

# Plastics Forming Enterprises LLC



Laboratory Report #2467  
APR PET Benchmark

Applicant:

**Brook and Whittle**

Tyler Matusevich





## **Plastics Forming Enterprises, LLC**

---

### **Plastics Consulting, Research and Engineering**

#### **Objectives:**

- To determine the impact of a shrink sleeve label through a recycling simulation in accordance with the APR's benchmark protocol for clear PET articles with labels and closures.
  - Test sample labels were pre-shrunk before testing and blended in at 6% by weight of the blend. The material was then blended with unlabeled control at a 50/50 ratio to produce a final blend with 3% by weight of label.

#### **Materials:**

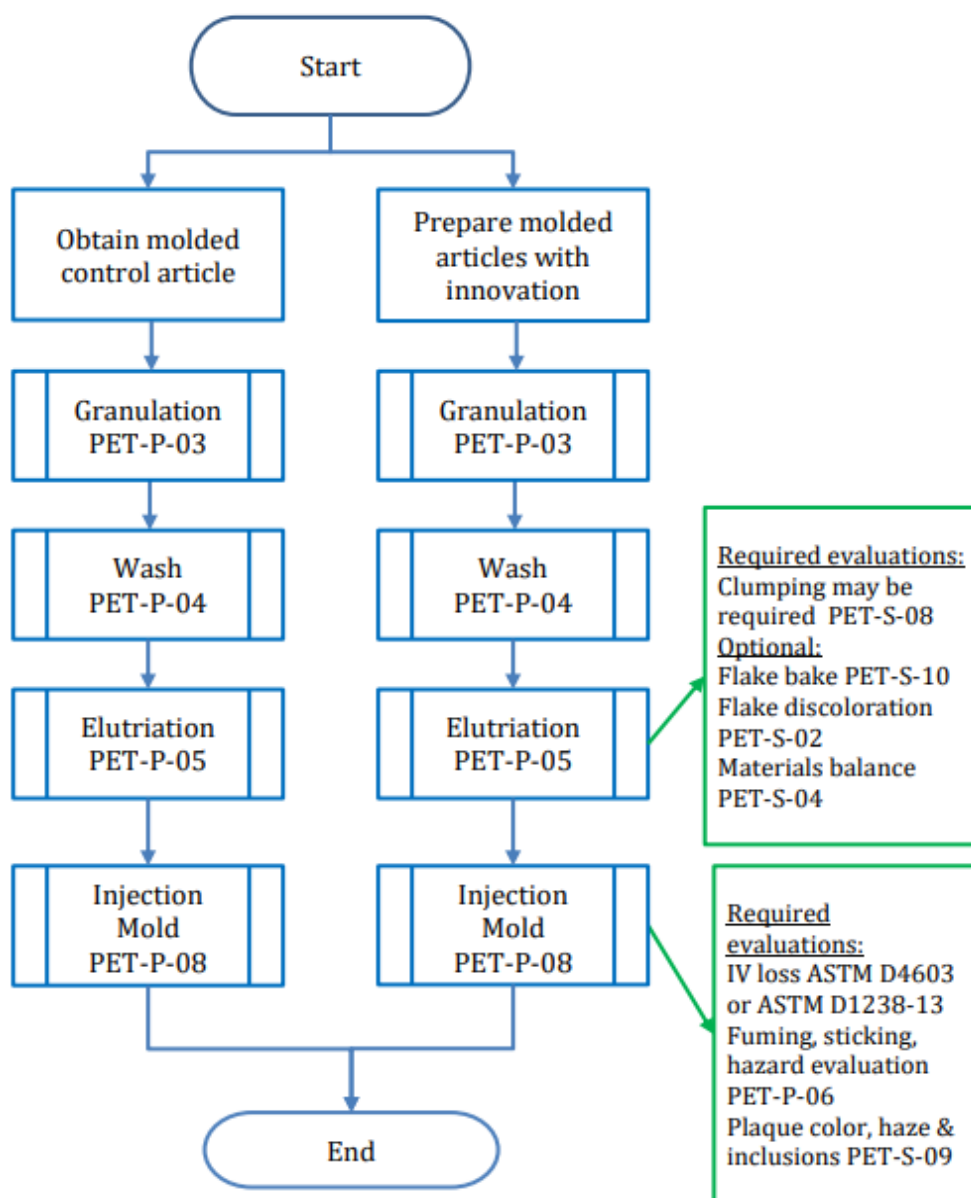
- Control – Indorama 1708 PET Bottles
- Test – 40-micron crystallizable PET with deinking (shrink sleeve)

