

The RecyClass HDPE Technical Committee (TC) submitted to the RecyClass Decoration Task Force (TF) for rigids the request to investigate the impact of different permanent adhesives on the recyclability of High-Density Polyethylene (HDPE) rigid packaging.

The test campaign was performed using different type of permanent adhesive for labels representing about 2.5 % of the total weight of the packaging. Labels facestock was Polyethylene (PE) and was applied unprinted on white HDPE bottles, as illustrated in *Figure 1* (see Annex 1). Tests were carried out following a simplified version of the procedures described in the RecyClass Recyclability Evaluation Protocol for HDPE containers¹ due to the large number of samples. Tests focused on the pre-treatment steps, specially grinding, extrusion process, pellet and injection moulded parts' properties.

Different adhesives' chemistries were evaluated, as shown in *Figure 2*, 4 acrylic emulsions (2 tackified, 1 non-tackified and 1 removable), 5 hotmelts (4 multipurpose rubber and 1 UV acrylic) and 2 solvent-based acrylics. The control material used for the test was the same HDPE bottle used for the innovation without the adhesive and the label facestock. The recyclability evaluation was performed at the Centre Technique Industriel de la Plasturgie et des Composites (IPC).

During the pre-treatment, problems at the grinding step were identified for some of the samples, where the grinder was covered with glue and showed the formation of agglomerates. This issue was overcome by using a granulator instead of a grinder and by means of cleaning procedures using isopropanol. Nevertheless, this behaviour could not be attributed to a specific chemistry or type of adhesive.

Regarding the extrusion process, some samples showed issues when feeding the extruder, showing a sticky behaviour. In addition, other samples showed a chemical odour during extrusion. Nevertheless, these behaviours were not representative of a specific chemistry.

All the samples showed a stable extrusion process, with similar extrusion pressure levels. The highest ΔP over run observed was representing about 17 % of pressure increase and falling under the acceptable deviation stated in RecyClass protocol (25 %). The 120 μm filters did not show signs of degradation of the material.

¹ [RecyClass Recyclability Evaluation Protocols](#)

Extruded strands were clean and without black spots, only one of the solvent-based acrylic samples presented a rough aspect. Pellets and injected moulded samples were analysed, with specific focus on Melt Flow Index (MFI), Ash Content, Differential Scanning Calorimetry (DSC) and impact behaviour (IZOD).

It was observed that the MFI was higher for all hotmelt multipurpose rubbers, and for one of the tackified permanent acrylic emulsion samples. Nevertheless, all samples showed higher MFI values compared to the control material, attributable to the label facestock material. No specific deviations were observed for the ash content neither for the DSC measurements.

Injection moulding was carried out to obtain IZOD samples and plaques. The process was stable with no issues relating to the processability of the samples and without any fumes nor odours during processing. Plaques were clean and with a smooth aspect, except for one of the solvent-based acrylic samples showing a rough aspect and small black spots. Impact strength characterization showed that rubber-based adhesives have a better behaviour, indicating that these adhesives may be enhancing the impact resistance due to their chemical nature. A similar behaviour was observed for one of the tackified acrylic emulsion adhesives.

The trials carried out for this test campaign are complementing the tests obtained by RecyClass through several technology approvals released for the coloured HDPE and PP streams². In total, information about 16 acrylic emulsions, 5 hotmelt rubbers, 2 UV acrylic hotmelts and 2 solvent-based acrylic adhesives has been collected. This information has shown that there were no important issues observed related to the pre-treatment, extrusion, pellet and injection moulded parts' properties. Moreover, in the aforementioned trials, bottles were obtained without any relevant problem regarding the bottle production process or the bottles' properties assessment. Considering the available data and information, the HDPE TC has concluded that:

- *Acrylic emulsions and hotmelt rubber adhesives* do not disturb the HDPE recycling process and can be considered as limited compatible with coloured HDPE recycling.
- *UV acrylic hotmelts and solvent-based acrylics* need to be further tested before to define the level of compatibility with the HDPE coloured guidelines.
- **Any other permanent adhesive will need to be tested to ensure that it does not pose any risk to HDPE recycling for coloured stream.**

² [RecyClass Recyclability Approvals](#)

It is important to highlight that, since the labels will be printed, the guidelines' update is only valid for the HDPE coloured stream. The fact that the adhesives and labels will not be removed from the bottle means that the generated pellets after recycling will be coloured, rendering permanent adhesives as no compatible for the natural and white HDPE streams.

Moreover, the full compatibility column of the Design for Recycling Guidelines is reserved to adhesives that are washable according to the current state of the art technologies used by HDPE recyclers.

Finally, RecyClass is currently developing a new test campaign to assess the removability of labels and adhesives from HDPE and PP containers within a new Task Force fully dedicated to white packaging. Further recommendations in this regard are expected by December 2023.

About RecyClass

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. RecyClass develops Recyclability Evaluation Protocols and scientific testing methods for innovative plastic packaging materials which serve as the base for the Design for Recycling Guidelines and the RecyClass Online Tool. RecyClass established Recyclability Certifications for plastic packaging, Recycling Process Certification and Recycled Plastics Traceability Certification for plastic products.

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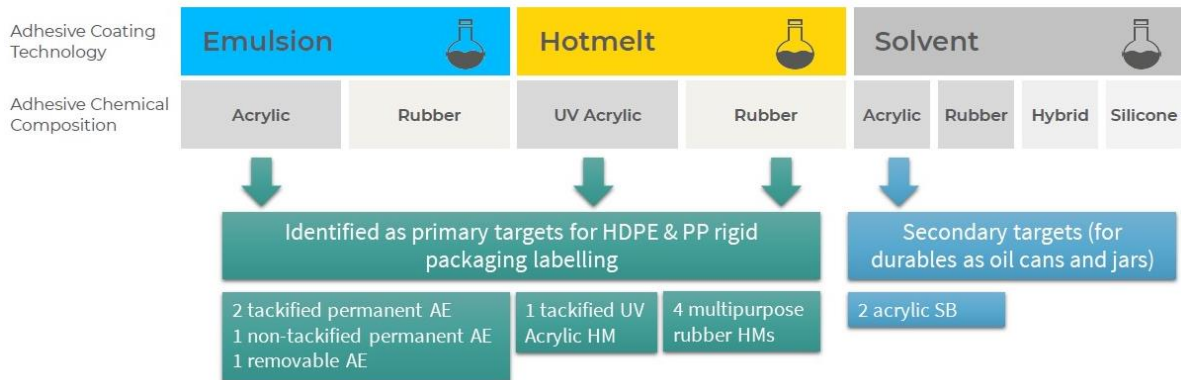
Annex I



Figure 1. Innovation and Control materials

Samples

Adhesive representing $\approx 2.5\text{wt}\%$ of the total weight



→ 11 adhesive formulations tested in the same conditions (bottles, surface coverage, coating weight, facestock, label unprinted) and compared to an unlabelled bottle (control)

Figure 2. Samples