

TECHNICAL BULLETIN

ColorMatrix™ Amosorb™ SolO$_2$: a recyclable solution

Recyclability has become a fundamental requirement for convertors and brand owners. Pressure from the media, the scientific community, end-consumers, and legislation is pushing members of the polymer industry value chain to play their part, in proposing alternative sustainable solutions that can perform in terms of recyclability.

The food and beverage market has taken on many challenges within this capacity, with the aim of conciliating a need for preserving the integrity and nutritional characteristics in packaged goods throughout their required shelf life, and at the same time allowing full circularity of the packaging used to distribute such goods into the market.

The European Union has encouraged and acted on the need for circular packaging by implementing many initiatives, including mandating legislation in order to achieve an ambitious target of 25% rPET being utilized in PET packaging by the year 2025, and then scaling this figure up to 30% for the overall plastic packaging industry by 2030.[1]

With 47% of PET demand in Europe used to produce bottles,[2] it is no surprise PET has long been at the center of this green revolution. Scenarios for 2030 predict that of the 1300kt of PET material coming from PET bottles collected from the market yearly, between 20 to 30% will be colored bottles;[2] these will enter their respective sorting and collection systems to ultimately produce rPET material that will be fed as new raw material for non-food PET applications. Providing solutions that are considered recyclable within the colored bottle stream will thus be an integral part of the recyclability strategy for both convertors and brand owners.

[1] How to keep a sustainable PET recycling industry in Europe - EPBP - European PET Bottle Platform
[2] How circular is PET? - Zero Waste Europe

AVIENT™

Avient is committed to playing its part in this recyclability journey and helping achieve such ambitious targets by providing solutions that will allow the market to fully achieve these goals.

Active and passive oxygen barriers are additives that are broadly used in the PET bottle industry, across the value chain; they guarantee the optimal shelf life of packaged goods such as beer, juices, RTD beverages, or condiments, to name a few. The ColorMatrix™ Amosorb™ product line currently offers a wide range of masterbatch grades that can be used to address the needs of different beverages or foods in terms of protection from oxygen ingress. Amosorb SolO_2 in particular is often utilized for products requiring long-term shelf-life protection from oxygen ingress and/or CO_2 egress.

Avient undertook a recyclability study to show how bottles containing 0.09% Fortis Amber-1 and 4% Amosorb SolO_2-2 achieve optimal results when going through two full loops of recycling.

RECYCLABILITY METHOD-1

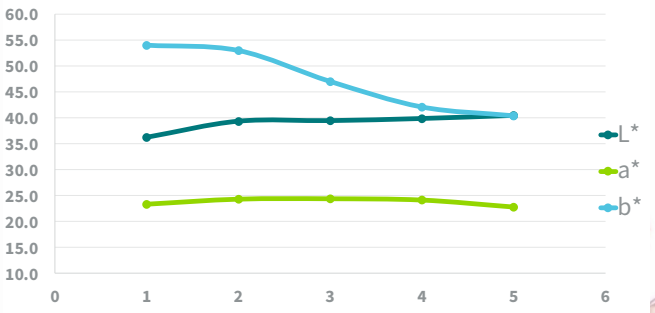
- Preforms were produced by dosing 0.09% of Avient Fortis Amber-1 and 4% of our nylon-based oxygen scavenger Amosorb SolO_2-2
- Preforms were ground down to a coarse granule size (~2mm) using a Retsch mill.
- The coarse ground material was then crystallized in a vacuum oven at 160°C before drying the material at 160°C for approx. 4 hours within a PET drier
- Plaques were then molded on a BOY XS and 10 of these were kept after each cycle, to take color measurements
- This process was then repeated until 5 heat cycles had been completed

RESULTS FOR RECYCLABILITY METHOD-1

As plaques were produced while the material went through five different melt heat histories, plaques were produced at each cycle and L*, a*, and b* values were measured. The table and graph below summarize the values of the plaques recorded for L*, a*, and b*, throughout the different 5-melt histories.

	L*	a*	b*
1st Mould*	36.3	23.4	54.0
2nd Mould	39.3	24.3	53.0
3rd Mould	39.4	24.4	47.0
4th Mould	39.8	24.2	42.1
5th Mould	40.4	22.8	40.4

MELT HISTORIES



For each melt history, a picture of the respective plaques was also taken and is reported in the figure below. Note that the bottles produced in the first melt history were used to replicate the thickness of a plaque. To do so, three pieces of bottle walls were stacked for this measurement and referred to as first melt history.

