PET Thermoformed Packages

PET thermoformed packages are produced by extruding a sheet, then heating that sheet to a pliable forming temperature and then usually assisted by a vacuum formed by a mold and trimmed into a package or product. These packages include but are not limited to cups, baskets, clamshells, trays, covers, egg cartons, lids and blister pack. There is also a growing category of containers made from folded PET sheet (like greeting card and Christmas ornament boxes) that should also be included in this category.

A wide range of PET materials are used to produce either the sheet from which the packages are formed or in some cases from which the packages are manufactured in-line. These materials include:

- Prime bottle resin from domestic producers
- Off-spec bottle resin from domestic producers
- Amorphous chip and pellet from domestic producers
- All of the above from foreign producers
  - Industrial regrinds from sheet performs and bottles
  - Reprocessed industrial waste
  - Post consumer RPET flake and pellet produced by domestic reclaimers
  - Post consumer RPET flake and pellet produced by foreign reclaimers

Despite the variety of these potential feedstocks, customer requirements with respect to clarity and performance, in general, demand a quality level of the raw materials used be comparable to bottles. A study commissioned by NAPCOR and APR to examine this issue found that in fact, at aggressive levels of blends of bottle and thermoform recyclate the resins passed APR Application Guidance test protocols.

However, APR also recognizes that labels, adhesives, additives and treatments used either during the manufacturing or use of the package, or in the case of processed scrap during a previous intended purpose, can have serious impacts on the quality of the post consumer RPET produced. What follows are general guidelines to consider when making decisions with respect to a PET thermoformed package. This is followed by the Thermoform Guidance Document that will allow interested parties to test the impacts on the recycling stream of a particular package and finally a protocol that tests whether a particular label and adhesive is compatible with the PET recycling stream.

GUIDANCE

The basic design guidance to consider when making material choice for thermoforms is to consider its general compatibility with the base resin (PET) or the removal efficiency.
in conventional water-based separation systems that separate plastics by density. Attachments may include labels, seals, coatings, and layers. PET has a density or specific gravity greater than 1.0 (the density of water) and will sink in water-based separation systems. For efficient separation and removal in conventional sink/float separation systems, attachments should be made from materials with a density less than 1.0 or be otherwise compatible with PET in the reclamation process. Non-adhering materials with a density less than 1.0 will float in these systems and can be separated easily from the PET.

The use of non-PET polyesters must be confirmed not to interfere with the recycling process or impair the use of the recyclate into applications served by recycled PET. The PET Thermoform Guidance Document should be used for the confirmation.

COLOR
Traditionally, unpigmented PET has the highest value and the widest variety of end-use applications. All other colors, transparent and opaque, should be avoided.

Inclusion of nucleating agents, hazing agents, fluorescers, and other additives for visual and technical effects should be considered highly questionable and should be examined specifically per the reclaiming industry’s PET Thermoform Guidance Documents for impact on the overall PET recycling stream. (Thermoform decision makers should test their opaque, translucent, and unusual transparent colors through Guidance testing programs to determine if the selections of color will act detrimentally on the reclaiming industry and if markets may be available for such colors.)

PVC and/or PLA ATTACHMENTS
The use of PVC or PLA attachments of any kind on PET packages is undesirable and should be scrupulously avoided. This includes thermoforms of PVC and/or PLA that may be visually confused with PET thermoforms. Very small amounts of PVC or PLA (in the parts-per-million range) can severely contaminate and render large amounts of PET useless for most recycling applications. In addition, PVC and PLA are very difficult to separate from PET in conventional water-based density separation systems, due to similar densities (densities greater than 1.0) that cause both to sink in these systems.

OTHER MATERIALS IN OR ON PET THERMOFORM PACKAGES
Plastic enclosures, liners, and labels may be included in thermoform packaging. All such items should be either completely compatible with the clear PET thermoform (no printing, made of the same PET resin) or made of materials that float in water. Such materials include polyethylene and polypropylene. The use of PVC should be scrupulously avoided. The use of other materials with specific gravities greater than 1.0, including polystyrene and polylactic acid (PLA) and glycol-modified PET (PETG)
should be avoided unless means are generally available to remove such materials from the stream of PET recyclable material. Metals and metal foils and metalized substrates that sink in water should be avoided. Paper and molded pulp should be avoided as the PET reclamation process can disaggregate to fibers which contaminate PET. Non-pulping paper labels should be tested per the Protocol for Evaluating PET Thermoform Labels and Adhesives for Compatibility with PET Recycling to check of effects.