#### **Equipment:**

- Recycle System
  - Grinder with 3/8" Screen
  - Pilot Wash System
  - Kice Elutriator
  - Desiccant Dryer
  - Arburg Injection Molder
- Test Equipment
  - Moisture Analyzer
  - Water Filtration Setup
  - Melt Indexer
  - Color Spectrophotometer
  - Vacuum Oven
  - Convection Oven



## Benchmark Protocol for Clear PET Articles with Labels and Closures PET-B-02



\*This test protocol flow diagrams include a notice of copyright by APR, and appear on PFE's report with permission from APR. The flow diagram provided is a summary of the protocols for illustration. To view the complete test protocol, visit the APR's website.

## **APR PET Benchmark Summary for Test Material**

| Property                                       | Critical Value                                                                                  | Control | Test         |
|------------------------------------------------|-------------------------------------------------------------------------------------------------|---------|--------------|
| Wash Floatables (%)                            | Record Value                                                                                    | 0.00%   | 0.00%        |
| Label Type                                     | Criteria for Label Type                                                                         | NA      | Ink Filtered |
| Elutriation Lights (%)                         | Record Value                                                                                    | 0.58%   | 1.73%        |
| Clump Testing (%)                              | Less than a 1% weight retention                                                                 | 0.00%   | 0.00%        |
| 1 <sup>st</sup> Heat Processed Flake IV (dL/g) | Record Value                                                                                    | 0.825   | 0.805        |
| 2 <sup>nd</sup> Heat Plaque IV (dL/g)          | IV loss for test less than a 0.025-unit delta when compared to control                          | 0.640   | 0.614        |
| Plaque Colors L*                               | Greater than 82                                                                                 | 92.99   | 83.79        |
| Plaque Colors a*                               | Less than a 1.5 delta to control                                                                | -0.17   | -4.42        |
| Plaque Colors b*                               | Less than a 1.5 delta to control. Control must be below a 4                                     | 1.87    | 2.73         |
| Plaque Colors Haze %                           | Less than a 10% delta to control. Control must be below a 9.5%                                  | 3.59    | 13.11        |
| Black Specks                                   | Control = 0, Test = 2 or less<br>Control = 1, Test = 4 or less<br>Control = 2, Test = 6 or less | 0       | 0            |

## **Conclusions**

1. **This test does not meet all APR guidelines for PET.**
2. Discoloration was observed in the wash water.
3. A side-by-side comparison of the label shows that the label ink only partially removed.
4. Wash water was able to be filtered.
5. No floatables were observed during the wash processing.
6. No irregularities were observed during elutriation.
7. Clump testing did show favorable results, as the tests did not exceed clumping of more than 1% which is the max allowable limit in accordance with APR guidelines.
8. Plaques do not meet the APR guidelines for colors as the delta a\* to control is greater than 1.5.
  - a. The source of this discoloration appears to be due to some ink remaining on the label substrate. When viewing these sections of label with ink retained, it appears that these sections have curled during the wash. Due to this, the ink became trapped and was not able to be released, carrying forward into plaque production.
9. IV loss through processing meets APR guidelines.
10. Plaques meet the APR guidelines for black specks and inclusions analysis.



*Plastics Forming Enterprises, LLC*

*Plastics Consulting, Research and Engineering*

# Flake Processing and Testing

APR Granulation..... 7

APR PET Wash and Sink/Float Evaluation..... 8

Wash/Rinse Pictures ..... 9

Washed Flake/Floatable Pictures..... 10

APR PET Wash Water Evaluation ..... 11

Wash Water Visual Evaluation..... 12

Wash Water Visual Evaluation Pictures..... 13

APR PET Wash Water Filtration Evaluation..... 14

Filter Pictures ..... 15

APR PET Elutriation..... 16

Heavies/Lights Pictures ..... 17

Clumping Evaluation ..... 18

1<sup>st</sup> Heat Processed Flake Colors..... 19

1<sup>st</sup> Heat Processed Flake Melt Indexer..... 20



## APR Granulation

### References:

PET-P-03

### Test Summary:

Granulate incoming articles to the required grind size.

