer ratio would be preferred.

5. LABORATORY TEST PROCEDURES

5.1 PRE-TREATMENT STEPS

5.1.1 GRINDING

Control (if provided as film) and innovation samples are separately ground in order to fit the throat of a standard laboratory extruder. In case the control is provided in form of pellets, only the innovation sample has to be ground.

Procedure:

- Report the mass of each sample before grinding as m_0.
- Grind separately control and innovation sample to flakes of 3 to 15 mm.
- Store in separate containers.
- Report the mass of each sample after grinding as m_1.

5.1.2 WASHING

Control and innovation samples are separately washed to test the impact on wet washing operations. Washing shall only be performed if paper, labels or surface printing is present in the innovation film. If none of those are present, go directly to step 5.1.3.

The following procedures have to be utilized for innovation sample only.

Procedure:

- Prepare the wash container at a 1:24 ratio (1 g flakes vs 24 ml water) with tap water at a room temperature (+/- 20 – 25 °C). No added detergents or caustic soda.
- Wash each sample separately at a 1:24 ratio (1 g flakes vs 24 ml water) at 1,000 rpm for 10 minutes.
- Rinse each sample at the same ratio with 500 rpm for 5 minutes.
- Pour the liquid-flake mix over the de-watering screen and save the wash water.
- Report the mass of innovation sample after washing as m_2.
- Take photos at each step.

Save the washing and rinsing water separately for visual observation. Record the presence of suspended particles or fibers within the water as well as any water coloration. Check and record if the glue has been diluted after the rinsing or it remains attached to film flakes.

5.1.3 FLOTATION TEST

The flotation test will determine if the flakes can be separated by density in the float/sink tank used in the recycling operation.

The following procedure has to be utilized for innovation sample only.

Procedure:

- Pour the washed flakes in a tank of water filled with water at a 1:24 ratio at a room temperature.
- Stir at 500 rpm for 10 minutes.
- Stop the stirrer and allow the water to rest for 2 minutes.
- Remove the tank from the magnetic stirrer.

- Collect all particles that float on the surface with a sieve.
- Collect separately the particles that sink.
- Report the mass of innovation sample after sink-float separation as m_3f and m_3s for floating and sinking fraction respectively.

The efficiency of the sink/float separation should be measured using 50 g of washed flakes of innovative samples and a graduated beaker filled with tap water, as described by the following procedure.

Procedure:

- Fill a 1 l graduated beaker with 700 ml of tap water (pH between 7 and 8).
- Boil the water for 10 minutes, and then cool at room temperature.
- Transfer 300 ml of water in a graduated beaker.
- Put the innovative sample in the water and stir at 500 rpm for 2 minutes.
- Stop the magnetic stirrer and allow the water to rest for 2 minutes.
- Take photo of the beaker.
- Remove all particles that float at the surface with a sieve.
- Take photos of the floating and sinking fractions separately.
- Save the water for visual evaluation.
- Dry the floating fraction for 1 hour at 80 °C in a bed desiccant or 3 hours at 65 °C with air.
- Cool to room temperature, weigh and record the weight of the float fraction.
- Calculate the test efficiency as:

$$\eta = \frac{W_F}{W_I} = \frac{(W_I - W_S)}{W_I}\ x\ 100\ [\%]$$

Where:

η: Test efficiency

W_F : weight of floating fraction

W_S : weight of sinking fraction

W_I : weight of innovative sample

5.1.4 DRYING

Reduce the flake moisture at 60°C without application of vacuum to release surface moisture to less than 1%. .

Procedure:

- Heat the oven to 60 °C.
- Divide the flakes evenly between at least 4 dishes. The dishes are sequentially numbered.
- Weigh the different dishes with the control or innovation material before introducing them in the oven.
- As soon as the oven has reached 60 °C, the flakes are added to the oven without the application of vacuum until 1% moisture content is reached.
- Report the mass of each sample after drying as m_4.
- Record the moisture content.

According to the mass measured at the different steps of the pre-treatment, fill the table in Annex 2 and determine the pre-treatment yield for both control and innovation as follow:

$$\eta_{PT} = \frac{m_4}{m_0}$$

Where:

ɲ: Pre-treatment yield

m_0 : mass of sample before grinding

m_4 : mass of sample after drying

5.2 EXTRUSION

5.2.1 FLAKE BLENDS PREPARATION

For each sample obtained, to evaluate and record the properties of innovation PP films against control as laid out in this Protocol, a set of flake blends is prepared as described in Table 1. Blends shall be produced once the control and innovation films have separately gone through all pre-treatment steps described above.

