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Shrink Sleeve Labels on PET Containers
APR Resource Document

Introduction

This Resource Document presents APR Guidance for characteristics of shrink sleeve labels for PET packaging that will have the most benefit for today's PET container recycling processes, and that will have the most positive environmental impact in support of the plastics circular economy.

Shrink sleeve labels have been developed that allow the label film and inks to have negligible impact on the quality or productivity of PET recycling. Such shrink sleeve labels are in commercial use today, but not yet used widely or routinely. The quality of recycled PET can be improved—to the benefit of all recycling and sustainability stakeholders—when recycling compatible labels become the standard for the PET packaging industry.

The resources described herein can be helpful to each segment of the package supply chain:

- Consumer brands can learn what comprises a recycling compatible shrink sleeve label and inform their label suppliers that they expect such technologies be offered to them;
- Label suppliers can assure brands that PET packages using their products meet recyclability guidance by performing APR Test Methods to demonstrate this;
- Converters and manufacturers who want to lead the industry in sustainability can use APR shrink sleeve label design guidance to develop and commercialize innovations that will benefit the entire packaging industry.

This document is written to complement the APR Design® Guide for Plastics Recyclability by consolidating key shrink label guidance:
https://plasticsrecycling.org/apr-design-guide/apr-design-guide-home

The APR offers programs, such as Critical Guidance Recognition, that distinguish innovations that are demonstrated to be compatible with recycling: https://plasticsrecycling.org/recognition/programs

This document contains four sections:

1. A brief review of shrink sleeve label selection criteria and potential impacts on PET recycling.
2. A listing of companies and trade associations with experience in labels and PET recycling that can help source shrink sleeve labels that are compatible with PET recycling.
3. A model specification that may be used as a starting point for buyers and sellers to specify a shrink sleeve label that is compatible with PET recycling.
4. Frequently asked questions concerning shrink sleeve labels and PET recycling.

The Association of Plastic Recyclers

Brief Review of Shrink Sleeve Label Selection Criteria and Potential Impacts on PET Container Recycling

Auto-Sortation Potential (Most important)

The near infrared (NIR) auto-sorters used at Materials Recovery Facilities (MRFs) must be able to identify the PET bottle beneath a shrink sleeve label, or else the PET bottle is lost to the waste stream and is not recycled. When a label is highly opaque, covers the majority of the bottle surface area, contains metal film layers, or is dark in color, the PET container is at risk of not being correctly identified by the NIR unit.

Selection of a film substrate

APR recommends films that are compatible with PET recycling such as:

1. Films that float in water and that can be separated from PET that sinks in water, or,
2. PET based films that crystallize and can be recovered with the PET stream.

PVC has been used for shrink label films, however the impact of PVC on recycled PET color and black speck contamination is very severe. A PVC label renders the PET container non-recyclable.

PETG has been a widely used shrink label film substrate, but PETG is not compatible when PET containers are recycled and so should be avoided. Films based on polystyrene or PLA are also not compatible with PET and should be avoided. PETG, PLA and OPS shrink films are detrimental to PET recycling.

Selection of printing inks

APR offers tests that can be used to identify inks that have negligible, if any, impact on PET recycling. An important consideration for inks on shrink sleeve labels is that the ink not contaminate or discolor PET flake when mixed in hot caustic wash water used in the recycling process. If the ink separates from the label film in the wash step, it is desirable that the ink be readily filtered from the PET flake as well as the wash water. If the sleeve label floats, it is desirable that the ink remain adhered to the floating label, and that the ink density not cause a floating label to sink.

Additional label design considerations

APR encourages labels that:

- Do not cover the entire bottle surface areas; exposed PET provides the opportunity for color sorters to most accurately identify clear PET beneath the label. Small surface area labels can also result in lower label waste and bale yield loss when bottles are recycled. Transparent areas designed into labels can potentially allow for better sorting of clear PET. An APR Working Group is currently conducting new work in this area; results will be reported when available.