### Procedure:

Articles are then manually fed into a grinder with screen holes ranging from 9.5-12 mm in diameter.

| Variable | Incoming Article                                                                     | Ground Article                                                                        |
|----------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Control  |    |   |
| Test     |  |  |

## **APR PET Wash and Sink/Float Evaluation**

### **References:**

PET-P-04

### **Test Summary:**

Remove any contamination from PET and help in the liberation of labels, adhesives, coatings, and layers.

### **Procedure:**

#### **Wash**

PET flake is added to tap water at a 4:1 ratio of water to flake and heated to  $85\pm 2^{\circ}\text{C}$ . Surfactant, Triton X-100 or McDermid RP24, is added at a 0.3% concentration and caustic, NaOH, is added at a 1% concentration. The flake and water are mixed with an impeller for 15 minutes at least 546 rpm. After 15 minutes, the impeller is stopped, the mixture is removed from the heat source and allowed to sit for five minutes. After five minutes, the wash water, floatables and sinkables are retained.

#### **Rinse**

The sinking fraction of the washed PET flake is added to tap water at a 4:1 ratio of water to flake and heated to  $45\pm 2^{\circ}\text{C}$ . The flake and water are mixed with an impeller for five minutes at least 546 rpm. After five minutes, the mixture is removed from heat and allowed to sit for five minutes. After five minutes, the rinse water, floatables and sinkables are retained.

#### **Sink/Float**

The rinsed PET flake is added to tap water at a ratio of 8:1 water to flake. The tank is agitated by hand or at 500 rpm for five minutes and then allowed to sit for five minutes. After five minutes, the floatables and sinkables are retained.

### **Data Table:**

| Variable | Wash Temperature (°C) | Rinse Temperature (°C) | Starting Flake Weight (kg) | Total Floatables (grams) | Total Floatables (%) |
|----------|-----------------------|------------------------|----------------------------|--------------------------|----------------------|
| Control  | 85                    | 44                     | 4.55                       | 0.00                     | 0.00%                |
| Test     | 84                    | 43                     | 4.55                       | 0.00                     | 0.00%                |

Wash/Rinse Pictures

| Variable | Settled Waters                                                                     | Shaken Waters                                                                        |
|----------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Control  |   |   |
| Test     |  |  |

## Washed Flake/Floatable Pictures

| Variable | Washed Flake                                                                        | Floatables            |
|----------|-------------------------------------------------------------------------------------|-----------------------|
| Control  |   | <b>NOT APPLICABLE</b> |
| Test     |  | <b>NOT APPLICABLE</b> |

## **APR PET Wash Water Evaluation**

### **References:**

PET-S-01

### **Test Summary:**

Visual evaluations of the wash water take place to determine the characteristics of the label substrate, inks and adhesives utilized within the label. The water is examined for any suspended ink or adhesive. If ink or adhesive is seen, the water is evaluated.

### **Procedure:**

500mL of water is transferred into a graduated cylinder, allowed to settle for 30 minutes, then ranked depending on the amount of settling of the inks and adhesive. After the setting evaluation, the wash water is passed through a 250-mesh screen using a Buchner funnel. The filtered water is ranked on its appearance. The wash water is then filtered again with a Whatman Grade 1 filter (11µm), using a Buchner funnel. The time it takes to filter the wash water is measured and compared to the time it takes for clean tap water to filter. The filtered water is ranked on its appearance.