INKS & ADHESIVES
Some label inks bleed color when agitated in hot water and can discolor PET regrind in the reclamation process, diminishing or eliminating its value for recycling. The APR and NAPCOR have developed a testing protocol to assist label manufacturers in evaluating whether a label ink will bleed in conventional PET reclaiming systems. Label inks must be chosen that do not bleed color when tested under this protocol. The use of label inks that bleed or discolor PET moldings should be scrupulously avoided. The APR Protocol for Evaluating PET Thermoform Labels and Adhesives for Compatibility with PET Recycling, Appendix A should be used to examine candidate inks, printing, and decoration.

Pressure sensitive labels should separate from PET regrind in the hot caustic water wash step. Label adhesives should be water soluble or dispersible at temperatures between 140 °F to 180 °F in order to be removed in conventional washing and separation systems. If adhesives are not removed efficiently, they may disperse on the PET regrind and embed unwanted contaminants and can discolor PET upon melting. The use of adhesive types which discolor PET upon melting are discouraged. Adhesive usage and surface area covered should be minimized to the greatest extent possible to maximize PET yield and avoid contamination. The APR Protocol for Evaluating PET Thermoform Labels and Adhesives for Compatibility with PET Recycling should be used to examine candidate adhesives. Paper substrates that pulp in the PET washing conditions are not favored. Oriented polypropylene labels are favored as having minimal effect on PET recycling so long as they float in water.

DIRECT PRINTING/DECORATION
The impacts from the use of inks for direct printing on cups and other packages should be evaluated using the APR Protocol for Producing PET Flake for Evaluation and Evaluating for Discoloration from “Bleeding Labels”. Direct printing that cannot be removed or that stains the flake after removal is undesirable and should be avoided. See Bleeding labels protocol for a more complete discussion and details.

THERMOFORM ADDITIVES, MODIFIERS, AND ADDITIONS
Some PET thermoform designers use additives to meet the requirements of specific
product applications. Additives to PET thermoforms which cause the PET to discolor, fluoresce, and/or haze after remelting and solid stating, should be avoided unless means are readily and economically available to minimize the effects. Similarly, blends of PET and other resins are undesirable unless they are compatible with PET recycling.

In general, the use of non-PET layers and coatings are undesirable and should be avoided, unless they are compatible with PET or are easily separable from PET in conventional recycling systems. This includes sealing layers. When used, their content should be minimized to the greatest extent possible to maximize PET yield, limit potential contamination, and reduce separation costs. The use of non-PET layers and coatings can drastically reduce the recyclability of PET.

Recognized additives used for thermoforms include the following and each should be examined by the PET Thermoform Guidance Document to show the effects on PET recycling:

1. Denesting agents
2. Anti-stat agents
3. Anti-blocking agents
4. Anti-fogging agents
5. UV barrier or stabilizer agents
6. Anti-slip agents
7. Heat receptors
8. Lubricants

Optical brighteners can create an unacceptable fluorescence for next uses of recycled thermoforms containing the brighteners. Optical brighteners should be avoided. Based on public product performance claims, it appears that the use of degradable additives may result in shortening the useful life of the items made from recycled PET thermoforms. Degradable additives (photo, oxo, or bio) should not be used without an evaluation confirming that their expected use will not materially impair the full service life and properties, including successful recycle and durability, for the next use of recycled PET. Aging under specific environmental exposure is needed for the technical assessment of the initial postconsumer thermoform. Additionally, the next use applications must be tested under conditions of specific aging and environmental exposure to assure full service life and subsequent next use recycling. Testing should be conducted per APR’s Degradable Additives and PET Recycling Technical Compatibility Testing Guidance.

The use of RFID’s (radio frequency identification devices) on thermoforms is discouraged and should be avoided unless they are compatible with PET recycling and are demonstrated not to create any disposal issues based on their material content.

PET Thermoforms excerpt from
The APR Design™ Guide for Plastics Recyclability
The use of RFID’s is discouraged as it limits PET yield, introduces potential contamination, and increases separation costs.

Silicone polymer parts are discouraged as they may present significant technical problems in the process of recycling and to the usefulness of the recycled plastic.

POSTCONSUMER CONTENT
The use of postconsumer PET in thermoforms is encouraged, whenever possible.

RESIN IDENTIFICATION CODE, RIC
Use the correct Resin Identification Code symbol of the proper size as detailed in ASTM D7611 is encouraged.