



Cracking the Code on Thermoforms



All Thanks to our Project Partners



FOODSERVICE PACKAGING
INSTITUTE®



The Association of
Plastic Recyclers





Project Overview

Variables one, two and three were sourced from a MRF in California. All variables were processed at Indorama.

Incoming flake was spiked with various percentages of thermoforms:

- Control: 0%
- Test 1: 15%
- Test 2: 25%
- Test 3: 40%

PFE performed flake, pellet, plaque and various end market application testing.

Based on the flake analysis, pellet data and the end market applications, PFE did not observe a significant impact on the result due to the thermoform presence. Although there is an obvious reduction in thermoform presence from the initial flake to the accepted material.



Tests Performed by PFE

- Flake Testing
 - QC
 - Visual Percentage of Thermoforms
 - Pre-Bake Visual
 - Post Bake Visual
 - Particle Distribution
 - Solution IV
 - Bottle Flake
 - Thermoform Flake
 - Bulk Density
 - Clumping
- Pellet Testing
 - Melt IV
 - Solution IV
 - Solid Stating
 - Colors
- Plaques
 - Colors
 - Haze
- End Market Applications
 - Preforms
 - AA
 - SIV
 - Black specs and inclusions
 - Bottles
 - DSC
 - Black specs and inclusions
 - Colors
 - Dimensions and Weights
 - Capacity
 - Burst Strength
 - Top Load
 - Drop Impact
 - Sheets and Thermoforms
 - Impact
 - SIV
 - Fiber
 - Florescence
 - Tensile
 - Strapping



Incoming Flake Processing

- Incoming flake was sorted and either accepted or rejected by a mechanical recycler.
- PFE received accepted flake and rejected flake for testing.

Accepted Flake



Rejected Flake

Polymer



Color



Dry Fines

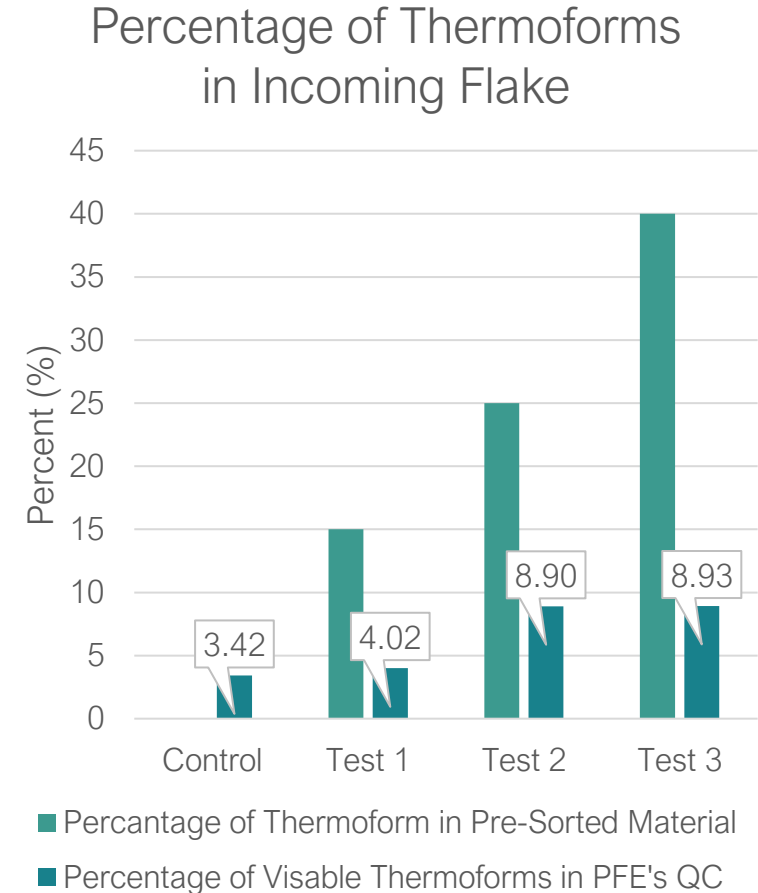


Metal



Accepted Flake: Percent Thermoforms






- PFE performed a visual QC to determine the amount of thermoforms present in the accepted flake after mechanical sortation.
- The control and test one seem to have comparable amounts of thermoforms.
- There is a clear increase from control to tests two and three.
- Test three was anticipated to have a higher percentage of thermoforms; however, due to yield loss at the reclaimer, the lower value is not surprising.




