RecyClass

RECYCLABILITY EVALUATION PROTOCOL

FOR ATTACHMENTS ON PS CONTAINERS

STANDARD LABORATORY PRACTICE

REP-PS-03

VERSION 1.0

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RecyClass

CONTENT

DISCLAIMER

"RecyClass is a non-profit, cross-industry initiative advancing recyclability, bringing transparency to the origin of plastic waste and establishing a harmonized approach toward recycled plastic calculation & traceability in Europe. The Recyclability Evaluation Protocols promote recyclability by encouraging the industry to test new plastic technologies, materials or products, providing recommendations on improving their recyclability before market launch.

The Recyclability Evaluation Protocols are freely available to download on the RecyClass website. Companies developing new plastic 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, will decide on the compatibility of the innovation with recycling according to the evaluation results, granting a Technology Approval Letter to the Applicant.

All tests must follow the Evaluation Protocols recommended by the RecyClass Technical Committees and 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."

1. INTRODUCTION AND PURPOSE OF THE PROTOCOL

The "Recyclability Evaluation Protocol for attachments on PS containers" referred to in this document as "The Protocol" describes the methodology the Applicant must follow at a laboratory scale to determine if attachments combined to PS packaging are separable by the post-consumer PS recycling stream.

The Protocol aims to evaluate the separability behaviour of closure systems, lids, valves, decorative technologies, or any other components attached to PS containers during the grinding, washing and flotation process by performing a test at laboratory scale. The applicant shall proceed with the Protocol as established in the Assessment Process for Applicants of Recyclability Evaluation in the RecyClass Internal Procedures[1] and RecyClass Technology Approvals Quality Management & Procedures document[2]

In case the component tested with the Procedure does not meet the requested assessment criteria, the combination can be submitted to the full Recyclability Evaluation Protocols of RecyClass to demonstrate that, even though not separable, the combination does not negatively affect PS recyclability in terms of process and recycled material quality. This option can only be considered for coloured packaging. For natural and white packaging other components must be released to avoid a contamination of the material obtained after the recycling process.

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

[1] RecyClass Internal Procedures

[2] RecyClass Technology Approvals Quality Management & Procedures

2. SCOPE OF THE PROTOCOL

The scope of The Protocol covers any materials related to closure systems, lids, valves, decorative technologies, or any other components introduced to the existing PS packaging solutions, such as handles. Prior to initiating the evaluation, the Applicant is required to review the Design for Recycling Guideline for PS containers[3] in order to confirm that the material is compatible with these requirements.

The following non-exhaustive list of materials are covered by the scope of this Procedure:

1. PP
2. PE
3. TPE
4. EVA
5. Paper, cardboard
6. Foams
7. PET, PETG, PLA
8. Aluminium lidding

The Protocol provides guidance on the separability behaviour of the components during the PS recycling process. Components should be separable by density from the PS packaging during the flotation step (after grinding). Welded non-PS components to PS packaging should be avoided as not separable by the recycling process. **Releasability of adhesives used on labels or any other attachments must be tested additionally according to The Protocol REP-PS-02 to evaluate the potential issue coming from the adhesive.**

3. LABORATORY EQUIPMENT

- Laboratory grinding machine[4].
- Washing vessel/equipment preferably with deflectors (4 x 90°).
- Overhead stirrer with selectable rotation speed.
- Paddle stirrer.
- Dish detergent.
- Sodium chloride.
- Analytical balance with an accuracy of 0.001 g.
- Strainer (mesh size of 0.5 x 0.5 mm).
- Moisture Analyzer (res. 0.001 %).
- Digital camera.
- Optical Microscope.

[3] *Design for Recycling Guidelines* https://recyclass.eu/recyclass/design-for-recycling-guidelines/

[4] *Dry or wet grinding.*

4. LABORATORY TEST METHODOLOGY

This methodology aims to reproduce the grinding, washing and flotation steps of the recycling process at a small scale to determine the separability of components in the PS 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 all the results obtained shall be prepared. Any remarks while following The Protocol shall be also noted down.