## Wash Water Visual Evaluation

| Variable                                | Control | Test |
|-----------------------------------------|---------|------|
| Label Format                            | NA      | 2    |
| Ink Design                              | NA      | 2    |
| Wash Impact on Label                    | NA      | 2    |
| Presence of Ink in Wash Water           | NA      | 3    |
| Presence of Free Adhesive in Wash Water | NA      | NA   |
| Settling Ranking                        | A       | B    |

### **Types of Labels:**

#### **Label Format**

1. *Floating Film*
2. *Sinking Film*
3. *Direct Print*

#### **Ink Design**

1. *Hot Caustic Resistant Ink*
2. *Wash-Off Ink*

### **Ranking System for the Visual Evaluations:**

#### **Wash Impact on Printed Area Appearance and Legibility Comparison to Unwashed Label**

1. *Good retention - The label graphics are still clear, crisp, and legible, colors are unchanged. The examination will show that small text on the ingredients and nutrition panels can be read, bar code is in place, corporate and product logos are clear. If a label with a printed test grid is employed, all patterns have crisp borders, colors are not changed, printed company logo on the test label is legible.*
2. *An intermediate result – where there is ink and color on the label film, but graphics are no longer legible, and colors are muted.*
3. *Poor retention - The ink was substantially removed from the label film by the wash; the washed label may have some residual or trace color from the ink remaining on the film.*

#### **Presence of Ink in Wash Water**

1. *No wash water discoloration - Inks that are resistant to hot caustic, remain on the label film and do not discolor the wash water based on visual assessment.*
2. *Incidental wash water discoloration - Inks that are resistant to hot caustic and remain adhering to the label film may create some incidental tint color to the wash water from pigments that are slightly soluble in hot caustic, or from ink abraded from cut edges. Incidental ink is not a concern when there is no plaque discoloration determined in PET-B-02 or PET-CG-02.*
3. *Ink is visible in wash water.*

#### **Presence of Free Adhesive in the Wash Water**

1. *No adhesive in wash water or the adhesives is bound to the label.*
2. *There is adhesive visible in wash water.*

#### **Settling Evaluation**

- a. *No clear evidence that any settling has taken place – the sample is uniformly colored from top to bottom, there are no solids evident at the bottom of the graduate cylinder.*
- b. *Some settling has taken place.*
- c. *Solids in the sample have substantially settled – the amount of color at the top of the cylinder is substantially less than at the bottom, there is visible evidence of ink and/or adhesive at the bottom of the cylinder.*

## Wash Water Visual Evaluation Pictures

| Variable | Unwashed Label vs Washed Label                                                                                                                                                                                                                                    | Settled Wash Water                                                                                                                                                                                                                                                                                  | Shaken Wash Water                                                                                                                                                                                                                                                                                    |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test     |  A photograph showing several small, torn pieces of a multi-colored label (pink, yellow, blue, and clear) against a black background. The pieces represent the 'Unwashed Label'. |  Two glass bottles side-by-side. The left bottle, labeled '2467 Test 1 Wash Water', contains a cloudy, yellowish liquid. The right bottle, labeled '2467 Test 1 Rinse Water', contains a clear, colorless liquid. |  Two glass bottles side-by-side. The left bottle, labeled '2467 Test 1 Wash Water', contains a cloudy, yellowish liquid. The right bottle, labeled '2467 Test 1 Rinse Water', contains a clear, colorless liquid. |

## **APR PET Wash Water Filtration Evaluation**

| Variable                                 | Control | Test   |
|------------------------------------------|---------|--------|
| <b>250-Mesh Evaluation</b>               |         |        |
| 250-Mesh Starting Weight (g)             | 2.1144  | 2.0728 |
| 250-Mesh Ending Weight (g)               | 2.1221  | 2.0857 |
| 250-Mesh Collected Weight (g)            | 0.0077  | 0.0129 |
| 250-Mesh Collection (Y/N)                | Y       | Y      |
| 250-Mesh Appearance Ranking              | A       | B      |
| <b>11µm Evaluation</b>                   |         |        |
| 11µm Filter Starting Weight (g)          | 1.0438  | 1.0415 |
| 11µm Filter Ending Weight (g)            | 1.1069  | 1.1061 |
| 11µm Filter Collected Weight (g)         | 0.0631  | 0.0646 |
| 11µm Filter Collection (Y/N)             | Y       | Y      |
| 11µm Filter Appearance Ranking           | A       | B      |
| 11µm Filter Time (s)                     | 138.13  | 231.97 |
| Tap Water Filter Time (s)                | 74.48   |        |
| 11µm Filter Time / Tap Water Filter Time | 1.85    | 3.11   |