- Employ a de-seaming adhesive so that the label can be removed from the PET container at those PET reclaimers that employ a hot whole bottle wash step.

APR has not yet developed guidance with respect to labels that:

- Employ perforations on a label, either as a tear-strip so that consumers have an opportunity to easily remove the label before recycling the bottle, or to help improve label removal efficiency in recycling operations. The consumer tear-strip option requires on-package instruction to encourage effective label removal; removed labels have the potential to become mismanaged waste. Labels not removed by consumers will enter the recycling stream and be subject to the label recycling compatibility guidance detailed in this document. Also, in states with container deposit laws, labels can be important for reverse vending deposit redemption, or other system verification purposes. For these reasons, this is not a complete solution, and there is no industry consensus on the value of these tear strips.

The industry is evolving

In the last few years:

- Label film suppliers have innovated and there are new label films available for shrink labels.
- A de-seaming adhesive has been developed that allows shrink labels to be removed in a process step used by several PET reclaimers known as a whole bottle wash step.
- Ink suppliers and label converters have developed ink formulations that do not impact PET recycling; there is no impact on PET color, and any separating inks can be filtered from wash water.
- PET process equipment designers and suppliers have developed new equipment to help manage the impact of shrink sleeve labels – an example is that machines known as “de-labelers” that mechanically remove labels from bottles early in the PET recycling process are beginning to find use.
- Some PET reclaimers now employ a float-sink step after bottle granulation to allow floating labels to be separated from PET flake prior to a hot PET flake wash so that there is reduced risk of label inks contaminating PET flake.

Because of these innovations, there is not one single best recommendation for shrink sleeve label design and performance. However, shrink labels and inks that meet the Criteria of APR Critical Guidance or Benchmark Tests, along with the innovations listed above, clearly move the industry forward and are encouraged.

The APR offers a range of tests that can be used to confirm that labels are designed to be compatible with PET recycling. Those that supply labels and are familiar with PET recycling will already have test data and experience to demonstrate the recycling compatibility of label products. Those that have received APR Critical Guidance Recognition have employed a rigorous laboratory procedure to demonstrate that their label product is compatible with recycling.

Following are resources that can be contacted to help supply labels with good recycling compatibility for all PET packaging applications.

APR Design® Guide Label Supply Resources

The companies listed below are APR member companies and/or companies that have engaged in the APR Critical Guidance Recognition Program to demonstrate a product that is compatible with PET recycling. The contact information given below is current as of the publication date of this document: October 2019. Additional information for those APR member companies may be found in the APR Member Directory: https://plasticsrecycling.org/membership/members-profiles. The APR encourages the use of any label supplier that offers test data to support the recycling compatibility of its labels.

Shrink sleeve film label converters – These are member companies and those that supply finished printed labels that have employed APR's Critical Guidance Protocol for Clear PET Articles with Labels and Closures, PET-CG-02, to demonstrate that their printed labels are compatible with PET recycling, or can supply labels using APR Recognized unprinted labels:

- American Fuji Seal – Scott Giffels; sgiffels@afseal.com; (502) 203-4678
- Brook & Whittle – Andy Sharp; asharp@bwhittle.com; (716) 830-9402
- CCL – Daniel Webb; dwebb@cclind.com; (651) 341-1510
- Multi-Color Corp – Matthew Thomas; Matthew.Thomas@mcclabel.com; (402) 973-8018
- Sleever International – Laurent Lamotte; laurent.lamotte@sleever.com; (647) 201-0940

Suppliers of un-printed shrink sleeve substrate films that offer APR Recognized labels – These un-printed labels have employed APR's *Critical Guidance Protocol for Clear PET Articles with Labels and Closures* to demonstrate that the unprinted labels are compatible with PET recycling:

- Eastman Chemical – Carl Williams; jcarlw@eastman.com; (423) 229-6821
- Klöckner Pentaplast – Ravi Kalkunte; ravi.kalkunte@kpfilms.com; (540) 832-8037
- Polysack – sales@polysack.com
- SKC Inc. – Eugene Jung; ejung@skcfilms.com; (678) 342-1137
- Taghleef Industries – Duncan Henshall; duncan.henshall@ti-films.com; (843) 862 2032
- UPM Raflatac – Kyle Strenski; kyle.strenski@upmraflatac.com; (513) 313-4782

Independent consultant companies that can conduct testing – The independent consultants and laboratories listed below are experts in PET recycling and testing; they can help evaluate new innovations:

- Plastic Forming Enterprises – Kristi Hansen; khansen@plasticsforming.com; (603) 668-7551
- Plastic Technologies Inc – Wei Zhang; w.zhang@pti-usa.com; (419) 867-5402

Trade association contacts

- The Association of Plastic Recyclers – Please refer first to the APR Design® Guide for Plastics Recycling: https://plasticsrecycling.org/apr-design-guide/apr-design-guide-home
- TLMI – Many label converters in North America belong to this organization; TLMI can help communicate steps its members can take to supply recycle compatible labels for PET packaging. Primary contact: Rosalyn Bandy, Rosalyn.Bandy@tlmi.com; (513) 401-9578

Model Specification - Shrink Sleeve Labels on PET Containers

Introduction

The APR has prepared this Model Specification to promote awareness and discussion of the characteristics of shrink sleeve labels that are expected to be compatible with PET recycling. This Model is not intended to replace detailed specifications agreed to between individual buyers and sellers of labels, and which may include requirements that extend beyond the guidance provided in this Model.

The Model Specifications present:

1. A guidance table describing the most important characteristics that must be demonstrated for the labeled container to provide a preferred level of performance with negligible impact on the quality and productivity of PET recycling. Those committed to a plastics circular economy will want to consider this level of performance.
2. Minimum guidance for a labeled container. (If a labeled PET container meets minimum guidance, it is likely to pass into the PET recycling stream, however the label, adhesive or inks may contribute detrimental impacts on the recycled PET.)
3. Alternate next best steps that can be taken should the preferred level not yet be possible.

APR Guidance for a shrink sleeve label to be "APR Preferred"

With today's emphasis on developing the circular economy for plastics, packages that are compatible with widely used recycling processes and have negligible impact, if any, on the quality and productivity of PET recycling are considered APR Preferred. The following table presents the characteristics of a preferred shrink sleeve label that is expected to be compatible with most PET reclaiming processes:

Performance element	Test	APR Guidance	Impact
NIR optical sortation for polymer type	Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article, Sort-B-01	Meets preferred criteria	Provides support that labeled bottles can be positively identified as PET at a Materials Recovery Facility (MRF).
Impact of the label film on recycling	Critical Guidance Protocol for Clear PET Articles with Labels and Closures, PET-CG-02	Meets guidance criteria, and/or is an APR Recognized innovation	Label can be separated from PET in a float/sink step, or is compatible with PET flake
Table continues on next page ……			

Performance element	Test	APR Guidance	Impact
Impact of printed ink and label film on recycling	Critical Guidance Protocol for Clear PET Articles with Labels and Closures, PET-CG-02 OR Benchmark Test for Clear PET Articles with Labels and Closures, PET-B-02	Meets guidance criteria, and/or is an APR recognized innovation Ink meets guidance criteria	Testing confirms that ink from printed labels does not impact PET color and that the label film does not negatively impact PET recycling. In the case of floating labels, it is desirable that the ink and any adhesive used remain adhered to the label so that ink does not contaminate wash water, and adhesive does not cause flake discoloration or haze.
Color sortation at a PET reclaimer	None available today; see additional information immediately below	Surface area coverage with closure on container allows detection of clear PET containers	Label coverage expected to regularly allow a container to be identified as clear PET and included in the clear stream.
Note: metal film and foils are not expected to be used with shrink sleeve labels. A label with metal content would need to be evaluated for impact on NIR sortation and metals detection, including Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article, Sort-B-01			

