Best Practices in PET Recycling

Contamination Issues

Issue: *Contamination limits the ultimate marketability of the full range of PET plastic containers collected by local recycling programs. Contamination reduces the value of recyclable PET; it hinders processing and causes unproductive downtime and clean-up expenses for PET processors, reclaimers and end-users; and, it results in unnecessary manufacturing waste from the PET recycling process.*

Background: Intermediate plastic processors take in baled (and in some cases loose) plastic containers that have been separated from other recycable materials at MRFs, buy-back or drop-off centers. Intermediate processors then granulate the containers for sale as "dirty regrind" to reclaimers and end-users. In most cases, plastic intermediate processors take in loose plastic bottles and produce baled plastics for sale to plastic recycling facilities (PRFs), reclaimers or end-users. Most PRFs are designed to separate plastics into their individual resin categories (if they accept bales of mixed plastic bottles), and then further separate each plastic resin type by color or other market specification parameters. These color segregated plastic resins are then fed into granulators at PRFs or reclaimers to produce dirty regrind. Another major function of the plastics intermediate processor is the sorting and removal of contaminants from the plastic resin streams they process.

The specifications detailed in these *Best Practices* documents have been identified by the PET recycling industry to provide PET suppliers with a guide that can meet their particular purchaser's specifications for acceptable contaminant levels.

To the general public -- and even to trained personnel operating plastics sorting, recycling and reprocessing systems -- PET containers can be confused with food and liquid containers made from other plastic resins that pose major contamination problems for the PET recycling process. In addition, some PET containers are manufactured with barrier resins, closures, labels, safety seals, or contain product residues which can introduce incompatible materials that contaminate the PET recycling process. The increase in recycling collection programs that commingle different kinds of recyclable materials can also introduce non-plastic contaminants, like broken glass, or dirt. These contaminants can create operational or technical problems, quality-control problems, financial costs and unnecessary wastes for the PET recycling industry.

Packaging manufacturers are beginning to adopt "design for recycling" criteria that aim to limit the package's impact on the overall recycling process. Many materials that pose

contamination problems for PET recycling are contained on the PET bottle itself. As a general rule, the best practice for reducing the incidence of these contaminants is to design PET bottles and containers that do not contain materials that contaminate the PET recycling process. Materials utilization in a PET bottle or product should be designed to reduce impact on the recycling process. Design for Recycling (DfR) guidelines and protocols have been established in a number of important areas by the Association of Post-Consumer Plastics Recyclers (1). These protocols and guidelines are routinely updated as new practices and procedures are developed.

While any material that is physically present on a PET bottle or custom container by virtue of its manufacture and marketing is considered acceptable within the PET recycling industry, there are a number of design elements that can be implemented that significantly increase the efficiency and reduce the cost of the PET recycling process. These DfR efforts are aimed at reducing the impact of such materials as labels, the adhesives used to affix them and the inks used to print them.

What follows is a detailed discussion of the major contaminants to the PET recycling process. Much of this discussion will be directed at what facility operators need to do to remove these contaminants and to prepare materials that are of acceptable quality to their purchaser. However, it cannot be overemphasized enough that good public education programs can go a long way towards enlisting the public in removing some of these contaminants prior to collection.

Polyvinyl chloride (PVC)

The primary contaminant to the PET recycling process is any source of polyvinyl chloride (PVC) plastic resin -- the Society of the Plastics Industry "#3 (PVC)" resin identification code. The presence of PVC when reprocessing and remanufacturing post-consumer PET resin may cause one of several problems, even at very low concentrations.

PVC can form acids when mixed with PET during processing. These acids break down the physical and chemical structure of PET, causing it to turn yellow and brittle. This will render the PET material unacceptable for many high-value end-use applications. In addition, the presence of PVC may result in out gassing of chlorine vapors during certain stages of PET reprocessing. This can increase the cost of control systems or regulatory compliance for the facility operator.

There are four primary sources of PVC contaminants that can enter the PET recycling process. The first are PVC "look-alikes," that is, PVC bottles that resemble PET bottles. While it is possible to distinguish transparent PVC bottles from transparent PET bottles by the presence of white "crease" marks, or by the molding mark on the bottom of the

bottle, looking for these distinguishing characteristics can be time-consuming and limit processing throughput in manual sorting systems.

The second is PVC safety seals that are used on certain product containers, such as mouthwash. Every effort should be made to remove safety seals, if they are present, prior to baling PET bottles and containers. Safety seals should absolutely be removed prior to granulating.

The third potential source is PVC liners found inside some caps and closures. While the use of PVC as cap liners has virtually been discontinued in the United States, it is still possible to encounter the occasional cap with a PVC liner. The fourth source is PVC labels that are affixed to some PET containers. However, as a general rule, purchasers of PET bottles and containers will accept any material that is attached to the PET bottle or container.

The sensitivity of PET to PVC contamination is based on the ultimate end-use application for which the recycled PET is intended, but in general the tolerance for PVC contamination is extremely low. The negative impacts of PVC contamination can occur with concentrations as low as 50 parts per million (ppm). This is an amount equal to less than one PVC bottle ground into an 800-pound container of recycled PET regrind or "flake," made from thousands of PET bottles. However, many end-use applications have tolerances even lower than that.