### **Ranking System for Filtering Evaluation:**

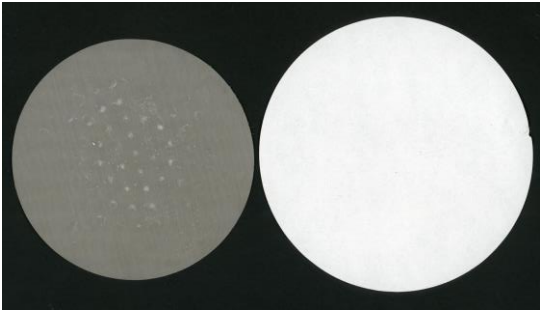
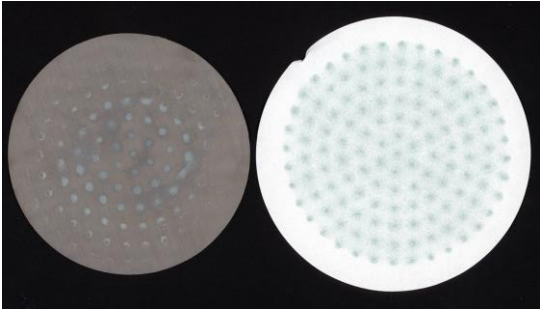
#### **250-Mesh Evaluation**

- a. Appearance after filtering is similar to the starting material.*
- b. Some level of colored material or adhesive was filtered out.*
- c. Most colored material was filtered out.*

#### **11µm Filter Evaluation**

- a. Appearance after filtering is similar to the starting material.*
- b. Some level of colored material was filtered out.*
- c. Most colored material was filtered out, but water is still hazy.*
- d. Color and haze are substantially absent in filtered water.*

## Filter Pictures

| Variable | 250-Mesh Screen                                                                    | 11µm Filter Paper | Settled Filtered Water                                                              | Shaken Filtered Water                                                                |
|----------|------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Control  |   |                   |   |   |
| Test     |  |                   |  |  |

## **APR PET Elutriation**

### **References:**

PET-P-05

### **Test Summary:**

Remove lights (fines, labels, layers) from washed flake before extrusion.

### **Procedure:**

The elutriator is calibrated using the washed and dried control flake so that the air speed is adjusted until the value of 0.5% for lights removed is achieved. Once the elutriator is calibrated, the rest of the control and tests are run. Air speed, heavies' weight, lights weight, and the percentage of lights are recorded for each test. Heavies are then prepared for the next steps of processing.

### **Data Table:**

| Variable | Air Speed<br>(m/s) | Heavies Weight<br>(kg) | Lights Weight<br>(grams) | Lights Removed<br>(%) |
|----------|--------------------|------------------------|--------------------------|-----------------------|
| Control  | 7.50               | 3.77                   | 21.94                    | 0.58%                 |
| Test     | 7.50               | 3.93                   | 68.98                    | 1.73%                 |

## Heavies/Lights Pictures

| Variable | Heavies                                                                             | Lights                                                                               |
|----------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Control  |   |   |
| Test     |  |  |

## Clumping Evaluation

### References:

PET-S-08

### Test Summary:

Evaluate the amount of clumping caused by low melting polymers or other contamination in washed and elutriated PET flake.

### Procedure:

1.5 kg of washed, dried, and elutriated PET is crystallized at 165°C for 30 minutes in an aluminum pan. After 30 minutes, one kilogram of crystalized material is transferred to a new pan and placed into a 195°C oven for 90 minutes. After 90 minutes, the flake is allowed to cool to room temperature. The pan is then emptied through a 12.5 mm screen. All agglomerated flakes that do not pass through the sieve through or remain on the pan are weighed and recorded.

