Recycling Report:

The truth about plastic clamshell and blister recycling in America
With suggestions for the industry

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The axiom “reduce, reuse, recycle,” which for so long represented our industry’s ambiguous approach toward “being green,” has in recent years translated into a quantifiable reality. Such a reality, with the help of EPI[i] and the FTC, is now defined by specific terms and qualifications.[ii] For instance, to claim that a package has been reduced, one must demonstrate the overall material reductions resulting from the redesign; to claim that a package is reusable, a system for the collection and reuse of said packaging must be presented with validating evidence; and, to claim that a package is recycled means, contrary to popular belief, that this package is in fact recycled in 60% or more of American communities. While everything conceptually is recyclable, only those types of package/material combinations[iii] that are literally collected, reprocessed and remanufactured can be labeled “recycled and/or recyclable.”

With this qualification of terminology came the unraveling of several myths: not only are the high rates for paper recovery attributed primarily to newspapers and corrugagte,[iv] those for plastic packaging are attributed mostly to PET beverage bottles and HDPE milk containers.[v] Why are certain material/packaging types recycled, while others are not?

The Economics of Recycling in America

The answer, like most things, lie in economics: Those material/packaging types that are easy to collect post-consumer, transport, sort, clean, bale, and remanufacture enjoy the likelihood of being recycled because the cost of the resultant “recycled” material is competitive with the cost of virgin material production. For example, because PET bottles are made from high value resin and are “easy” to recycle, the remanufactured resin enjoys a value that allows it to compete with virgin, facilitating the continued recycling of PET bottles. This can also be explained via the chicken and egg analogy: There is no supply if there is no demand; there is no demand if there is no supply. What this means is that a package/material type will not be collected via curb side systems[vi] if there is no buyer or end market for this recyclate.[vii] Often times, buyers/end markets need high generation i.e. quantity and consistent supply of a package/material type to economically justify the reprocessing of it. After all, a material has to be competitive in the market—why would someone source a package from recycled resin if the cost of virgin is cheaper? This translates into the following relationship between supply and demand in the context of plastic recycling: for a material/packaging type to be recycled, the cost to collect, transport, sort, clean and remanufacture must be competitive with the price of virgin resin production. If the cost to recycle a material/packaging type is too high, which often is the result of ineffective collection/sorting processes,[viii] the cost of the product/package for which said recyclate was intended would put the selling unit at a competitive disadvantage in the market. In a country with plentiful landfill space, often times the price to landfill a material/packaging type is much lower than the cost to recycle: this is due in part to the fact that in order to recycle a material, you must first establish a supply and demand equilibrium, develop various technology and make sizeable investment into infrastructure. So what does this all mean for the state of recycling non-bottle plastic packaging, like thermoformed clamshells, blisters trays and components in America?

The Economics of Collecting and Sorting Thermoforms

Thermoformed packaging is the thin gauged, rigid plastic packaging that is applicable to most consumer product packaging for its visibility, performance and cost. Such thermoform packaging types include clamshells, blisters, trays and components, which can be made from a multitude of different resins, depending on the application of the package. While many thermoforms are made out of high-quality resins, the recycling of such packaging/material type(s) has yet to be implemented on a large scale in America because of the economics of collecting and sorting said thermoforms. Unlike bottles, which are easy to identify via manual and automatic sorting systems, thermoforms come in all shapes and sizes, which makes sorting them difficult, thereby driving up the cost of reprocessing this material/package type. While the SPI ID code on the bottom of most plastic packaging attempts to represent the resin from which the package is made, thereby informing its end of life management, the recent influx of new resins, bio-based resins, barrier-resins and others have made the SPI ID code outdated and confusing. A simple example will make clear the inefficiencies of the SPI ID system: packages made from PET are prescribed with the ID code "1;"however, packages displaying the "1" may also be comprised of PETG, in which the –G lowers the melting point of the PET polymer, disrupting the established reprocessing of PET recyclate.[ix] Other examples include packages made from CPET and multi-layer PET containers,[x] which are prescribed with the ID code "1" and have the potential to ruin the PET recyclate for remanufacturing. We will expand on these issues below.

