NatureWorks LLC

Frequently Asked Questions on PLA Sortation

July 27, 2009

1. **Are you suggesting with this work that PLA bottles should just be recycled together with PET bottles, at existing PET reclaimers?**

   No, this work was done to simply demonstrate that as PLA enters the recycling stream that typical reclaimers will be able to separate out even reasonably high levels of PLA, bringing the residual amount of PLA left in the prime PET flake stream at a level where the residual PLA does not negatively impact the quality or salability of the rPET product.

2. **There are a lot of different types of technologies out there to sort different types of plastic materials. Your tests only looked at near-infrared (NIR), and not all recyclers use that technology.**

   Recyclers use several different processes to clean-up a wide range of incoming feed streams for a variety of end markets. Due to the diversity of processes out there, many of which recyclers consider proprietary, it is impossible to simulate all potential recycling operations. With it's simplicity of use and ability to sort a wide range of plastic types, near-infrared (NIR) sorting technologies are growing in use in the large-volume commercial recycling operations that are sorting high quantities of PET, including the newest, modern recycling facilities. Although this test was done at a commercial recycling facility that uses TiTech NIR technology, NatureWorks LLC or equipment manufacturers have also done testing on Pellenc, MSS, and Satake and NRT NIR sorting systems, as well as Unisensor laser systems. All have proven to give high sorting efficiencies compared with other known plastic contaminants. In fact, in a study of the predominant UK recycling technology, Waste Resources Action Programme (WRAP), a government sponsored waste reduction organization studying the UK market concluded that "NIR (near-infrared) sorting systems can be used to effectively remove PLA bioplastics and carton board from a mixed packaging stream."

3. **Some PET recyclers use a Vinyl Cycle detection system from National Recovery Technologies Inc. of Nashville, Tenn. How would this system handle PLA bottles?**

   National Recovery Technologies Vinyl Cycle detection system for PVC separation is an X-ray sorting system used to remove PVC from the plastics stream. While such systems are highly effective at removing PVC from mixed plastics streams, they are not designed to remove any of the other non-PVC contaminants typically present in an incoming plastics stream. Typical recycle streams will contain PET (various multi-layer, additive-modified and colored varieties), PETG, HDPE, LDPE, LLDPE, PP, PS, PC and PVC contaminants in quantities as high as 4-10% in total. Metals and other wastes in the stream push the total contamination as high as 15-20%. X-ray systems are often used in conjunction with NIR systems, as the X-ray systems do not have the ability to segregate any of these contaminating plastics other than the chlorine-containing PVC.

4. **What about smaller recyclers that don't have the capital to invest in this near-infrared sorting technology?**

   Primo Water has developed technology where they injected a dye into their bottle that fluoresces when exposed to a low wattage black light. This is a very low cost alternative that would allow the Primo bottle to be easily hand-sorted in non-NIR facilities. This sorting process was also proven in on-site testing at Reterra Plastics in Houston, TX earlier this year.

5. **Plaque samples were only measured across three different thicknesses. How can you be sure that thicker articles made from this r-PET with ~500 ppm PLA contamination would be acceptable?**

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APR Critical Guidance for PET recycling stipulates that plaques be tested at one thickness, 3 mm with 0%, 25% and 50% of the test material. Since this was thicker than the actual recycled article that this recycler was making from the recovered PET containing sheet, it was decided to add two additional thicknesses in the plaque evaluation step to ensure there was not a thickness-related haze issue. Furthermore, this plaque work added a 100% test material sample. The fact that the 100% test material 3 mm plaques were indistinguishable in haze when compared with the r-PET control (no PLA spiking) suggests, that at this level of contamination in the end article there is not a haze concern**.**

6. **How does using PLA bottles without caps or labels and only using bales collected from deposit programs simulate real-life conditions, as real-life baled material contains caps, labels and other plastics such as PVC?**

   It was agreed by the consultant and the recycler that using Primo bottles without caps and labels would not make a difference in the ability of the NIR sorter to detect PLA and therefore, interrupt one way or another the sorting process.

   According to NAPCOR, the National Association for PET Container Resources' *Post Consumer Plastics Market Update*, the level of, "deposit volumes (is) increasing," while the level of "curbside volumes (is) decreasing." Deposit materials are typically used in higher-valued end markets for recycling, while more contaminated curbside materials tend to be exported at a higher rate due to less stringent bale specifications and requirements by Chinese bale purchasers. Although this test used deposit material, the recycler claimed levels of other plastic contamination as high as 4-10% have been typical in recent times.

7. **You achieved a 93% sorting accuracy level. There are some recyclers who feel a 95% or better accuracy level is needed. Is 93% a good sorting rate?**

   Just to be clear, 93% of the PLA that was present in the stream was removed from the prime-valued clear PET stream. This compares favorably with the TiTech claim of **up to** 95% efficiency of removal. This PLA removal efficiency should not be confused with a **bale yield**. The resulting clear PET stream contained just 453 parts per million PLA, or 99.95% PET and plastics other than PLA. This compares very favorably with TiTech's claim of **up to** 98% purity. Although this is just one manufacturer's NIR sorting equipment, the technology is increasingly used for efficiencies and purities greater than 90%. This value of 93% removal efficiency is very consistent for NIR technology being used today to purify PET streams and separate out plastics.

8. **Did you test whether PLA that made it through the sorting equipment ended up being removed in the drying process? Some recyclers say some non PET plastics can "goop" up" the dryer or desiccant fan.**

   Ingeo bioplastic is not volatile at the temperatures used to dry PET (160^{o}C/320^{o}F, according to APR's critical guidance documents for PET recycling). No problems were noted in drying the PLA-contaminated PET flake during this real-life recycling test.

   In fact, recent efforts by a cross-functional consortium of APR members including brandowners, equipment suppliers and various other industry professionals, has recently investigated the source of materials collecting in dryer desiccant beds and found that the source was largely due to a build-up of lubricant coming out of the PET or additives, rather than other polymers.

9. **Can you explain how the level of 0.68% PLA spike in the PET stream was determined?**

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The 0.68% was achieved by adding in a calculated number of Primo bottles matched to the measured rate (lb/hr or kg/hr) of PET deposit bale throughput on the sorting line. It is important to note that relative to the North American water market, only Nestle, Coca-Cola and Pepsi water brands are present in the market at levels higher than this relative to the total amount of PET bottles available for recycling. It's also important to keep in mind that bottled water only makes up less than 30% of the liquid refreshment beverage market in the US (in millions of gallons). The majority of the PET bottles going down any recycling line are carbonated soft drinks (nearly 50%).

10. **As a recycler, why would we want to see another non-PET material included in our incoming streams? Even if successfully sorted, it still represents a yield loss unless there is an end-use market for recovered PLA bottles.**

    This test shows that through the use of NIR technology, it is possible to avoid significant contamination of the PET stream, including PLA, such that the rPET recovered can still be used and sold at the same value.

    NatureWorks LLC has in place a bottle buy-back program and separating out the Ingeo bottles is the first step towards recovering them. There are also several companies now looking to purchase collected PLA for chemical recycling to recover the feedstock. Owing to the fact that it is based on one simple naturally-occurring monomer, lactic acid, feedstock recovery of that lactic acid is a viable end-of-life option for recovering the value in Ingeo bottles. PET, on the other hand, is typically produced from both ethylene glycol and terephthalic acid, making recovery of its feedstocks much more difficult and costly.

11. **Wouldn't it be better for us to just avoid the contamination and try to focus efforts on increasing PET recovery rates through programs that incent PET recycling?**

    It is NatureWorks LLC's vision that all Ingeo bottles be recovered for value in the long term, and we regard today's US recycling rate for plastic beverage bottles of 24.6%, less than 1 in every 4 bottles available, as unacceptable. It is clear we need to make a major change in how products are recycled in order to make a significant step to overcome the low recovery rates present with PET. As with other non-PET plastics starting to be recovered from the recycle stream, the value of recovered PLA is growing.

    We support all efforts to increase recovery rates. However, no single plastic type can be used for all applications. Although most attention is given to the fate of the bottle after its use, it's critical to realize that regardless of what happens after its use, production of the PET in a PET bottle contributes 3.4[1] lbs of CO2 to the atmosphere per lb of PET. By contrast, with Ingeo, we are addressing this high carbon footprint burden directly, by using annually renewable feedstocks that effectively remove CO2 from the atmosphere as they are grown. This results in just 1.3 lbs of CO2 for each lb of Ingeo produced in 2009.[2]

    These 'front end benefits' of using Ingeo are in place today, with each lb of Ingeo offering ~ 60 % lower greenhouse gas emissions and ~ 50 % lower non-renewable energy use than bottle grade PET. With the sortation developments we've summarized here, we are working to only further improve the Ingeo eco-credentials with improved collection after use.

    Although NatureWorks LLC favors utilizing the best end-of-life option available, including recycling, it is important to note that from the standpoint of greenhouse gas emissions and non-renewable energy use, today's virgin Ingeo has been shown to outperform even 100% rPET, in clamshell containers.

[1] Plastics Europe Assessment
[2] NatureWorks LLC updated EcoProfile for 2009

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See www.natureworksllc.com for more information on the rPET clamshell comparison life cycle assessment.

12. Won't PLA bottles entering the PET bottle recycling stream mean significant logistical burdens or costs to existing recyclers?

Recyclers are already today dealing with a wide range of plastics in the recycling stream. In fact, APR and NAPCOR have participated along with NatureWorks LLC in a project within APR to attempt to recover all rigid plastic containers beyond just PET and HDPE bottles. Reality today is that within many existing curbside programs, all bottles numbers 1 - 7 are encouraged to be collected. APR has even promoted this type of approach as it has been shown to increase overall collection, including PET bottles. PET recyclers and reclaimers are already dealing with contamination from other plastics in the range of 4% - 10% in total. Keeping PLA out of the PET stream will initially be very similar to keeping some of these other plastics out of the stream. Additional costs associated with segregation of the PLA bottles for recycling will be justified as end-markets develop to consume the recovered resource.

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