### Data Table:

| Variable | Stuck on Pan (g) | Stuck On Sieve (g) | Percent Clumped |
|----------|------------------|--------------------|-----------------|
| Control  | 0.00             | 0.00               | 0.00%           |
| Test     | 0.00             | 0.00               | 0.00%           |

**APR PET Guidelines:** Percent clumped cannot exceed 1% by weight retention.

## 1<sup>st</sup> Heat Processed Flake Colors

### References:

ASTM D6290

*Within PFE's scope of ISO 17025 accreditation; certificate number AT-3210.*

### Test Summary:

Measure the degree of yellowness under daylight illumination of transparent, translucent, or opaque plastics.

### Equipment:

Konica Minolta 36dG

### Procedure:

The color analyzing equipment is set up on reflectance and calibrated using pure white and black standards. The sample cell is filled to the brim with randomly selected flakes. The cell is inserted into the machine and the equipment runs the color test. The test indicates L\*, a\*, b\* values. This test is completed in a conditioned laboratory at a temperature of 23±2°C and a relative humidity of 50±10%.

### Data Table:

| Variable | L*<br>Values | a*<br>Values | b*<br>Values | L*<br>Average    | a*<br>Average    | b*<br>Average  |
|----------|--------------|--------------|--------------|------------------|------------------|----------------|
| Control  | 69.82        | 0.03         | -2.00        | 68.53            | -0.01            | -2.00          |
|          | 67.72        | -0.02        | -1.99        |                  |                  |                |
|          | 67.75        | -0.03        | -1.94        |                  |                  |                |
|          | 70.26        | -0.01        | -1.92        |                  |                  |                |
|          | 67.09        | 0.00         | -2.13        |                  |                  |                |
| Test     | 71.18        | -1.08        | 1.64         | 68.21<br>(-0.31) | -1.18<br>(-1.17) | 1.31<br>(3.31) |
|          | 65.43        | -1.32        | 1.27         |                  |                  |                |
|          | 66.94        | -1.20        | 1.86         |                  |                  |                |
|          | 70.23        | -1.18        | 0.98         |                  |                  |                |
|          | 67.29        | -1.12        | 0.80         |                  |                  |                |

## 1<sup>st</sup> Heat Processed Flake Melt Indexer

### References:

ASTM D1238 A

*Within PFE's scope of ISO 17025 accreditation; certificate number AT-3210.*

### Test Summary:

Measures the rate of extrusion of molten resins through a specified die at specified conditions.

### Equipment:

Dynisco LMI5500

### Procedure:

#### Sample Preparation

Ten grams of randomly selected PET flakes are weighed and placed in a clean aluminum dish. The pans are placed into a vacuum oven set to  $160 \pm 5^{\circ}\text{C}$  and the vacuum is pulled. PET samples are allowed to dry in the vacuum oven for at least six hours before testing.

#### Sample Testing

Testing equipment is set to  $285 \pm 0.2^{\circ}\text{C}$ . The randomly selected PET sample is then transferred from the oven to the testing equipment where it is loaded. The piston and weight (2160 grams) are placed in the machine with a plug blocking the PET from escaping. The PET is softened for  $6 \pm 2$  minutes before the plug is removed allowing the PET to flow. Extrudate is the automatically timed to obtain a melt intrinsic viscosity. This test is completed in a conditioned laboratory at a temperature of  $23 \pm 2^{\circ}\text{C}$  and a relative humidity of  $50 \pm 10\%$ .

### Data Table:

| Variable | Processed Flake Melt IV (dL/g) | Delta From Control (dL/g) |
|----------|--------------------------------|---------------------------|
| Control  | 0.825                          | NA                        |
| Test     | 0.805                          | -0.020                    |



*Plastics Forming Enterprises, LLC*

*Plastics Consulting, Research and Engineering*

# Plaque Processing and Testing

2<sup>nd</sup> Heat APR PET Injection ..... 22

2<sup>nd</sup> Heat Injection Molded Plaques Pictures ..... 23

2<sup>nd</sup> Heat Transmission Plaque Colors and Black Specks/Inclusions ..... 24

2<sup>nd</sup> Heat Plaque Melt Indexer..... 25



## 2<sup>nd</sup> Heat APR PET Injection

### References:

PET-P-08

### Test Summary:

Injection mold 3mm plaques to test for color and haze values.