Non-PET Resins

The presence of plastic resins other than PET may also pose problems in the processing and remanufacture of PET. While some of these are acceptable to the PET recycling industry, many are not. The presence of closures may introduce plastics other than PVC that may contaminate the PET recycling process or add separation costs. In addition, some closures are made from aluminum, which can pose problems for some PET reclaimers and end-users or increase cleaning costs.

Plastic closures are made from plastics different than PET. While these plastics (e.g., polypropylene) are lighter than PET, which sinks in water, and can be removed in the "float-sink" stage of the process used to clean granulated post-consumer PET, the removal of caps early in the recycling process can reduce or eliminate the costs associated with this separation step.

Incompatible PET Resins.

There are a growing number of PET containers and other PET packaging materials which are marked with the SPI #1 resin identification code that pose a number of specific problems to PET reclaimers. In some cases these containers are manufactured with modified PET plastic resins or in laminated forms that contain barrier resins that are either incompatible with the recycling of "bottle-grade" PET plastic resin, or are difficult to distinguish from acceptable materials with current sorting technology. In addition, there are identical packaging items to those made from PET that are made with incompatible resins that current sorting technology cannot distinguish. Most recycling collection programs that collect PET plastics request the public to look for the #1 code before placing materials in their collection container or bag. Therefore, it is reasonable to expect that some of these materials may find their way to an intermediate processing facility.

These modified PET resins may have physical or chemical properties that make them incompatible with "bottle-grade" PET resin during the recycling process. However, very few of these modified PET resins are used to manufacture bottles or containers with screw-neck tops. And, the exceptions are very identifiable. This is why many recycling programs that collect PET plastic will request that only PET bottles and containers with screw-neck tops be included in the materials that are set out for collection. What follows is a brief review of the most common incompatible items.

PET Microwave Trays - these are manufactured from crystallized PET, known as C-PET, and are incompatible with bottle-grade PET resin and must be excluded. These C-PET trays are often solidly pigmented (opaque), adding to their incompatibility.

PET Drinking glasses, "Clamshells," and "Blister-pak" - other items that should be sorted out from PET carbonated beverage bottles and custom-PET containers are PET drinking glasses (like the ones used on commercial airlines), which are manufactured from A-PET (amorphous PET); PET salad/food take-out trays or "clamshells," and, PET "blister-pak" -- the clear plastic thermoformed cover affixed to a cardboard placard containing a product. While some of these materials are technically compatible with the recycling of bottle-grade PET, there are "look-alike" packaging items that are made from incompatible resins (e.g. oriented polystyrene) that current sorting technologies cannot distinguish from PET, and must be excluded.

PET Laundry Scoops - plastic laundry scoops with the SPI #1 (PETE) recycling code should also be excluded from your PET mix. While technically it is possible to recycle laundry scoops with PET bottles if they are clear or transparent green, it is best to exclude them as many laundry scoops are opaque and may introduce contaminants due to pigmentation.

PET-G - many custom-PET bottles and containers are now manufactured from a glycol-modified PET resin known as "PET-G." PET-G containers are manufactured differently than other PET containers and are generically known as extrusion-blown containers (referred to as E-PET containers). PET-G and other E-PET containers have a lower melting point than bottle-grade PET resin and can cause a number of technical and operating problems to PET reclaimers. Many of these PET-G and other E-PET containers are marked with the SPI #1 resin identification code and are difficult to distinguish from PET bottles that are acceptable for recycling, even with automated sorting technology. The best way to ensure that E-PET gets removed to the greatest practical extent is to remove any #1 container that contains a built-in handle. These handleware containers are manufactured exclusively with E-PET resins.

Multi-layer PET containers - an increasing number of PET containers on the market are manufactured with a multi-layer construction. Some of these containers are manufactured with a barrier resin known as ethyl vinyl alcohol (EVOH). The presence of EVOH is a problem for some reclaimers as it effects the clarity of the finished product or can cause a change in the intrinsic viscosity (IV) of the recycled PET that renders it unacceptable for certain end-use applications. Like PET-G, however, it is very difficult to distinguish a multi-layer PET container from a single-layer PET container. Once again, it is important to determine whether a particular purchaser has any specific restrictions on the presence of these materials.

Colored PET

While PET containers are manufactured in many different colors, PET reclaimers and end-users are generally only interested in clear and transparent green containers, as they have the best end-use applicability. While there are a growing number of transparent blue PET bottles and containers entering the marketplace, some reclaimers have restrictions as to the presence of blue containers, while other reclaimers are able to "blend" them off into certain end-use applications. Once again, it is essential to understand the exact specification of your particular PET purchaser. The presence of any pigmentation other than transparent green is unacceptable to most PET reclaimers and no other colors of PET bottles or containers should be included for recycling. These restrictions include any opaque colored PET containers as well as transparent amber (brown) or blue PET bottles or containers.

Labels

While most paper and plastic labels used on custom-PET containers and the glues used to affix them can be removed from granulated PET during the cleaning process, certain PET containers, including coffee containers, liquor bottles and mustard jars, may contain metallized labels that pose problems for some reclaimers. Not all reclaimers encounter these problems, but enough do to make it worth noting. Once again, check with the PET purchaser on specific restrictions they may have. s a general rule, PET purchasers will accept PET bottles and containers with whatever materials are physically affixed to the bottle or container.

References:

1. Association of Post-Consumer Plastics Recyclers, 1801 K Street, NW, Suite 701-L, Washington, DC 20006. (202) 974-5419 (P) (202) 296-7154 (F).