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

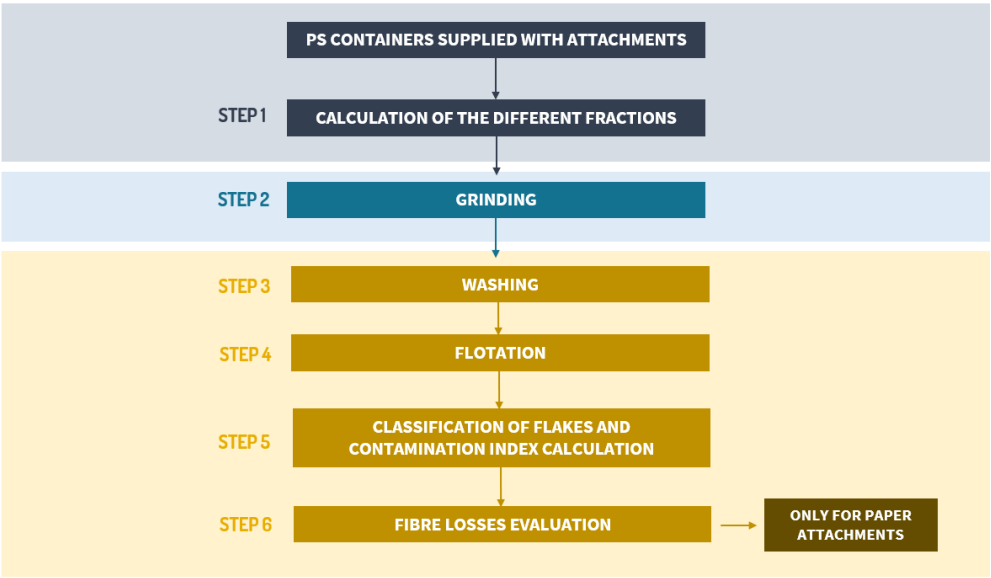

Figure 1. Flow process diagram

4.1 SAMPLES SELECTION & PREPARATION

For the purpose of the tests, the Applicant should provide about 500 g of containers with attachments.

In the case of assessing lids, the material should be supplied either with lids fully sealed to the PS container or with the lid opened, leaving 1/5 of the lid still attached to the container. In the case the container is fully sealed, the laboratory shall open the lid by leaving 1/5 of it still attached to the container.

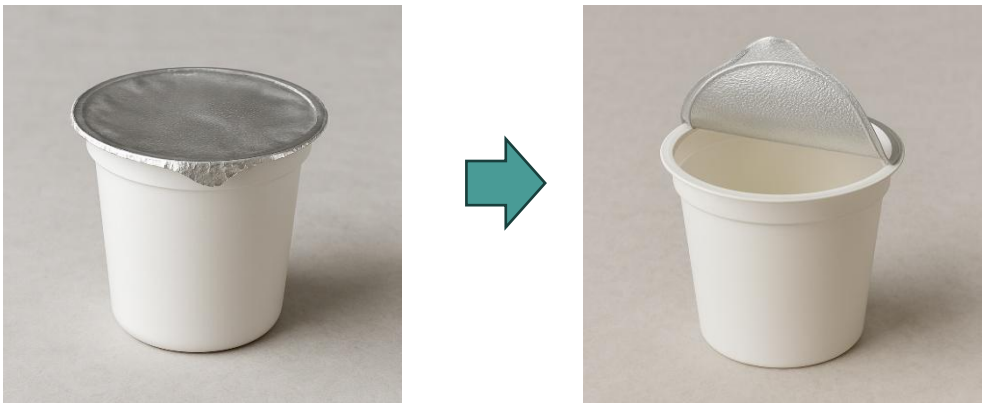

Figure 2. Preparation of containers with lids. The lid must remain attached to 1/5 of the sealed area.

In case of assessing liners, seals, valves or any other mechanically attached components, the packaging must be ground in its original form, meaning that the valve shall be supplied inside the closure system as it will be used in a real case, as indicated in Figure 3.

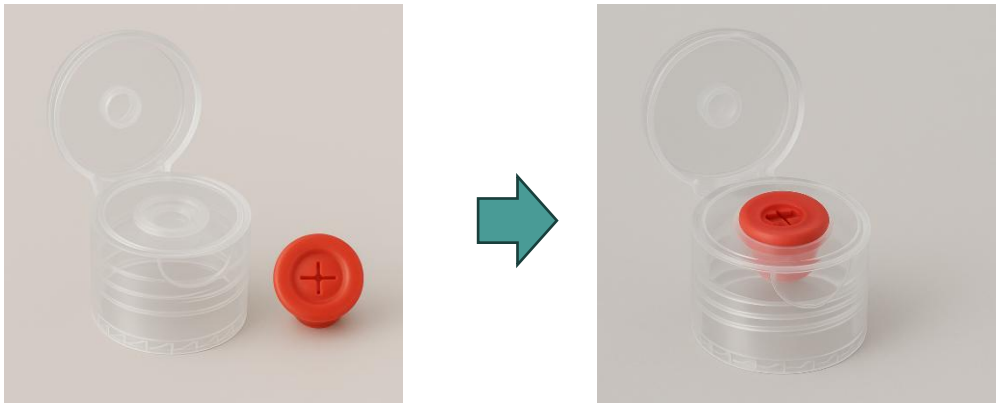

Figure 3. Liners, seals, valves or any other mechanically attached components shall be provided as they will be used in a real application.