Keep separated the control and innovation flakes obtained following the previous steps, and air dry for 24 hours at ambient air. Then, according to the values reported in Table 1 prepare three different blends with 100 % control (and 0 % innovation), 75 % control – 25 % innovation, and 50 % control – 50 % innovation, and tag them respectively as A.0, A.25 and A.50.

Eventually, depending on the application and its market penetration, the TC can ask the Applicant also to perform the tests with a sample of 100 % innovation (i.e., A.100, by replacing the test with A.25).

For the purpose of the tests the Applicant should provide enough innovation and control materials which allows for the blend preparations (cf. section 4.1.).

5.2.2 FLAKE BLENDS COMPOSITION

Three different blends 0 %, 25 % and 50 % of innovation film (optionally 100 % innovation film), will be prepared as described in Table 1.

Eventually, depending on the application, the TC can ask the Applicant also to perform the tests with a sample of 100 % innovation (i.e., A.100, by replacing the test with A.25).

Table 1: Flake blends composition for the production of pellets

BLEND	COMPOSITION	% CONTROL FILM	% INNOVATION FILM
A.0	100 % Control film	100	0
A.25	75 % Control film 25 % Innovation film	75	25
A.50	50 % Control film 50 % Innovation film	50	50
OPTIONAL A.100	100 % Innovation film	0	100

5.2.3 PELLET PRODUCTION

Both control and innovation flakes can be mixed manually before extrusion for blends preparation. The flakes will be dried under the same conditions with hot air and extruded using a co-rotative twin-screw extruder at a melt temperature of 230 °C. The extrudate will be filtered with a 110 µm filter. When needed, for low bulk density materials, a densification step can be used prior extrusion to effectively feed the extruder, under the agreement of the RecyClass PO Films Technical Committee. Densification should be done following the procedure FPE-P-04 developed by APR[1].

Control flake sample A.0 has to be extruded first. Further size reduction before extrusion is acceptable if needed to allow good feeding of the material into the extruder. Nevertheless, the flake size should be kept constant between all samples.

The extruder has to be cleaned before starting the extrusion process. This involves pulling the screws out of the barrel and then mechanically cleaning them with brass brushes until they reach a glossy finish. The barrel also has to be also mechanically cleaned with round brass brushes from the mandrel to the run-out zone.

Procedure:

- If a densification step was performed, report the equipment used, as well as condition and procedures followed.
- Dry samples A.0, A.25 and A.50 (optionally A.100) with hot air at 90 °C for 1 hour maximum to decrease surface moisture below 1%. Any agglomeration of flakes must be reported.
- Extrude at a preferred melt temperature from 230 ± 5°C with a suggested filtration screen at 110 µm. If the range is not optimal, record temperature and state reasons for alteration. Melt residence time should be less than 6 minutes.
- Recommended throughput is between 5 and 10 kg/h and rotation speed between 100 and 200 rpm.
- Extrusion run time per variable, no less than 30 minutes.
- Extrusion load > 50%
- Verify that the average pressure is less than 25 % superior to the control over a stable 15 minutes run time.

Record the resulting properties in Table 2. The processing conditions used for all the samples must be identical. If some operating conditions have to be modified for A.25 and A.50 (optionally A.100) samples, this information must be documented in the report. A small amount of each sample (50 g) will be retained for the RecyClass PO Films TC and the Applicant. The extruded pellets will be tested for pellet properties characterisation (Table 2). The pellets of the test samples will be compared with the pellets of the control sample. All pellets should meet the requirements reported in the Table 2.

5.2.3.1 PELLET PROPERTIES CHARACTERISATION

[1] APR PE Film Practices FPE-P-00

Table 2: Pellet properties characterisation

ASSESSMENT	STANDARD	BENCHMARK RECOMMENDATION
Density (kg/m^3)	ISO 1183-1	A.25 and A.50 (and eventually A.100) lower than 0.920 g/cm^3 for natural films and lower than 0.950 g/cm^3 for coloured films
Melt Index (g/10 min)	ISO 1133-1 (230 °C/2,16 kg)	A.25 and A.50 (and eventually A.100) less than 15 % deviation in respect to A.0
Gas content (wt%)	Heat 10g of pellets at 10°C/min up to 120 °C in a muffle oven. Report weight loss.	Record
Volatiles (wt%)	Heat 10 g pellets exposed to 180 °C for 10 minutes	± 0.1 % for A.25 and A.50 (and eventually A.100) respect to A.0
Ash content (wt%)	ISO 3451-1 (muffle) up to 750 °C	A.50 lower than 1 wt% (A.100 lower than 2 wt%)
Filtration (110 µm)	Visual inspection. In case of presence of build-ups, an FTIR analysis is recommended to identify the origin of the deposit.	No build-up on screen
Moisture content (wt%)	Moisture analyser	< 0,1 wt%
Melt Temperatures (°C)	ISO 11357-3 (Heat-cool-heat cycle under N_2 at 10 °C/min from 0 °C to 250 °C with 1 minute of isotherm between each ramp)	Melt temperature second heating <170 °C
Impurities (unmolten particles)	Visual inspection	Record
Surface appearance	Visual inspection	Record
PE (%), PE-Comonomers in PP are not counted	Differential Scanning Calorimetry or Spectroscopic measurement via FTIR (method under development)	No more than 2.5 % for A.50 (and eventually no more than 5 % for A.100)
Reflection Colour	(L*, a*, b*) + ΔE Reflectance mode, D65, 8-10°	For natural stream: ΔE < 5
Average Pressure (MPa)	Average Pressure after extruding through 110 µm for the stable 15 minutes run time	No more than 25 % higher pressure respect to the control sample
Pressure Variation (MPa)	($\Delta P_{25\text{-}30minutes}$ - $\Delta P_{5\ first\ minutes}$)	No increase higher than 25 % compared to start
Extrusion process	Unusual sticking, fumes, odour, and any build-up	Record