Accepted Flake: Color QC and Baked Color QC

- Manual QC was performed on accepted material. Post QC'd material was then baked and further QC'd.
- Minimal to no variation of contamination on pre-baked QC'd flake or post-baked QC'd flake was observed.
- PVC was expected to be increasingly evident, but this was not observed.
- Post-baked QC'd material indicates a possible, non-linear, trend between color and percentage of thermoforms.

Pre-Bake QC

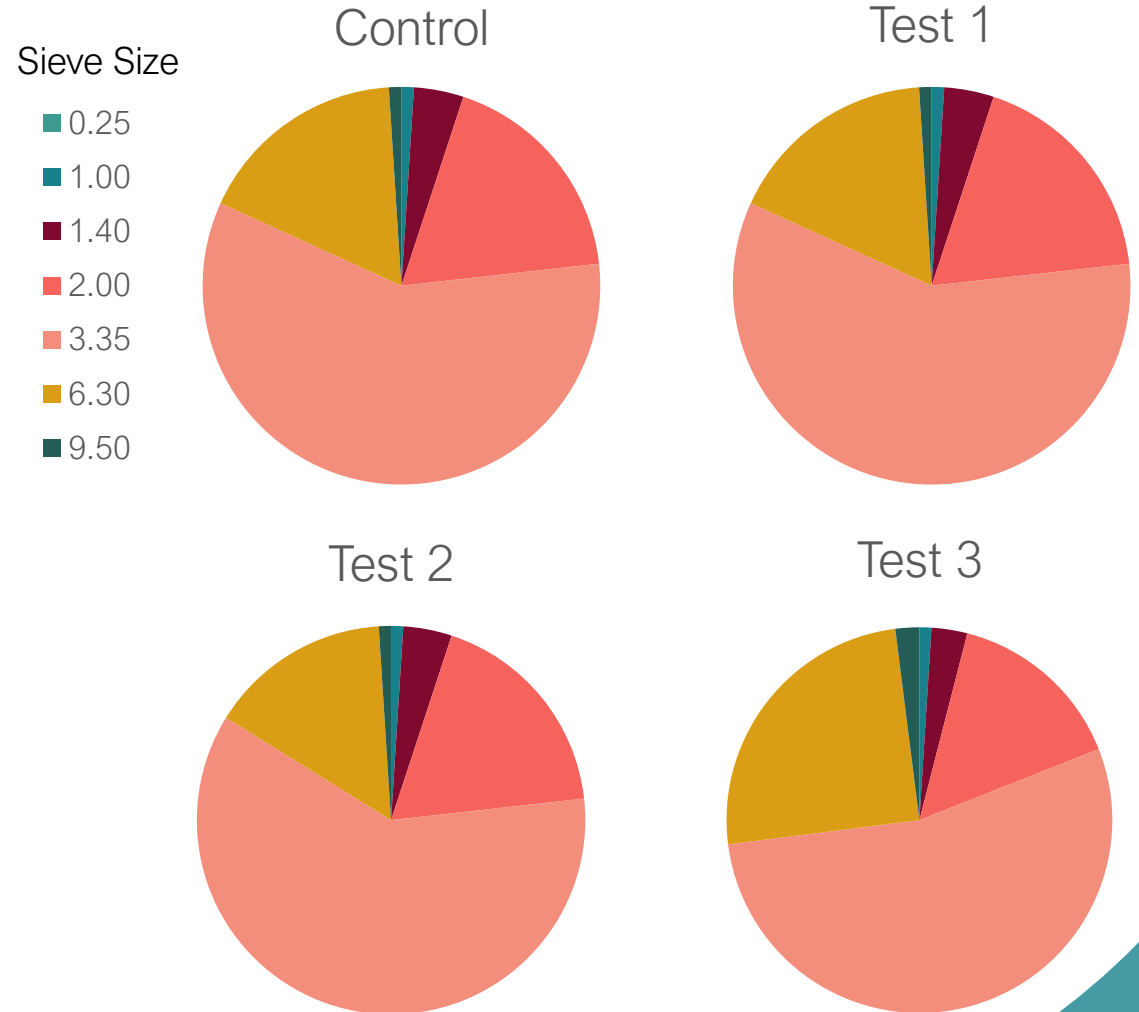
Accepts			
			
Blue	Green	Amber	Black
			NOT APPLICABLE
Other	Label	Metal	
NOT APPLICABLE		NOT APPLICABLE	