4.2 PROCEDURE

4.2.1 STEP 1: CALCULATION OF THE DIFFERENT FRACTIONS

Procedure:

- Take 5 specimens of clean, dry containers.
- Weigh the containers with attachments. Record the weights and assign the code C_{WA} to the average of the measurements. Take pictures.

- Remove the attachments by hand, without leaving any residues of it. Record the weight of the container without the attachments and assign the code C_{WOA} to the average of the measurements. Take pictures.
- Calculate the weight corresponding to the attachment as $C_{WA} - C_{WOA} = C_A$
- Calculate the following fractions:

Fraction of full container ($\chi_{C_{WA}}$)	$C_{WA} / C_{WA} = 1$
Fraction of the container without the attachments ($\chi_{C_{WOA}}$)	C_{WOA} / C_{WA}
Fraction of the attachment (χ_{C_A})	C_A / C_{WA}

4.2.2 STEP 2: GRINDING

Procedure:

- Containers with attachments should weigh around 500 g, which is equivalent to 100 containers approximately (depending on the type of container area). Report as N the number of containers to be ground. Please make sure N is a round number.
- Weigh the N containers that are going to be ground. Assign the code G_0.
- Grind sample C (containers). Use preferably a screen size between 15 and 20 mm.
- Collect the ground fraction, assign it code C_G. Weigh the C_G fraction, assign the code G_T to the recorded weight. Take pictures.
- Calculate the losses C_{LG}.

$$G_0 - G_T = C_{LG}$$

$$Losses\ \% = \frac{C_{LG}}{G_0}\ x\ 100$$

4.2.3 STEP 3: FLAKES WASHING

At the state of the art, European PS recycling lines typically use cold washing conditions, no detergents nor strong chemicals.

Procedure:

- Prepare the washing water in a vessel at a 1:4 ratio (1 kg flakes vs 4 l water) with tap water. No added detergents or caustic soda.
- Heat the washing water at 40 °C.
- Wash the sample at a 1:4 ratio (1 kg flakes vs 4 l water) at 1000 rpm for 5 minutes. Keep the wash water for further analysis.
- Rinse the flakes in a strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar. Keep the rinse water for further analysis.
- Then drain the material.
- Take photos at each step.

Save the washing and rinsing water separately for visual observation. Record the presence of suspended particles or fibres within the water as well as any water colouration.

If any noticeable change of colour or transparency occurs, report it, and document the colour with a photograph. In order to highlight the differences, take a photograph of both solutions in the beaker alongside each other in front of a light (white) and dark (black paper) background.

4.2.4 STEP 4: FLOTATION

Following the washing, the flotation process allows flake separation by density as occurring in the float/sink tank used in an industrial recycling line.

Procedure:

Step 1 (bath density of 1 g/cm^3) - The targeted material (PS) shall sink, whereas all non-PS flakes (with d<1 g/cm^3) shall float.

- Fill a vessel with tap water at a 1:12 ratio (1 kg washed flakes vs 12 l water).
- Add 0.2 wt% of dish detergent.
- Stir at 750 rpm for 4 minutes.
- Stop the stirrer and allow the water to rest for 10 minutes.
- Remove all the materials that float at the surface with a sieve. Keep them for further measurements.
- Take photos of the floating and sinking fractions separately.
- Take photos of the water and save it for visual evaluation.

Step 2 (bath density of 1.08 g/cm^3)- The targeted material (PS) shall float, whereas all non-PS flakes (with d>1 g/cm^3) shall sink.

- Fill a vessel with tap water at a 1:12 ratio (1 kg washed flakes vs 12 l water).
- Add 0.2 wt% of dish detergent.
- Add 12 % of sodium chloride to the water solution (or any other salt) to increase the water density up to 1.08 g/cm^3.
- Put the sank samples from step 1 in the water and stir at 750 rpm for 4 minutes.
- Stop the stirrer and allow the water to rest for 10 minutes.
- Recover all the materials that float at the surface with a sieve. Recover also the materials that sank.
- Rinse separately the floating and sinking flakes in a strainer with cold running tap water and stir vigorously for 5 minutes using manual stirring bar. **Ensure that all the salt has been removed**. Then drain the material.
- Take photos of the floating and sinking fractions separately.
- Take photos of the water and save it for visual evaluation.