Additional information on color sortation

When clear PET bottles with shrink sleeve labels that employ (a) APR Recognized film substrates and (b) APR tested inks pass through a color sorter, it is desirable that the color sorter be able to detect the clear PET bottle beneath the film and properly sort the shrink-labeled bottle with the clear PET bottles. For this to happen, there generally must be some level of clear PET exposed that is not covered by a printed label or an attached closure or tamper band.

It is not possible for the APR to give quantitative guidance, nor a standard test method, on this color sort topic today. The reasons include:

- There are several different suppliers of color sortation equipment that each have different designs and capabilities.
- The performance characteristics of color sortation equipment can be adjusted by individual PET reclaimers depending upon their objective and preferences.
- Sortation equipment performance can be influenced by the ink colors used on the label.
- The evaluation can be influenced by factors such as the size of the bottle, its orientation on a conveyor belt, and whether the bottle is flattened or folded over.

That said, here are steps that can be taken to confirm a label has the potential to allow detection of a clear PET bottle in the color sort step:

- Label converters that are engaged in providing recycling solutions either have prior experience, or the network that can be used to obtain evaluations.
- Companies that make color sortation equipment have demonstration laboratories where containers with labels can be tested.
- Work done by an APR Working Group on demonstration equipment with a single serve container size, developed data indicating that color sorters can be effective when about 20% of the PET bottle side wall and shoulder surface area is not covered with label. The area of the base and finish above the neck ring is not included in the area evaluation.
- PET reclaimers that are APR members are often able to help do evaluations of new container designs using their production equipment and provide feedback to package and label developers.
- If there is prior experience indicating good color sorting performance, that prior experience can be used to inform label coverage in a new application.

An APR Working Group is currently conducting new work in this area, the results of which will be reported when available.

Interim actions if APR Preferred label performance is not yet achievable in a specific application

APR acknowledges that companies may need time to change their specifications or develop innovations to allow the use of APR Preferred label technology. In the meantime, suggested below are alternate, next best, actions can reduce the risk of a shrink sleeve label impacting recycling.

APR recommends that minimum requirements are:

1. A PET container with sleeve label move correctly through the NIR sortation steps at the front of the process so that the container does not enter a waste stream. The labeled container should pass the Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article, Sort-B-01, to confirm that containers with labels have the potential to be positively sorted at a MRF into PET bales for recycling.
2. The label film is one that is APR Recognized, or that meets criteria of the Critical Guidance Protocol for Clear PET Articles with Labels and Closures, PET-CG-02, or which is the subject of a Responsible Innovation Program.
3. The Critical Guidance Protocol for Clear PET Articles with Labels and Closures, PET-CG-02, or the Benchmark Test for Clear PET Articles with Labels and Closures, PET-B-02, is employed to show that the ink does not discolor flake in cases where the ink is removed from the label in the wash step.

If for any reason, the Guidance immediately above cannot be satisfied, APR recommends:

1. Employ a label film that is APR Recognized, or which is the subject of a Responsible Innovation Program. These credentials provide support that the label film will be compatible with PET recycling or with a significant segment of recycling processes.
2. When using a label intended to float in water, employ the PET Packaging Component Sink or Float Evaluation, PET-S-05, to confirm that the intended commercially printed label floats and that the presence of inks used in the commercial graphics do not cause the label to sink.

Another interim step that can be taken is to employ a label film substrate that utilizes a de-seaming adhesive.