5.3 CONVERSION

Prior the recyclability assessment, the RecyClass PO Films TC will decide the process to be used for conversion according to the highest value recyclate application for the innovation. In the present case, all innovative PP Films recyclate will be converted via cast film extrusion.

For cast films production, three blends of innovation and control pellets will be produced aiming to assess different innovation concentration in the recycling stream, as described below.

5.3.1 PELLET BLENDS PREPARATION

Once PP pellets have been produced and tested, three additional blends of at 50 % virgin – 50 % blend "A.X" (X being 0, 25,50 or 100) shall be produced for the converting tests. Keep separated the pellet samples previously produced and dry them for 10 minutes at 60 °C. Then according to the values reported in Table 3 prepare three different blends with 0% innovation (50 % virgin and 50 % A.0 pellets), 12.5% innovation (50 % virgin and 50 % A.25 pellets), and 25 % innovation (50 % virgin and 50 % A.50 pellets), and tag them as samples B.0, B.25 and B.50 respectively.

Eventually, depending on the application and its market penetration, the TC can ask the Applicant also to perform the tests with a sample of 50 % virgin and 50 % innovation (i.e. B.100, by replacing the test with B.25).

For the purpose of the tests the Applicant should provide enough virgin materials which allows for the blend preparations. The laboratory carrying out the Protocol testing can define the amounts according to their best knowledge.

5.3.2 PELLET BLENDS COMPOSITION

Three different blends of cast film at 50 % virgin pellet – 50 % Blend A shall be produced as described in Table 3. Blends will be composed of 0 %, 12.5 % and 25 % content (end eventually 50 %) of the initial innovation film.

Table 3: Pellet blends composition for the application tests

BLEND	COMPOSITION	% VIRGIN RESIN	EFFECTIVE % CONTROL FILM	EFFECTIVE % INNOVATION FILM
B.0	50 % Virgin Pellet 50 % A.0	50	50	0
B.25	50 % Virgin Pellet 50 % A.25	50	37.5	12.5
B.50	50 % Virgin Pellet 50 % A.50	50	25	25
OPTIONAL B.100	50 % Virgin Pellet 50 % A.100	50	0	50

5.3.3 CAST FILM PRODUCTION

Procedure:

- Produce cast film at a melt temperature of 230 – 250 °C, chill roll temperature of 50-60 °C and a thickness of 35 µm
- Report the melt temperature and the chill roll temperature profiles during the 30-min run time.
- Record production properties in Table 4, including information regarding structure, holes, and stability of the cast film.
- For "Gels & Specks" evaluation, refer to the Annex 3 "PP Film Surface Impression Evaluation and Impurity Visual Inspection".
- Report the morphology of the gels by performing microscopy or any other optical measurement allowing it.

5.3.3.1 CAST FILM PROPERTIES CHARACTERISATION

Table 4: Cast film properties characterisation

ASSESSMENT	STANDARDS	BENCHMARK RECOMMENDATION	
Thickness (µm)	ISO 4593; DIN 53370	35 µm	
Tear Strength (TD**) (N)	DIN EN ISO 6383-2	No more than a 25 % delta decrease to B.0	
Tear Strength (MD***) (N)			
Tensile Stress at Yield (TD) (MPa) (if observed)	DIN EN ISO 527-3 (Type 2 samples, L0 = 50 mm, test speed = 100 mm.min^{-1})		
Tensile Stress at Yield (MD) (MPa) (if observed)			
Elongation at Yield (TD) (%)			
Elongation at Yield (MD) (%)			
Tensile Stress at Break (TD) (MPa)			
Tensile Stress at Break (MD) (MPa)			
Elongation at Break (TD) (%)			
Elongation at Break (MD) (%)			
Dart Impact (g)	ISO 7765-1		
Puncture Resistance (N)	DIN EN 14477		
Haze (%)	DIN EN ISO 14782	Record. Increase of haze will lower the visual aspects	
Gels and Specks (Annex 3)	5 samples of 100 cm^2 for a gel and specks count greater than 200 µm seen by the naked eye at 30 cm from sample. The number will be recorded but no standard required.	Record the amount and aspect of each gels, specks, fisheyes and holes separately.	< 100 Gels & Specks

		Add microscope pictures of them to show size, shape, distribution.	
Surface Appearance		Record. Limit the end use application.	