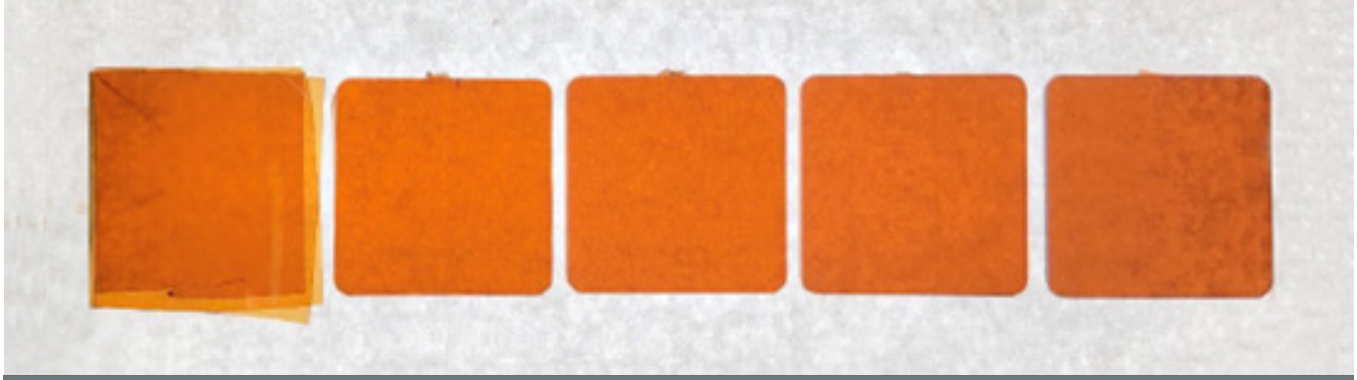


Figure 1. Picture of plaques originally made from preforms containing Fortis Amber-1 and Amosorb Solo$_2$-2. Five consecutive melt histories (left to right) are pictured. For fair comparison and to simulate the thickness of plaques with the original bottles (first sample on the left as first melt history) three equivalent pieces of cut-out bottles were stacked together.

It appears from both the picture of the plaques as well as the L*, a*, and b* values recorded, that the presence of 4% Amosorb SolO$_2$-2 in combination with Avient Fortis Amber-1 at 0.09%, does not cause a significant change in the appearance of the plaques. Δb values show a progressive decrease in yellowness while a* value does not show significant changes and L* increases of about 11% with respect to the original 1st melt history value that was measured.

REGRIND COMBINATION STUDY - METHODOLOGY

A second test was also carried out, which aimed to demonstrate how recycled material can be combined with vPET to produce bottles that are very similar to bottles produced with 100% virgin resin.

To do so the following procedure was carried out:

- Preforms were produced by dosing 0.09% of Avient Fortis Amber-1 and 4% of our nylon-based oxygen scavenger Amosorb SolO$_2$-2
- Preforms were ground down to a coarse granule size (~2mm) using a Retsch mill
- The coarse ground preforms were crystallized in a vacuum oven at 160°C before drying the material in a PET drier at 160°C for approx. 4 hours
- This material was then injection molded and blown into bottles with a) 50:50 dilution with Virgin PET with no color and b) 50:50 dilution with Virgin PET + Fortis Amber-1 at 0.045%

Figure 2. Key: A = 4% Amosorb SolO2-2 + Fortis Amber-1 @ 0.09%; B = 50% Regrind A + 50% Virgin PET; C = 50% Regrind A + 50% Virgin PET + Fortis Amber @ 0.045%

RESULTS FOR RE-GRIND COMBINATION STUDY

Bottle A is the original bottle with 100% virgin material and a combination of Amosorb $SolO_2$-2 at 4% with Fortis Amber-1 at 0.09% LDR.

Bottle B was produced utilizing 50% flakes of the original bottles, which were crystallized and dried before being diluted with 50% virgin PET to inject new preforms and blow bottles. A visual inspection of the bottles shows that bottle B still has a very recognizable amber tone.

It was also demonstrated that usage of a reduced amount of color, namely 0,045% of Fortis Amber-1, allows the production of bottles (Bottle C) that closely resembles the original bottles (Bottle A).

The L*, a*, and b* values recorded in the table below are also well in accordance with what can be visualized in Figure 2, where there is a shift in the b* value indicating a decrease in yellow tone. This explains the visual appearance of the plaques having a redder tone.

BOTTLE COMPOSITION	L*	a*	b*
95.91% Virgin PET/0.09% Fortis Amber-1/4% $SolO_2$-2	76.9	3.6	39.5
50% Regrind/50% Virgin PET	83.5	2.8	19.5
50% Regrind/50% Virgin PET/0.045% Fortis Amber-1	75.6	5.5	34.5

CONCLUSIONS

Our study has shown that the combined use of Amosorb $SolO_2$-2 and Fortis-Amber 1 in bottle applications allows for the material to be recycled through multiple recycle loops. After having the flakes coming from the original bottles go through up to 5 melt histories, it was shown that the L*, a* and b* values underwent minimal changes, thus allowing for retention of the original desired tone of the bottles.

The regrind combination study also showed how retention of original standard amber tone could be closely maintained with very minimal addition of Fortis-Amber 1, even after a dilution with 50% vPET of material coming from original packaging articles, with or without the further addition of $SolO_2$-2. This could represent an opportunity for the value chain looking into introducing bottles-to-bottles back to their original standard.

1.844.4AVIENT
www.avient.com