### Procedure:

Injection material is prepped in a dryer until the moisture content is below 50 ppm. PET is injection molded at a target melt temperature of 275°C. The injection unit is purged between each test innovation. Melt temperature, room temperature, and mold temperature are recorded for each variable.

### Data Table:

| Variable | Moisture Content (ppm) | Melt Temperature (°C) | Mold Temperature (°C) |
|----------|------------------------|-----------------------|-----------------------|
| Control  | 27                     | 276                   | 19                    |
| Test     | 23                     | 276                   | 20                    |

**APR PET Guidelines:** Moisture content of material needs to be below 50 ppm, nozzle melt temperature of 275°C, mold temperature of 20°C.

### Standard Operating Conditions:

| Zone 1 Temperature | Zone 2 Temperature | Zone 3 Temperature | Nozzle Temperature |
|--------------------|--------------------|--------------------|--------------------|
| 265°C              | 266°C              | 266°C              | 275°C              |

## 2<sup>nd</sup> Heat Injection Molded Plaques Pictures



## 2<sup>nd</sup> Heat Transmission Plaque Colors and Black Specks/Inclusions

### References:

PET-P-08

PET-S-09

ASTM D1003

*Within PFE's scope of ISO 17025 accreditation; certificate number AT-3210.*

### Test Summary:

Measure the color values L\*, a\*, b\*, and haze of a 3mm injection molded plaque. Visually identify the presence of black specks and inclusions. Data is designed to be correlated to production of reproduced bottles.

### Equipment:

Konica Minolta 36dG

### Procedure:

Pellets are dried to a moisture level below 50 ppm and injection molded into 3mm plaques. 50 molded plaques are visually examined for black speck or inclusions of 0.1mm<sup>2</sup> in size. The color analyzing equipment is set up on transmittance and calibrated using pure white and black standards. The molded plaque is inserted into the testing location and the equipment runs the color test. The test indicates L\*, a\*, b\* values and haze percentage.

| Variable | Black Specks | L* Values | a* Values | b* Values | L* Average       | a* Average       | b* Average     | Haze  | Haze Average    |
|----------|--------------|-----------|-----------|-----------|------------------|------------------|----------------|-------|-----------------|
| Control  | 0            | 93.03     | -0.18     | 1.85      | 92.99            | -0.17            | 1.87           | 3.43  | 3.59            |
|          |              | 93.02     | -0.18     | 1.84      |                  |                  |                | 3.62  |                 |
|          |              | 93.04     | -0.17     | 1.81      |                  |                  |                | 3.67  |                 |
|          |              | 93.02     | -0.18     | 1.88      |                  |                  |                | 3.46  |                 |
|          |              | 92.84     | -0.16     | 1.95      |                  |                  |                | 3.75  |                 |
| Test     | 0            | 82.82     | -4.69     | 3.03      | 83.79<br>(-9.20) | -4.42<br>(-4.24) | 2.73<br>(0.86) | 14.24 | 13.11<br>(9.52) |
|          |              | 84.16     | -4.34     | 2.52      |                  |                  |                | 12.42 |                 |
|          |              | 83.77     | -4.84     | 2.57      |                  |                  |                | 13.01 |                 |
|          |              | 83.10     | -4.78     | 3.12      |                  |                  |                | 13.83 |                 |
|          |              | 85.11     | -3.44     | 2.41      |                  |                  |                | 12.03 |                 |

Plaques are not randomly selected. Operators select five plaques that are free of imperfections that may alter results.

**APR PET Guidelines:** L\* value cannot be less than 82, a\* value and b\* value cannot be more than a 1.5 difference when compared to control, and haze cannot differ from the control by more the 10%. Control haze value cannot exceed 9.5%, and b\* must be below 4.

## 2<sup>nd</sup> Heat Plaque Melt Indexer

### References:

ASTM D1238 A

*Within PFE's scope of ISO 17025 accreditation; certificate number AT-3210.*

### Test Summary:

Measures the rate of extrusion of molten resins through a specified die at specified conditions.

### Equipment:

Dynisco LMI5500

### Procedure:

#### Sample Preparation

Ten grams of randomly selected PET plaques are weighed and placed in a clean aluminum dish. The pans are placed into a vacuum oven set to  $160 \pm 5^{\circ}\text{C}$  and the vacuum is pulled. PET samples are allowed to dry in the vacuum oven for at least six hours before testing.