**Film testing results are minimum conditions. Historical data over time may require adjustments for specification change and requirements for specific applications.*

***TD: transverse direction*

****MD: machine direction*

DOCUMENT VERSION HISTORY

VERSION	PUBLICATION DATE	REVISION NOTES
1.0	January 2021	Recyclability Evaluation Protocol for PP Films release
1.1	May 2021	Major modifications about procedure, wording & template
2.0	January 2022	Revised wording and removal of some testing
2.1	August 2022	Mandatory washing and floatation step for control sample removed Wording for sample quantity requested for testing Temperature recommendations for extrusion are now melt temperatures
3.0	January 2023	Addition minimum requirements for control material Addition pre-treatment yield and Annex 2 Addition of densification step prior extrusion, and addition of extrusion procedures Removal of TGA analysis for ash content Modification of the gels & specks evaluation with addition of Annex 3
4.0	January 2024	Modification of conditions for virgin material selection Modification grinding and drying conditions Removal of washing as mandatory for control material Addition of reference to APR densification procedure Removal of bulk and pellet size characterisation Clarification on colour, volatiles, and gas content characterisations Decrease of extrusion and cast film melt temperatures Harmonisation mechanical characterisation parameters Microscopy mandatory for gels/specks analysis

ANNEX I – CONTROL SAMPLES SELECTION

Application	Copolymer structures	Grade	MFR at 230 °C, g/10 min	Melting temperature, °C	Flexural Modulus ISO178 (MPa), measured on IM specimen 23 °C / 50 %RH
Cast film	Homopolymer	HD204CF	8	164	1350
Cast film	Homopolymer	HD601CF	8	164	1400
Cast film	Heterophasic copolymer	BC918CF	3	168	1400
Cast Film	Random Copolymer	RD204CF	8	150	1100
BOPP	Terpolymer	TD310BF	6	130	n.a.
BOPP	Homopolymer	HC101BF	3.2	161	1350

For control material, a mono-material (mono-grade) approach remains mandatory, selecting a grade with properties as close as possible from the innovation. In the case the control material selected has an MFI out of 3 to 8 g/10min, the virgin material should be selected as homopolymer : copolymer blend that can lead to an MFI for B.25 and B.50 blends in the range of 3 to 8 g/10min (230°C, 2.16 kg).

ANNEX II – MASS BALANCE PRE-TREATMENT

MASS (g)	CONTROL SAMPLE	INNOVATION SAMPLE
Before grinding: m_0		
After grinding: m_1		
After washing: m_2		
Floating fraction after sink-float separation: m_3f		
Sinking fraction after sink-float separation: m_3s		
After drying: m_4		
Pre-treatment yield: η_{PT}		

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ANNEX III – PP FILM SURFACE IMPRESSION EVALUATION AND IMPURITY VISUAL INSPECTION

PP Film Surface Impression Evaluation and Impurity Visual Inspection

Defect description	Rating			
Texture	Very Smooth	Smooth	Rough	Very rough
Gels larger than 0.2 mm	: Defined as visually uniform small clumps of crosslinked polymers			
	< 50	50-100	> 100	for 500 cm^2
Carbon black particles/Specks	: Defined as very small contaminants, possibly darker in colour			
	< 10	10-15	> 15	for 500 cm^2
Fisheyes	: Defined as small round or oblong shapes with darker/more concentrated centre			
	≤ 3	4-6	> 6	for 500 cm^2
Holes	: Defined as tears in the blown film bubble starting at, or caused by, gels, specks or fisheyes			
	0	1 or more		

Preferred range	Limited	Non-acceptable

For evaluation procedures, RecyClass recommends following the Appendix A "Evaluation of Blown Film Appearance Rating Calculation Totals for Control and Test" present in the APR PE Film critical guidance FPE-CG-01[1]

Defect description	B.0	B.25	B.50	B.100
Texture				
Gels larger than 0.2 mm				
Carbon black particles/specks				
Fisheyes				
Holes				

Report here the exact amount of defects observed, as well as standard deviations.

[1] APR PE Film critical guidance FPE-CG-01

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