The Association of Plastic Recyclers

Frequently Asked Questions addressing testing and selection of shrink sleeve labels for PET containers

1. ***What factors impact the ability of a container with a shrink sleeve label to be sorted by near infrared optical sorters for polymer type?***
   Cases where a label might interfere with NIR sortation include:
   - Complete coverage of the bottle side wall and shoulder where the label film attenuates the NIR spectrum for the PET container.
   - Complete coverage of the side wall when very opaque or dark colored inks are used that attenuate the NIR spectrum and prevent detection of the PET container.
   - Use of metalized films which are highly reflective of NIR light and may prevent detection of the PET container.

2. ***Why don't all PET reclaimers use a de-labeling unit?***
   De-labelers are a relatively new piece of equipment available to PET reclaimers. While the equipment can be effective in removing shrink sleeve and wrap-around labels from containers early in the recycling process and can provide process benefits, there is not wide agreement on their value. For example:
   - De-labelers require additional capital, floor space, power, maintenance, labor and process down-time.
   - De-labelers are not 100% efficient in removing labels.
   - De-labelers can create process yield loss by creating what are known as "broken necks" when the finish of a bottle is torn from the side-wall.

3. ***What happens to containers with shrink labels that are identified as colored bottles in a color sorter?***
   The outcome depends upon the process equipment and sorting procedures used at a given PET reclaimer. Some possible outcomes are:
   - Bottles are included in the color stream and recycled with the colored bottle stream (limited, lower-value markets).
   - Colored bottles are diverted to a de-label unit that is designed to mechanically remove shrink labels from bottles. After the de-label unit, bottles are re-evaluated in a second pass through a color sorter.
   - Some reclaimers pass all PET containers through a de-labeler to minimize the chance that a sleeve label is still on a bottle at the color sorter.
   - Bottles are sent to the landfill or for incineration.

4. ***Can the tests recommended in this document rely on labels printed with "generic ink" test data, or should the actual intended printed commercial label be tested?***
   Least risk of a label causing a problem in commercial use will result when actual commercial labels are tested. Some specific concerns known from industry experience that need to be managed:
   a. Substantially black or dark colored labels interfere with NIR sortation. APR recommends the Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article, SORT-B-01, to confirm label performance.
   b. Labels printed with layers of white ink may cause a label, intended to float in water, to sink instead. APR recommends PET Packaging Component Sink or Float Evaluation, PET-S-05.
   c. The Benchmark Test for Clear PET Articles with Labels and Closures, PET-B-02 can be used to confirm overall label performance.

   That said, prior successful experience with defined inks can eliminate the need for testing of all label designs.

5. ***What happens to printing ink on labels when PET is recycled?***
   Shrink sleeve labels are likely to introduce printing ink into the wash water. The tests listed above are intended to confirm that the inks do not have an impact on discoloring the washed PET flake. Those specifying shrink sleeve labels should be aware that inks in wash water can create the need for more make-up water, wash water heat energy, filtration maintenance, detergent, and waste water treatment costs. For floating labels, inks that adhere to the floating label and that do not wash off into wash water are the most desirable option.

6. ***Are the shrink sleeve labels by themselves able to be recycled, or do they become waste?***
   This is an important question with the circular economy in mind. Shrink sleeve labels can be on the order of 7 to 12% of the total package weight and so an appreciable source of waste if not recovered. There is no single answer, but here is some general guidance that can be given:
   - If a floating label is removed from PET flake in the float sink step, the label is recovered along with HDPE and PP closure material. Most PET recyclers today report that they elutriate this float stream to remove label residue from the closure granulate. Because the removed label fraction has especially low bulk density, it is difficult to find recycling applications for this material so this is most likely to become a waste stream.
   - If a PET recycler employs a mechanical de-labeler or a whole bottle wash – the mixture of labels generally does not have recycling value and so will be a waste stream. In the case of dry labels recovered from a de-labeler, labels may become a waste to energy stream.
   - A crystallizable PET based label film that sinks with PET may be recovered with the PET flake and have recycled value included in the PET stream. Some fraction of this label residue might be lost as waste from the PET flake during a recycling step known as elutriation.
   - Inks removed from labels in the PET wash process become waste.

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