Post-Bake QC

Baked Accepts			
			
PVC	Multi-Layer	Light Yellow	Dark Yellow
NOT APPLICABLE	NOT APPLICABLE		
Low Melt with Clumps		PET with Adhesive	Others
			

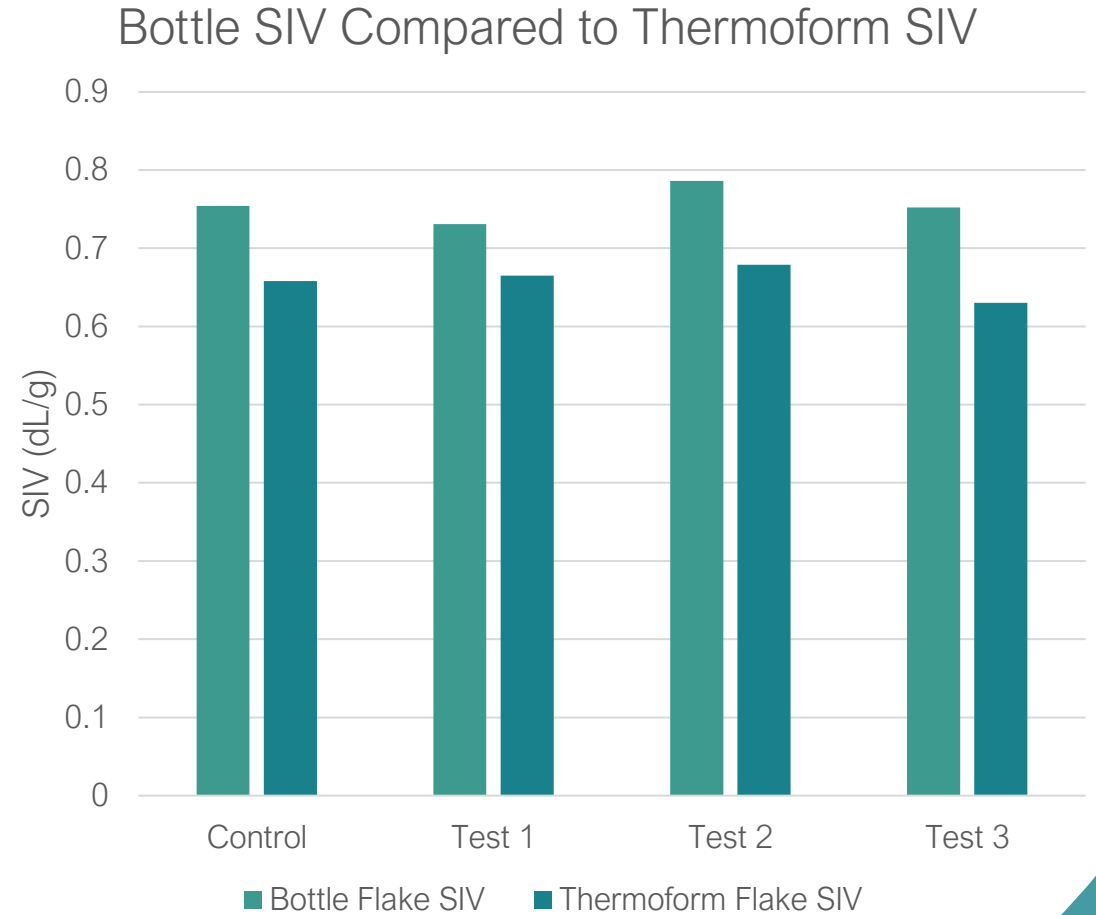
Accepted Flake: Sieve Analysis

- Fines were already accounted for and removed during reclaimer processing.
- Thermoform concentration did not meaningfully impact particle size distribution.
- In addition, low melt concerns were evaluated and did not show trends with increasing thermoform concentrations.



