The APR Design® Guide for Plastics Recycling
Guidance Addendum for HDPE Packaging

November 29, 2022

New Guidance impacting HDPE packaging has been recently approved for inclusion in the APR Design® Guide for Plastics Recycling. This new guidance is shown below and is available for immediate use. There are three sections presented below:

Contents

Design Guide section title:

Labels for mixed color HDPE bottles

Brief description of the section: This section speaks to the design of labels for mixed color HDPE containers.

Additional information - Before HDPE bottles are granulated, complete packages with labels and closures are likely to be sorted by a NIR optical sorter and run through a sensitive metal detector. These situations create the need for testing to evaluate the impact of a label on NIR optical sortation or metals detection:

1. If a label does not allow the package to be positively identified as HDPE by NIR sorters, the container will go to the waste stream and not be recycled.
2. If metal decoration used on a label is detected by a metal detector… the package will be ejected and sent to waste. Metal decoration can include: vapor deposited films, metal foils, and metallic flake inks.

During the reclaiming process, mixed color HDPE packages are most likely washed in water near room temperature and with mild detergents. These wash conditions will have negligible impact on inks and adhesives and in most cases labels, inks and adhesives are expected to become included in the recycled HDPE product.

Preferred guidance

Automated sorting performance criteria

- For containers with a brimful volume of 550 ml or less, the surface area coverage of the label is no more than 55%, and no metal decoration is employed on the label.

  Additional information - Surface area is defined as the area of the label divided by the area of the side wall and shoulder of the container. The area of the neck ring, threaded finish and base are not included in the area calculation. Metal decoration includes vapor deposited metal films, metal foils, or inks with metallic pigments.

  Containers with no more than 55% surface area coverage by a label are expected to sort accurately through NIR optical sorters. Labels with metal decoration can be tested for any impact on sorting performance using SORT-B-03.

- For containers with a brimful volume of over 550 ml, the surface area coverage is no more than 75%, and no metal decoration is employed on the label.

Additional information - Surface area is defined as the area of the label divided by the area of the side wall and shoulder of the container. The area of the neck ring, threaded finish and base are not included in the area calculation. Metal decoration includes vapor deposited metal films, metal foils, or inks with metallic pigments.

Containers with no more than 75% surface area coverage by a label are expected to sort accurately through NIR optical sorters. Labels with metal decoration can be tested for any impact on sorting performance using SORT-B-03.

- When higher surface area coverage than detailed above is employed, a label can be categorized as preferred when meeting guidance criteria of SORT-B-01 for NIR detection of the HDPE container.

  Additional information - Labels with high surface area coverage may interfere with detection of the HDPE container. The label substrate (film or paper), inks, and metal decoration can interfere with NIR detection when the label covers a high surface area of the container.

- When metal decoration is employed, a label can be categorized as preferred with respect to sorting performance only when the metal detection criteria presented in SORT-B-03 are met.

  Additional information - Metal foils are categorized as detrimental because they can impact HDPE extrusion performance when foils not liberated from the HDPE bottle flake build-up on extruder screen packs.

Preferred guidance for labels that meet NIR sorting and metals testing guidance

- Polyolefin film labels

  Additional information - Polyolefin labels are commonly expected to be PP films or PE films. This includes film labels for each of conforming, adhered, and in-mold style of labels. Some additional considerations:

  - If the label is designed to remain with the granulate (an adhered or in-mold label) and adhere to the granulate, or is molded in, the label should not interfere with the ability of the granulate to float in water.
  - If the label is designed to separate from the HDPE container, it is desirable that the label floats so that the label might be recovered for recycle value.

- Those committed to developing a circular economy for HDPE containers will favor labels with either of these characteristics:
    - Labels have been shown to be compatible with HDPE recycling using the APR Critical Guidance Test for HDPE containers.
    - Labels are made from fractional melt index HDPE and so are fully compatible with the HDPE used to make the bottle.

- Direct printed as well as heat transfer inks labels

- Shrink or stretch labels that sink in water, and which are not made with PVC film.

  Additional information - When a label is liberated from an HDPE package during the granulation step used in recycling, labels that sink in water will be separated from the HDPE during the sink/float step. Labels that sink in water go to waste, but do not interfere with the reclaiming process.

Detrimental

- Paper labels

  Additional information - Managing the paper pulp that is generated from washing containers with paper labels adds to the complexity of the recycling operations and increases waste disposal costs. When paper is not fully removed from the container, paper blinds melt filter screens and contributes to waste and process down-time. That said, a paper label and adhesive that can be washed cleanly from the HDPE and not discolor the HDPE flake is more desirable than a label used with no test evaluation

  - Labels made with PVC film.