It is also important to note that another complication with sorting thermoforms visually, with or without reference to the SPI code, is time constraints: it is difficult for manual sorters at a MRF[xi] to visual identify those thermoforms intended for recycling from those still with no end market when all types of materials are moving down the line quickly. Some MRFs use air blasts to divert PET bottles from other materials thereby reducing labor costs, which would be complicated with the introduction of thermoforms in the recycling stream. The more difficult and time-intensive the process is for the manual sorters to identify the "recyclable" materials from those destined for landfill, the higher the reprocessing costs; therefore, the more expensive the recyclate and the less competitive it will be with virgin material.

In addition, different MRFs have different sorting technologies depending on the materials they collect for recycling; because of the ease of manually/visually identifying PET bottles and HDPE milk containers from un-recyclable materials as well as the high cost of automatic sorting technology, these technologies may not be available at a majority of MRFs.[xii] If the investment has not been made in optical sorters or more sophisticated sorting technologies, the MRFs ability to sort thermoforms by material type from those still with no end markets may be time-intensive, resulting in higher reprocessing costs. Therefore, a materials' ability to be competitive after the cost of recycling depends, in large part, on the technologies employed by the MRFs; and, a MRF will not make an investment in said technology until they can guarantee the supply of and demand for the material the necessary to sustain the continued recycling thereof.

Supply/Demand Considerations

As alluded to above, the likelihood of recycling a material/packaging type depends on its generation or supply. While very large quantities of PET bottles are manufactured each year,[xiii] there are not as many clamshells of a single resin manufactured, which makes the collection of an adequate supply of this material/package type difficult and therefore its recycling economically problematic. By understanding the different properties of the available resins, packaging engineers—unintentionally—bombard the waste stream with a multitude of different resins in the form of thermoforms, making it difficult to isolate any one resin in order to collect and reprocess. While food requires its packaging to demonstrate certain properties, like preservation and safety, other products, like consumer electronics, require completely different packaging properties, like impact strength and protection against pilferage. Because of the wide variety of different resins from which thermoform packages are manufactured, it is difficult to estimate whether any one resin is used in a sufficiently high proportion, and would therefore be the most "economical" to collect for recycling. In short: there has to be enough of a specific material/packaging type to economically justify the collection and recycling thereof; and, "enough" is defined by the buyer/end market and is difficult to quantify without conducting research on the generation of the different thermoform material types in the consumer waste stream.

According to the ACC, there has to be about 400 million lbs of a particular plastic for the recycling to be profitable.[xiv] Fortunately, as reported on plasticstoday.com, 1.4 billion lbs of PET thermoforms were produced in North America in 2008. This data suggests that the recycling of PET thermoforms can be an economically sustainable process; and, as more and more thermoforms transition from PVC to PET the amount of material in the waste stream available for recovery will continue to climb, thereby providing further support for the recycling of PET thermoforms in the context of material generation/supply.

Lastly, industry perspectives suggest that right now, the demand for PC[xv] PET material in North America surpasses the supply, 3 to 1.[xvi] While I do not know of the validity of this statement, I have witnessed an increase in the desire for recycled PET material for remanufacturing into packaging and products as encouraged by retailers and consumers alike. This interest in increasing the supply of PET recyclate may ultimately facilitate the inclusion of PET thermoforms in the PET recycling infrastructure, allowing the creation of a supply-and-demand equilibrium in the context of PET recycling.

It is important to note that most of our recyclable materials are exported to international markets for reprocessing. According to NAPCOR's "2008 Report on Postconsumer PET Container Recycling Activity," 793.6 millions of pounds[xvii] of PC PET material was purchased by export markets while 615.5 MMlbs was purchased by U.S. reclaimers. U.S. reclaimers consequentially supplement their domestic purchases by importing 98 MMlbs of PC bottles from Canada, Mexico, and South and Central America. Most PC PET material generated in the U.S. is sold to export markets because export buyers will pay more per pound than domestic reclaimers. Therefore, in order to increase the available supply of PET recyclate in America in order to meet the growing demand, the amount of PC PET bales exported should be limited, domestic markets for the recyclate should be developed, and domestic reclaimers should be more aggressive.