#### Sample Testing

Testing equipment is set to  $285 \pm 0.2^{\circ}\text{C}$ . The randomly selected PET sample is then transferred from the oven to the testing equipment where it is loaded. The piston and weight (2160 grams) are placed in the machine with a plug blocking the PET from escaping. The PET is softened for  $6 \pm 2$  minutes before the plug is removed allowing the PET to flow. Extrudate is the automatically timed to obtain a melt intrinsic viscosity. This test is completed in a conditioned laboratory at a temperature of  $23 \pm 2^{\circ}\text{C}$  and a relative humidity of  $50 \pm 10\%$ .

### Data Table:

| Variable | Plaque Melt IV (dL/g) | IV Drop from Flake (dL/g) | IV Drop A'-B' |
|----------|-----------------------|---------------------------|---------------|
| Control  | 0.640                 | 0.185                     | NA            |
| Test     | 0.614                 | 0.191                     | -0.006        |

**APR PET Guidelines:** Delta in loss of MIV between incoming flake/pellet and extruded flake/pellet compared to control  $\pm 0.025\text{dL/g}$ .

## Report Statements

### Next Steps

In the event that all results are favorable for the APR benchmark protocol, please understand that these results should not be represented as certification or compliance with the APR protocol.

### Conformance Statements

Plastics Forming Enterprise (PFE) is an ISO 17025 accredited laboratory whose management system conforms to all requirements of the standard; all testing done within the scope is identified. The material was evaluated through testing that conforms to the APR's benchmark testing protocols as described, omitting no steps. Testing was done making no deviations to the agreed upon methods unless otherwise noted and agreed upon prior to testing. The evaluation was processed according to the APR's benchmark test for **PET labels and closures**. Results stated in the report are only relevant to the items tested and the test performed. All testing was completed at PFE's New Hampshire laboratory unless otherwise noted. All sampling was done using random selection, by experienced technicians unless otherwise noted. Test specimens are conditioned at  $23\pm 2^{\circ}\text{C}$  and  $50\pm 10\%$  relative humidity for at least 40 hours in accordance with ASTM D618 procedure A, as required. All customer supplied data or other information will be clearly identified. Additional information and results are available upon request. PFE will retain available hard copies of records related to this project for a minimum of one year from its completion and available digital copies of records for a minimum of three years.

### Conclusions Statements

Any interpretations of data are done by experienced staff members with a good knowledge of the materials used during testing. All interpretations or conclusions about data can be found in the conclusions section of the report, unless noted. Opinions, interpretations, or statements of conformity included are based on results for which accreditation is held. Opinions, interpretations, or statements of conformity outside the scope of accreditation but based on those results for which accreditation are clearly identified as such by a disclaimer. PFE prides itself on being able to help the clientele understand possible failures with over 40 years of experience in plastics recycling. PFE does not its own employ decision rules nor set the acceptance criteria. All outliers are determined though an interquartile range and are marked with yellow highlighting. Uncertainty values are available upon request.

### Report Authorizations

| Report Written by | Report Approved by | Report Approved on |
|-------------------|--------------------|--------------------|
| KG                | ML                 | 2/2/2024           |

| Date of Amendment | What was Amended? | Reason for Amendment | Amendment Performed by | Amendment Approved by |
|-------------------|-------------------|----------------------|------------------------|-----------------------|
|                   |                   |                      |                        |                       |

## **PFE ADDRESS**

6B Continental Boulevard  
Merrimack, NH 03054

### **President:**

Kristina Hansen  
(khansen@plasticsforming.com)

### **Technical Director:**

Matthew Levesque  
(matt.levesque@plasticsforming.com)

### **Quality Assurance:**

Kathryn Goodale  
(kgoodale@plasticsforming.com)

### **Accounting Email:**

(admin@plasticsforming.com)

### **Contact Phone Number:**

603-668-7551



[www.plasticsforming.com](http://www.plasticsforming.com)



Document Number: RT018  
Version Number: 1.0