Accepted Flake: Solution IV's

- Previously QC'd material was tested for solution IV's.
- Bottle flake SIV's are higher than the thermoform flake SIV's.
- There was not a significant difference between the SIV's themselves from test to test.



Pellets: IVs

- MIV and SIV results were consistent with each other.
- Between control and test materials, an IV drop was not observed.
- The PCR source seems to have a more meaningful impact on the IV build rates than the concentration of thermoforms, based on the difference between the control and the test.

BSSP

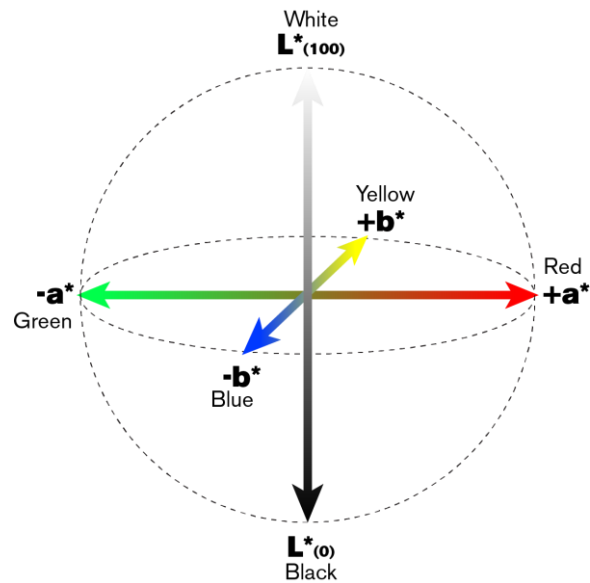


ASSP

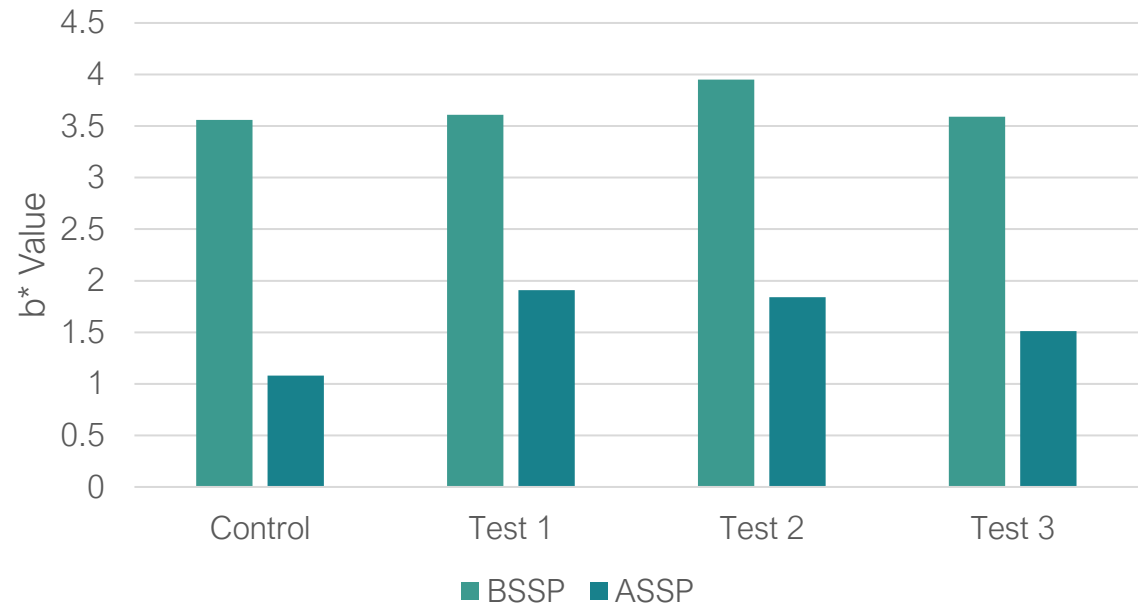


Pellets: Colors Before and After SSP

- The concentration of thermoforms does not show negative impacts on the amorphous and after solid stating colors.



BSSP vs. ASSP b^* Values



End Market Applications

PREFORMS, BOTTLES, SHEETS, THERMOFORMS, FIBER AND
STRAPPING



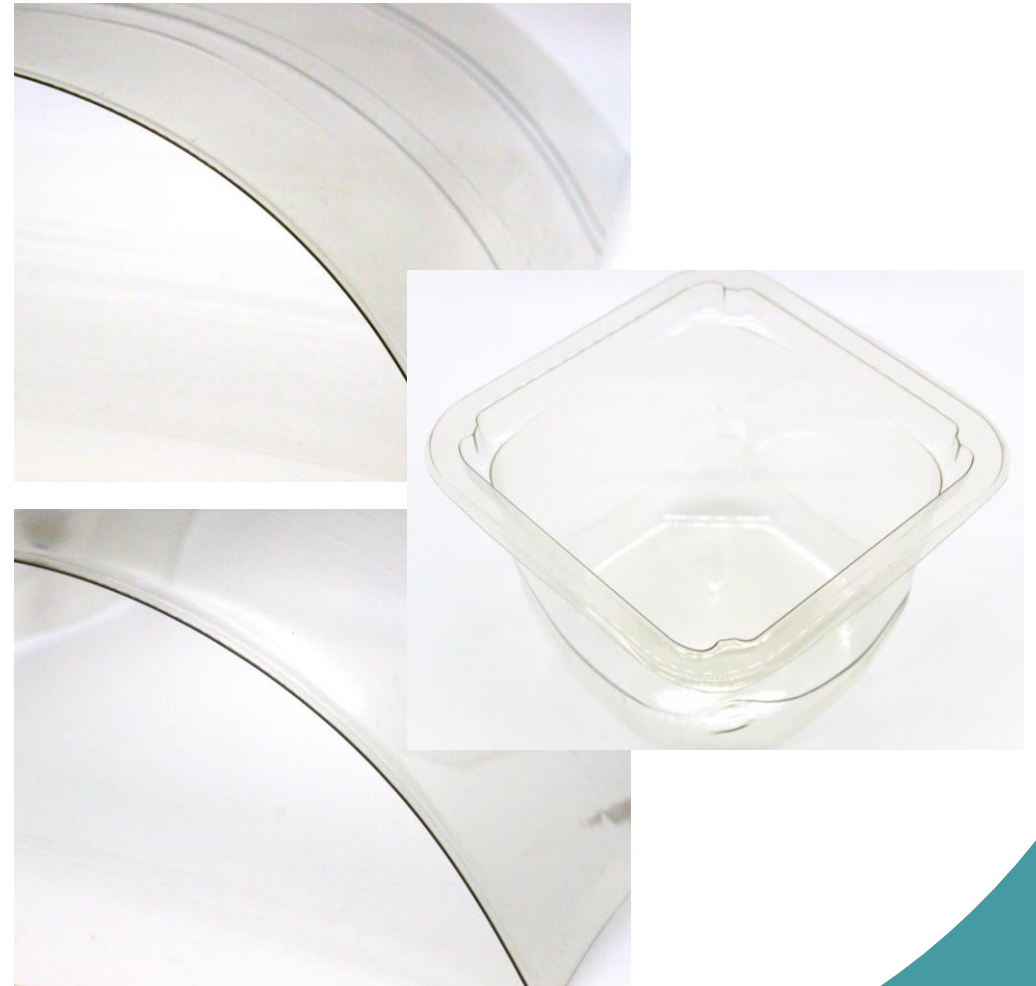
Preforms and Bottles

- AA of the preforms was constant between the control and tests (range of 13-15 ppm).
- Preform SIV's are within the APR guidelines of no more than a 0.025-unit difference between the control pellet and preform IV drop.
- There is no notable variation or trends in the bottle data.
- *Converting partner for preform and bottle production stated no questions or concerns regarding results.*



Sheet and Thermoforms

- Production of sheet shows no variability in processing conditions that could be observed.
- *Converting partner for sheet and thermoform production stated no questions or concerns regarding the results.*



Fiber

- Converting partner performed color analysis of the traditional swatch samples during production and stated that results were insignificant.
- PFE performed further testing on tensile elongation. Results show minimal to no variation.
- Test fiber was not shown to fluoresce more than the control.
- *Converting partner for fiber production stated no questions or concerns regarding results.*



Strapping

- The one measurement to verify strapping per APR protocol is the ability to raise IV at a rate the industry has set.
- All values for all variables, *including the industry accepted control*, do not meet the IV build rate conditions set by the APR.





Thank you!

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