    Additional information - The low thermal stability of PVC makes its use in any HDPE recycling process undesirable.

Design Guide section title:

Closures, fitments, liners, and safety seals

Preferred

Primary material employed to make a closure shell, fitment, or spout

- HDPE, LLDPE, and LDPE closures when the melt index of a blend of the closures and base resin employed for the container is less than 4.00

  Additional information - APR Guidance is that the melt flow rate (MFR) of a blend made from a blend of the base resin with the closure resin at the ratio employed in the package be less than 4.00. The reason for the value of 4.00 is given below.

  APR Guidance given in the Critical Guidance method HDPE-CG-01 is that the MFR of a 50/50 blend of control resin with an innovation should be less than 0.75 units greater than the control alone. The following calculation is offered and can be employed as an alternative to laboratory testing to determine the MFR of a blend of two different polyethylene resins:

  $$log(MFR_{blend}) = \sum w_i log(MFR_i)$$

  Using the lowest MFR control choice in the O-P-01 of 0.25 MI and targeting 1.00 (0.25 + 0.75 = 1.00) as the maximum MFR of the blend of closures and container base resin, one solves to determine the MFR for the blend of closures with base resin:

  $$log(MFR_{blend}) = 0.5\log(4.00)\ (Closure + base\ resin\ blend) + 0.5\log(0.25)\ (Control) = 0.00$$

  $$MFR_{blend} = 1.00$$ (<0.75+0.25 per CG criteria)

  The table below gives some illustrative closure/container blends that do not exceed the < 4.00 limit.

Cap (wt%)	Cap MFR (190/2.16)	Bottle (wt%)	Bottle MFR (190/2.16)	Blend Final MFR (<4.0 g/10 min)
0.10	15	0.90	0.25	0.38
0.20	20	0.80	0.70	1.37
0.30	30	0.70	0.35	1.33

  Of course, the MFI of the blend can be measured experimentally as well employing ASTM D1238 (190/2.16)

- Polypropylene closures that are less than 10 wt% of the package weight

Additional information - Polypropylene can be a contaminant in HDPE. When HDPE and PP are melt mixed in an extruder the PP exists as a second phase which can dramatically reduce the impact toughness that is a valuable property of recycled HDPE.

To evaluate the 10% limit, APR guidance is to employ as numerator the sum all the PP employed on a closure, fitment, pour spout, or over-cap employed on a package. Then the denominator is the sum of the PP just mentioned along with the weight of the HDPE used to make the package. Any PP from labels or attachments is ignored in this evaluation.

An allowance for up to 10 wt% polypropylene from closures reflects that the HDPE recycling stream routinely contains PP and reclaimers can manage and accept some PP content in the HDPE stream.

Liners and over-molding employed with closures

- Any floating olefin-based polymer, or polymer compound, may be employed to make a liner or employed to make an over-molding on a closure shell.

  Additional information - These materials are within the scope of floating olefin-based polymers:

  - The finished polymer compound with any additives and color concentrate has a density less than 0.985 g/cm^3, or can be shown to float in water using APR's test O-S-01
  - Polypropylene – including copolymers with ethylene, impact modified grades, nucleated or clarified grades.
  - Ethylene polymers and copolymers including EVA copolymers and ionomers.
  - Thermoplastic elastomers based on olefinic constituents. The more common elastomers are ethylene and/or propylene based plastomers/elastomers as well as olefin block copolymers including SEBS.
  - Foamed olefin-based materials.

Design Guide section title:

HDPE base resin

Brief description of the section: This section speaks to the selection of a HDPE base resin for blow molded containers.

Preferred

HDPE base resin for blow molded containers

- Melt index between 0.20 and 1.61 g/10min and density between 0.941 to 0.970 g/cm3

  Additional information - Melt index measured using ASTM D1238 and density measured using ASTM D792.

- Ethylene derived from either petroleum or natural renewable products is suitable for manufacture of HDPE

- Packages produced with the highest possible level of postconsumer HDPE content are encouraged.

Renders the package not recyclable

- Blends of HDPE with other polymers that prevent NIR identification of the blend as HDPE.

- HDPE compositions containing fillers or additives that cause the composition to sink in water.

DOCUMENT VERSION HISTORY

Version	Publication Date	Revision notes
1	11-29-2022	Corrected typos referencing PET, clarified language on sinking shrink


APR
The Association of
Plastic Recyclers