“Specs” and Baling Considerations

“Specs” are the documented qualifications a buyer/end market outlines to the supplier of PC material upon procurement. As alluded to above, these specs often times depend entirely on the end use of the recyclate: If the buyer/end market is a bottler, the PC material has to meet one set of specs; if the material is intended for thermoformed packaging, it has to conform to another; and, if the material is used in non-packaging applications like industrial piping, imitation timber, etc., it has to demonstrate compliance with another set of specs. It is assumed that the highest valued recyclate(s) are those materials generated via closed loop systems; by remanufacturing bottles from bottles or thermoforms from thermoforms, the value of the PC material is not diminished after reprocessing. However, if bottles are recycled into polyester fiber applications, the value of the recyclate is diminished because it does not have to conform to as stringent specs during reprocessing, which often times results in a lesser-grade resin with a diminished market value when compared to its virgin form. In summary, the more stringent the specs, the higher value the recylate and the more likely the end market attempts to “close the loop” of the material/package type.

Specs for thermoform bales need to be created if we intend on the future inclusion of thermoforms in the recycling infrastructure. Without a buyer/end market and therefore specs, these material/packaging types will not be collected post consumer and sold for remanufacturing. When creating specs, one must consider the way in which the desired material “bales.” If a material/packaging type cannot be economically collected and baled, as in the case with expanded polystyrene[xviii], than it is difficult to justify the recycling of it because again, the economics don’t support the process. Concern in the industry has been voiced in regard to the way to bale thermoforms for reprocessing: due to their differing densities, geometries, and often times materials, it is difficult to come up with a uniform bale for market, especially when no specs for thermoform bales exist, to my knowledge. Therefore, investment must be made into the development of specs for recycling thermoforms, including specs for baling, which again, rest entirely on the end-market/buyer. We are back to the chicken and the egg insofar as no one will create specs for thermoform-only bales or PET thermoform/PET bottle bales if there is no buyer/end market and there will not be a buyer/end market if there are none of these materials available for market.

Contamination Considerations

Like any procured packaging material, the value depends on its ability to conform to the specs of the buyer/end market. Those instances in which the recyclate does not meet specs is generally the result of contamination issues; contaminates are a recycler's/reprocessor's number one obstacle. Simple design changes to thermoformed packaging, modeled after those advocated by the APR's Design for Recycling Guidelines for PET bottles,[xix] could decrease the likelihood of contaminates in the thermoform recycling stream, resulting in lower reprocessing costs. However, this all depends on the approach one takes to recycling thermoforms. Based on research, it is evident that there are two popular approaches for recycling thermoforms. The first, like the Starbucks cup recycling pilot that integrated the fiber-based cups into the existing and efficient corrugate recycling stream, would be to integrate PET thermoforms into the existing PET bottle recycling infrastructure. By piggy backing on an already sophisticated recycling process, the PET thermoforms would only have to demonstrate to recyclers/reprocessors that they do not contaminate the PC PET material, which will again, depend on the specs of the buyer/end market. The second approach is to recycle all thermoforms together, resulting in a low-grade plastic mix suitable for application in a multitude of products. Another approach, which would require supply-chain collaboration and industry-led initiatives, would be for manufacturers of thermoforms to restrict the number of resins used and/or to make the thermoforms easy to identify by resin type to facilitate efficient sorting/recycling. Such actions could allow thermoforms to be recycled together (after being sorted by resin type) and still maintain high levels of quality. This approach, however, receives some criticism because it requires a new labeling/identification system for resins in addition to placing limits on what resins are available for thermoformed packaging.

According to Hurd in "Best Practices and Industry Standards in PET Plastic Recycling," bales of a single resin, like PET, enjoys more PC value than mixed resin bales, described above as a low-grade plastic mix. Therefore, it appears as though the inclusion of PET thermoforms into the existing PET bottle recycling infrastructure would yield the highest value PET recyclate available for application in a multitude of end markets. If this approach is taken, however, many “contamination” issues need to be addressed, which again, could be presented in a Thermoform Design for Recyclability document. However, these considerations apply if the end market of this mixed thermoform and bottle PET recyclate is for remanufacturing into RPET bottles, food-grade packaging, or other high end packaging applications that require exacting specs and contamination-free bales. If intended for use in down-cycled applications, like decking, such considerations would probably not be necessary; however, this is contingent on the specs of the buyer/end market, as previously discussed. Known contaminates to PET recycling are: PVC, PET “look-a-likes” like PETG, described above, colors, barrier resins, laminates, inks, adhesives, food, etc.

What we can do

Where do we go from here? As illustrated above, the recycling of thermoforms depends on the ability to collect, transport, sort, clean, bale, and remanufacture material into new products in an economically competitive way. Issues such as adequate supply/generation, demand i.e. who is the buyer/what is the end market, investment in sorting and reprocessing technologies, etc. need to be address if we as an industry plan on the inclusion of thermoforms in our recycling infrastructure. Because recycling is a business, it is our responsibility to nourish it through supply chain collaboration and industry-led initiatives. The infrastructure is weak; we must collaborate if we intend to make it strong.

Below is information that I believe is needed to begin work on recycling thermoforms in America:

- Determine how much non-bottle plastic packaging is generated in America by resin and packaging type.
- Determine how much non-bottle plastic packaging is recycled in America and where it goes/what it becomes.
- Determine if anyone is recycling thermoform-only bales and if so, what kind of sorting technologies are employed, what are the specs, and what is the end market of the recyclate?
- Determine if anyone is recycling PET thermoforms with PET bottles and if so, what kind of sorting technologies are employed, what are the specs, and what is the end market of the recyclate?

Next is my understanding of the actions that are needed to begin work on recycling thermoforms:

- Encourage producers to set minimum PC content in their packaging and retailers to insist upon it from their suppliers.
- Work with MRFs to develop more efficient sorting systems for thermoforms and/or encourage industry collaboration for the development of an "easy" way for MRF's to visually identify the different thermoform material types as they move down the line, facilitating efficient sorting and lower reprocessing costs.
- Work with municipalities to generate investment in sophisticated sorting technologies.
- Determine the technical feasibility of recycling PET thermoforms with PET bottles regardless of the various grades.
- Develop Design for Recyclability Guidelines for Thermoforms, which would decrease the amount of contaminates in the thermoform recovery stream i.e. no PVC labels on PET thermoforms.
- Develop local markets for PC resin, be it material extruders, converters, product producers, brand owners, retailers, etc.
- Educate consumers and the industry about the importance of recycling plastic packaging.
- Limit the amount of PC PET bales exported.
- Encourage that the types of resins used in the manufacturing of thermoforms be limited in order to generate large quantities of different material types available for recovery post consumer.

Author's note:

The information presented in this document is the result of a year of research, drawing on the work of APR, NAPCOR, SPC, among others. Proper documentation is provided. However, this is not meant to be an exhaustive study on the topic and does not represent the views of the industry as a whole.

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[i] EPI stands for Environmental Packaging International, which is an organization that specializes in extended producer responsibility/product stewardship requirements. For more information, visit http://www.enviro-pac.com/indexM.htm.

[ii] The FTC first issued its "Guides for the use of Environmental Marketing Claims," commonly called "Green Guides," in 1992 in hopes of educating marketers how to make environmental marketing claims without being deceptive or manipulative. These Guides were revised in 1996 and 1998 and are currently under review. For more information, visit http://www.ftc.gov/opa/reporter/greengds.shtm.

[iii] This terminology, "packaging/material combinations," "types of packages/material combinations," etc. mean that for a package to be recycled, one has to specify the packaging type i.e. thin neck bottle versus plastic tub, and the material type i.e. PET versus HDPE. It is the desired material and packaging type combination that provokes a packages' ability to be recycled. The need to specify the specific packaging type i.e. bottle versus tub is because,

often times, sorting is done manually and it is easier and therefore cheaper to visually sort similar looking packages than independently inspect every SPI resin ID code, which are confusing and in the process of being reviewed.

[iv] According to the EPA's 2009 report titled "Municipal Solid Waste Generation, Recycling, and Disposal in the United States Detailed Tables and Figures for 2008," "other paper packaging/other paperboard packaging" has no recovery data (listed as Neg.), which suggests that most fiber-based packaging is not recycled. The high recovery rates attributed to paper are therefore the result of newspaper (87.6% recovery) and corrugate (76.6% recovery) recycling. To download the report, visit http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw2008data.pdf.

[v] 28% of HDPE milk containers were recycled in 2007 (U.S. EPA 2008); 27% of PET bottles were recycled in 2008 (NAPCOR, http://www.napcor.com/PET/pet_reports.html).

[vi] Curb side systems are one type of collection method employed by municipalities in their waste management strategy. In curb side collection systems, consumers place those materials intended for recycling on the curb for pickup. There are many different types of collection methods, which are often informed by the economics of the waste management system. Other collection examples include drop-off recycling centers, buy-back centers, and returnable container legislation/bottle bills. Information from "Best Practices and Industry Standards in PET Plastic Recycling," by David J. Hurd, Associate Director, BRONX 2000 ASSOCIATES, INC., 1809 Carter Avenue, Bronx, NY 10457 for WASHINGTON STATE DEPARTMENT OF COMMUNITY, TRADE AND ECONOMIC DEVELOPMENT'S CLEAN WASHINGTON CENTER, 2001 6th Avenue, Suite 2700, Seattle, WA 98121, CONTRACT # S97-220-028.

[vii] End markets/buyers are not the only determinants for what package/material types are collected for recycling. Often times, municipalities enter into long-term contracts with haulers in order to lock in rates, which can sometimes lead to materials with high-end value not being included in the system because an old contract.

[viii] The high cost to recycle some package/material combinations is also attributed to the following situations, in addition to inefficient collection and sortation: packaging design without thought to recycling, subsidized raw material costs, inexpensive foreign labor for virgin manufacturing vs. high domestic labor costs for collection, sortation etc., misc. technical barriers, and, the financial outlay for infrastructure creation.

[ix] Hurd, "Best Practices…"

[x] An increasing number of PET containers are manufactured with 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 reclaimers as it effects the clarity of the finished product or can cause a change to the intrinsic viscosity (IV) of the recycled PET that renders it unacceptable for certain end-use applications. Like PETG, it is difficult to distinguish a multi-layer PET container from a single-layer PET container. Information from "Best Practices…"

[xi] MRF stands for material recovery facility, which is where haulers bring those materials intended for recycling for sortation and baling for reprocessing.

[xii] Automated sorting systems employ a detection, or combination of collection systems, to analyze one or more properties of the plastic passing through and automatically sorts these materials into several categories, either by resin type, color, or both. There are three different types of detection systems used in the sortation of plastic bottles: Optical sorting systems use visible light to separate plastic bottles by color. This is called near infrared (NIR); transmission technologies pass a signal directly through the bottle, which is read by a sensor on the other side of the bottle. Each plastic resin has a characteristic response to the signal based on its unique chemical composition. This is called X-ray transmission (XRT); and, surface scanning devices bounce signals off the surface of the bottle, which are reflected back to the sensor for identification. When a sensor detects what it is looking for, it will generally activate an air jet that will eject or direct the item it has positively identified. This is called X-ray fluorescence (XRF). Information from Hurd's "Best Practices…"

[xiii] According to NAPCOR's "2008 Report on Postconsumer PET Container Recycling Activity," the total number of pounds of PET bottles and jars available in the U.S. for recycling in 2008 was 5.366 billion. Download the report at: http://www.napcor.com/PET/pet_reports.html.

[xiv] Plasticstoday.com.

[xv] PC stands for post-consumer.

[xvi] Perhaps an example will make clear that the demand for PC PET exceeds the available supply: According to a plasticstoday.com article, Coca-Cola's plant bottle capped its PC content at 30% in North America, due to limited supply.

[xvii] Hereafter, *MMlbs*

[xviii] EPS is 98% air and 2% resin, which makes the collection/transport of the material costly.

[xix] Guidelines available for download at:
http://www.plasticsrecycling.org/technical_resources/design_for_recyclability_guidelines/index.asp