Observe the colour of the wash water solutions of both steps. If any noticeable change of colour or transparency occurs, report it, and document the colour with a photograph. In order to highlight the differences, take a photograph of both solutions in the beaker alongside each other in front of a light (white) and dark (black paper) background.

Reduce the flake moisture with ambient air to release surface moisture to less than 1 %. Perform this step to all the fractions obtained, meaning the floating fraction of step 1 (F_{F1}), and the floating and sinking fractions of step 2 (F_{F2}, F_{S2}).

Dry the flakes collected after flotation with air at room temperature without applying vacuum or heat sources until 1 % moisture content is reached. If the moisture content cannot be reached under these conditions, mild heat can be used with prior notification and approval from RecyClass.

4.2.5 STEP 5: CLASSIFICATION OF FLAKES AND RELEASABILITY RATE CALCULATION

Procedure:

- Weigh the flakes after drying (C_F fraction), assign the following codes:
  - F_{F1} = floating fraction of step 1
  - F_{F2} = floating fraction of step 2
  - F_{S2} = sinking fraction of step 2
  - $F_T = F_{F1} + F_{F2} + F_{S2}$
- Spread the flakes coming from the F_{F2} fraction and classify them according to the following table.

Flakes separation and quantification of the C_w fraction	Letter
Contaminated flakes and fines (Container flakes with attached lids, fines, etc)	F_{F21}
Clean attachment (e.g. lid) flakes	F_{F22}
Clean container flakes	F_{F23}
Total (Should be equal to F_{F2}, with a tolerance of 0.2 %)	

- Calculate the contamination index after the flotation procedure.

$$CI = \frac{F_{F21}}{F_{F23} + F_{F21}} x\ 100$$

- Calculate the yield of the process (Y_P)

$$Y_P = \frac{F_{F23}}{G_0\ x\ \chi_{C_{WOA}}} x\ 100$$

Validation criteria:

- The Contamination Index (CI) should be 0.2 % or lower[5]

- Y_P must be ≥ 90 %

[5] *The Technical Committee reserves the right to apply more stringent criteria, where deemed necessary, depending on the specific type and characteristics of the attachment under evaluation. The Technical Committee may also require a full Recyclability Evaluation Protocol to be performed, if considered necessary.*

4.2.6 STEP 6: FIBRE LOSSES EVALUATION (ONLY FOR PAPER ATTACHMENTS)

This section only applies to attachments in paper (e.g. paper filters).

The last step is to verify the fibre losses that can occur during the washing step of paper labels. The following procedure must be performed for the wash water.

Procedure:

- Weigh the dried strainer of 190 µm. Record the weight before filtering as "FW_{BF}".

- Filter the wash water.

- Dry the strainer in the oven 1 h at 120 °C.

- Weigh the strainer. Record the weight after filtering as "FW_{AF}".

- Calculate the weight change of the filter as "FW" ($FW_{AF} - FW_{BF}$).

Repeat the procedure with the rinse water:

- Weigh the dried strainer of 190 µm. Record the weight before filtering as "FR_{BF}".

- Filter the rinse water.

- Dry the strainer in the oven 1 h at 120 °C.

- Weigh the strainer. Record the weight after filtering as "FR_{AF}".

- Calculate the weight change of the filter as "FR" ($FR_{AF} - FR_{BF}$).

Assessment criteria: The tested paper attachment can be considered as "without fibre loss" and pass the procedure if all the following criteria are met:

Fiber losses: FW/CA x 100 < 4 % and FR/CA < 4 %.

5. REPORT CONTENT

The report should contain the following information:

- Reference to The Protocol: *REP-PS-03 – v. 1.0*

- A full and complete identification of the material tested, including:

    - **Container**: size, PS grade, and density.
    - **Attachment(s)**: type of material(s), density, size, proportion compared to the overall container, connection type to the container, component type (e.g., closure system, lid etc.)

- Description and photographs of the set-up.

- Description of the samples during each step

- The photographs indicated in the test procedure. Additional photographs are welcome whenever useful for documenting specific situations.

- Details of any deviation from the test method, as well as any incident which may have influenced the results.

- Test figures.

RecyClass

DOCUMENT VERSION HISTORY

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1.0	July 2026	REP-PS-03 released

RecyClass

Avenue de Broqueville 12
1150 Brussels – Belgium

Phone : +32 2 786 39 08
info@recyclass.eu

www.recyclass.eu