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REPORT

Issue Date:	**September 16th, 2014**	
Issued To:	**Jesper Van Berkel**	**Avantium**
Issued By:	**Stéphane Morier**	**PTI-Europe**
Subject:	**EPBP BtP Route 1 Protocol with 2% and 5% PEF**	
Project number:	**3244.11598**	
Proposal number:	**SMO 170614 001**	

Dear Mr. Van Berkel,

We are pleased to provide you with the following report regarding the recycling evaluation of PEF bottles according to the EPBP Bottle to Properties test protocols Route 1 for 2 test concentrations 2 & 5%.

Background

Avantium wants to evaluate the recyclability of PEF bottles. For this first trial, Avantium has requested to perform an EPBP Route 1 protocol.

The intent of this trial was to perform a preliminary screening, the results will not necessary be shared with the EPBP. Because of that, the setup of the protocol (bottle selection, concentration selection) has not been reviewed by the EPBP prior to the evaluation.

This report is divided in two sections:

The first section called "**Bottle-to-Properties protocol**" describes the protocol, the required test specifications and all test results.

The processing conditions are grouped at the end of the report in a second section called "**Appendix**".

Summary of results

The impact of the PEF on the clear PET recycling stream was evaluated according to Route 1 of the EPBP protocol. In this protocol we evaluate how the presence of this material influences processing and performance properties during different steps such as washing, extrusion, solid stating and plaque injection.

It was decided to test the impact on recycling for two single test flakes concentrations: 2% and 5 %.

The Test 1/Plaque B1 variable (PET bottles with 2% concentration of PEF) meets all EPBP specifications as outlined in the EPBP protocol Route 1.

The Test 2/Plaque C1 variable (PET bottles with 5% concentration of PEF) meets most EPBP specifications as outlined in the EPBP protocol Route 1 but **does not** fulfil the color condition for b* value.

1. