The Impact of Recycled PET Content on PET Hot-Fill Containers

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Objective

Brand owners continue to challenge themselves to bring their products to market in packaging that not only delivers the desired performance requirements, but also minimizes the carbon footprint. With regard to polyethylene terephthalate (PET) packaging, a viable option that many have considered is including a percentage of recycled PET (rPET) content to minimize dependence on virgin materials.

Other than obvious economic considerations, it is critical to understand how rPET can potentially impact performance and appearance. While this exercise has played out a significant number of times in consumer product goods, water, and carbonated beverage applications, it has happened much less so with hot-fill food and beverage containers.

With the industry knowledge and experience being limited in this area—and these containers subjected to additional rigors during the filling process—PTI wanted to help provide brand owners with additional knowledge to facilitate the decision making processes. What follows are the findings of PTI's research project to determine the commercially viability of including a high percentage of rPET in hot-fill containers.

Executive Summary

The use of rPET in hot-fill packages has no significant adverse impact on the bottle performance until the blend exceeds 50%. Even at 100% rPET resin use, the performance of the package used in this study was still acceptable. Haze and yellowing were the main impacts of higher rPET levels. This is similar to what has been experienced with containers that are not hot filled. However, the typically-thicker walls of hot-fill bottles may result in slightly more noticeable haze or yellowing than other applications such as very thin-walled water bottles.

Therefore, we conclude that converters and brand owners can use up to 50% good quality rPET in hot-fill bottles without performance being negatively impacted. rPET levels greater than 50% can also be used, however desired package aesthetics will drive the acceptable level.

Research Overview

As the availability of high quality rPET resin increases, it is important for food and beverage processors to understand how the amount of recycle content in their package affects its performance capabilities.

This study was focused on evaluating virgin PET and two different rPET resins added to virgin PET at 25%, 50% and 100% levels. A 27g commercial 500mL six-panel hot-fill bottle and preform were used for the study. Bottles containing recycled-content variables were processed similarly to maintain equivalent bottle wall thicknesses and maximize preform temperatures. The objective was to ensure that the only difference was the amount of recycled content.

The bottles were then tested to determine hot-fill and top load performance, wall thickness, color, haze, crystallinity and acetaldehyde (AA) content. Following are the main study conclusions:

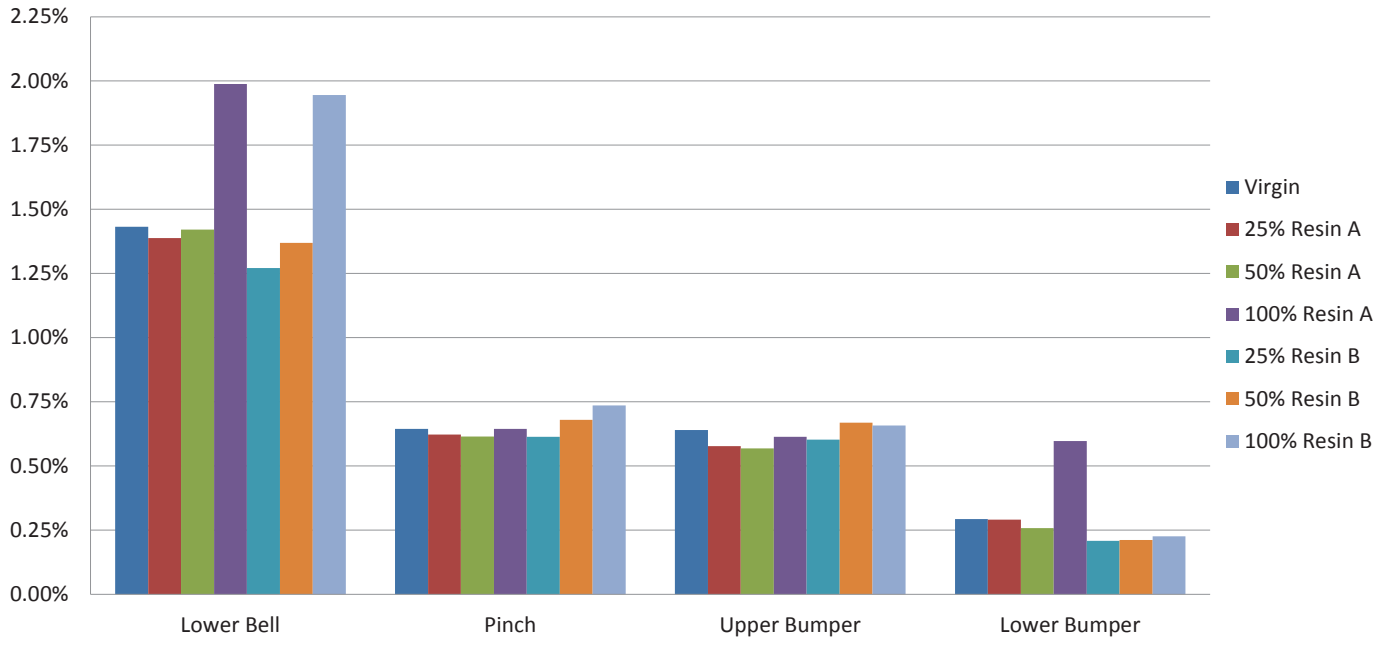
- All samples passed the standard performance specifications for hot fill bottles, even at high percentages of rPET.
- Shrinkage increased slightly as the recycled content grew above 50%, but the bottles remained within the specification.
- The top load performance slightly increased for one of the rPET variables as the recycled content increased. However, the performance increase can be correlated to wall thickness differences, more than the rPET content.
- The drawbacks of high rPET content are increased yellowing and higher haze levels. However, these are aesthetic issues and do not impact performance.
- The table on the following page summarizes the results of the key performance tests.

	Spec	Virgin	25% rPET A	50% rPET A	100% rPET A
Min Peak Top Load (lbf)	≥ 44	86	87	86	91
Max Ovality (mm)	≤ 3	0.53	0.42	0.3	0.93
Max Diameter Shrinkage (%)	≤ 2%	-1.43%	-1.39%	-1.42%	-1.99%
Max Volume Shrinkage (%)	≤ 2%	-0.91%	-0.87%	-0.90%	-1.55%

Hot-Fill Testing

Hot-fill testing is indicative of how the bottles will perform under commercial hot-filling conditions. As the hot product cools inside the enclosed containers, a vacuum forms, increasing the chance for ovality or bottle denting to occur. The heat of the product also causes the PET to shrink through relaxation of the stresses created during the blow molding process. Ovality and shrinkage were measured in order to ensure that they met standard performance specifications.

The results show that the virgin, 25% and 50% for both recycle resins performed similarly. At 100% recycle, the bottles experienced increased shrinkage at the bell that was almost outside of the specification. The 100% rPET A resin also had increased shrinkage at the lower bumper, which was due to the decreased thickness in that area compared to the other variables, but the results were still well within performance requirements.



Color and Haze

Yellowing (b*) and haze both increase as the recycled content increased. Bottles made from rPET A yellowed more than rPET B as the rPET level increased. Bottles made from rPET B had higher haze on average as the percentages increased than rPET A. The yellowing and haze are both aesthetic factors, and the acceptable levels will be dependent upon the bottle manufacturer, or brand owner.

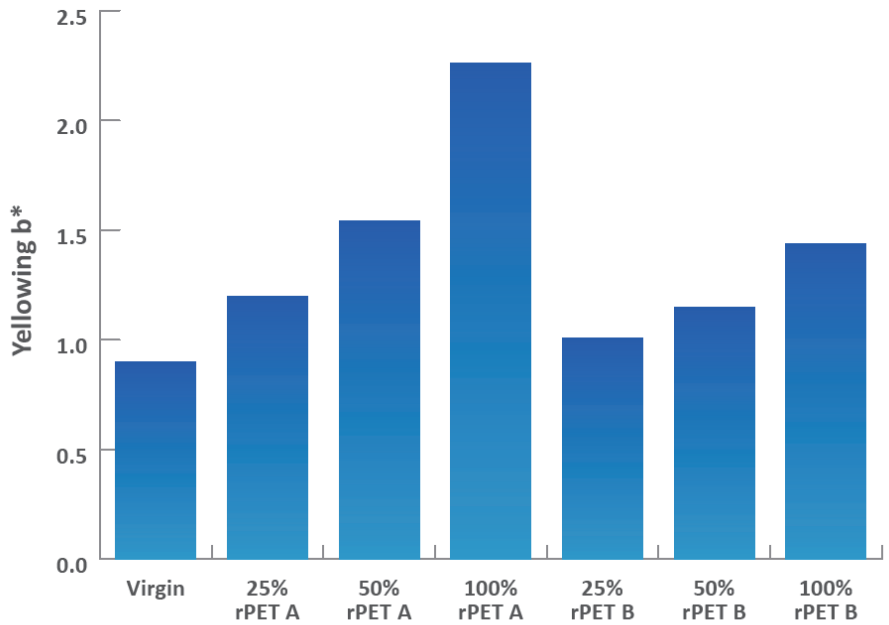


Figure 2: % RPET vs. b*

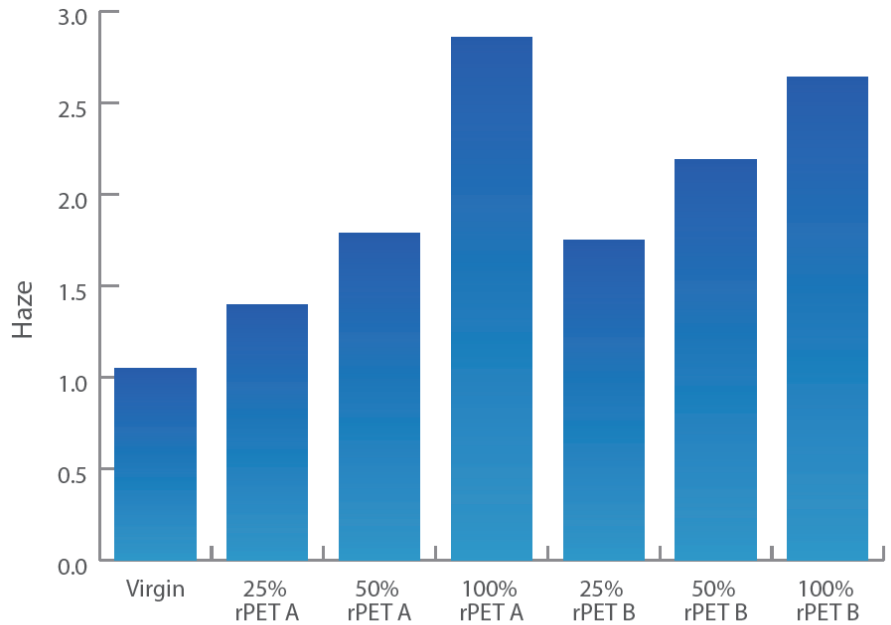


Figure 3: % RPET vs. Haze

Conclusion

Companies using hot-fill bottles that are looking to improve their environmental profile can confidently use up to 50% rPET content in their PET bottles without negatively impacting performance. The aesthetics of the package will dictate the level of rPET acceptable for a particular application. For additional information on the research study (expanded findings, data, etc.) please contact +1-419-867-5400.

About PTI

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