



The Impact of Repeated PET Melt Cycles on Color

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One of the primary issues that recyclers face today is the challenge to produce high-quality recycled polyethylene terephthalate (rPET) with low b^* (yellow) values. This study wanted to example the effect that repeated melting of PET resins has on color.

Executive Summary

The trend seen shows (with some sample variability) that the yellowness, measured by b^* , increases with each melt history. The other color attributes such as L^* and a^* are not nearly as affected by repeated melting. The haze level of rPET materials is also a critical attribute but as the data in this report shows, the haze levels of these resins are not appreciably affected by repeated melting.

Lastly, one of the resins included in this study was dried using two different methods; one being the traditional desiccated hot air drying and the other vacuum drying. The exclusion of oxygen clearly showed a positive benefit in keeping the b^* from increasing with repeated melting. Vacuum dryers are now available for high productivity PET injection systems and might be a method reclaimers should consider to improve upon their recycling process.

Project Description

Eight virgin resins were chosen to be part of this study. They were extruded multiple times and plaques were made in order to see the changes in color, primarily in the b^* and haze values. The b^* values and haze are the two values most monitored in the recycle industry as problem areas in the bottle-to-bottle recycle stream.

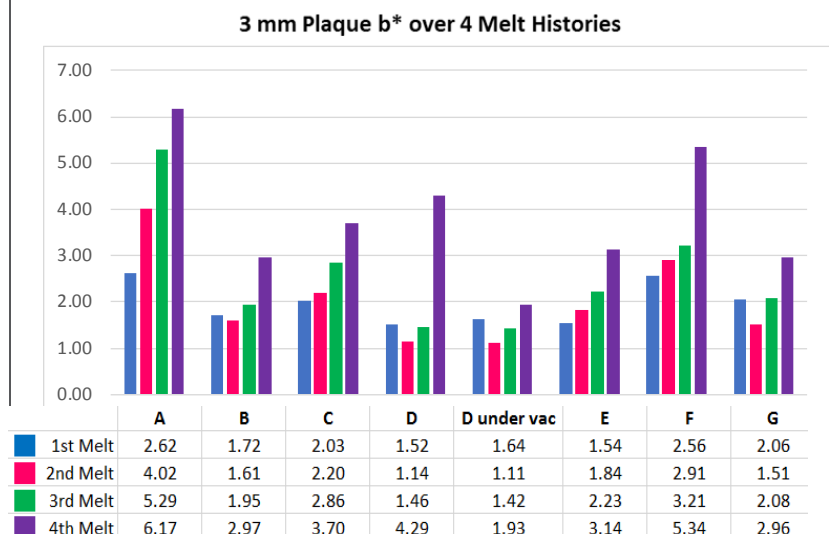
One of the same resins studied was dried under different drying conditions and added to the study for comparison. The resins were molded into plaques after each melt for a total of four melt heat histories.

RESIN SAMPLE	RESIN IV (DL/G)	M.P. (°C)
A	0.84	248
B	0.82	252
C	0.75	244
D	0.83	252
D (dried under vacuum)	0.83	252
E	0.74	248
F	0.84	242
G	0.83	238

Below are the color and haze results from the molded plaques arranged by the tested condition. This shows the progression of change in the resin quality under each color and haze component. The virgin samples for the first heat were molded on a different injection molding machine than those molded for heat histories two through four. The color results vary as some worsen and others seem to improve. This may be due to the molding conditions of the different injection machines or the variation in the process.

Color/Haze Results Summary

Fifty plaques were molded for each variable and six plaques were randomly chosen for color/haze testing (Note: L^* value indicates lightness where 100 is lightest; b^* value indicates yellowness with higher values being more yellow; a^* value indicates red to green with higher values being more red). Below are the results of the color measurements.



In most cases, each melt history has a negative effect on the b^* values of the melted resins and varies with each manufacturer. Typically, the L^* , a^* and % of Haze are much less affected.

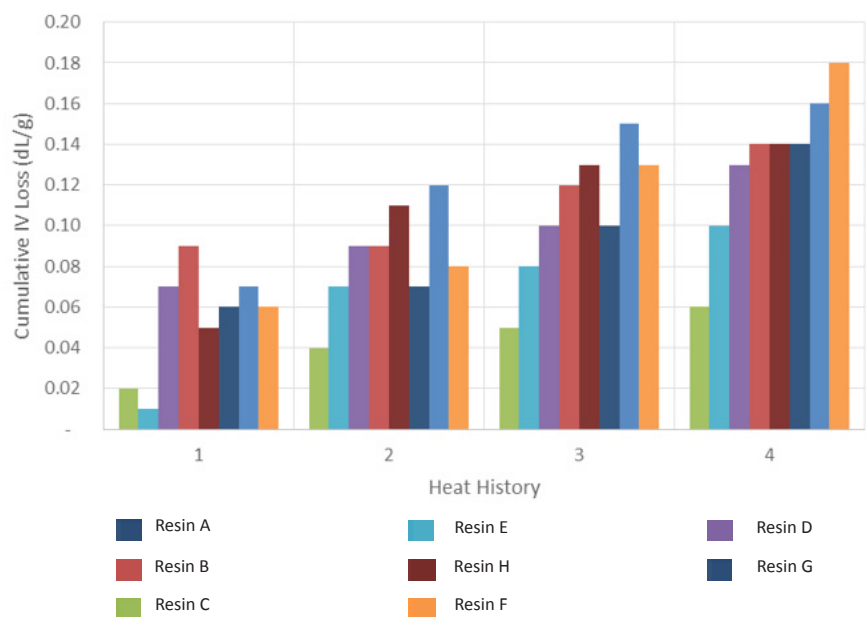
The largest change in b^* values was observed in Resin A with a b^* increasing to over six. The worst in haze value is the Resin D dried under normal conditions with a very high level of haze, over 26%. However, it should be noted that this very high and unusual level of haze was probably caused by a contaminant introduced during grinding or extrusion.

Typical haze levels for the remaining resins were under 10. A second set of Resin D was dried under vacuum before molding to see if there would be an improvement in color. There was an improvement in b^* and haze values after the fourth melt heat history when comparing it to the resin being dried in a desiccant dryer. This may warrant further studies using all types of resins dried under vacuum.

According to the Association of Post Consumer Recyclers (APR), desired L^* values after three melt heat histories should be greater than 82 and desired b^* values should be less than 3 after three melt histories. The desired APR haze levels below 9.5% should not be a problem based on this study. The graphs below show the combined b^* and haze values after four melt heat histories from each resin.

IV Results

To the right you will find the solution IV (dL/g) results for the molded plaques at each melt phase. The IV drop is a little less each time as expected, due to the degradation of the material through melt processing. The vacuum drying does not appear to influence the IV drop of Resin D.



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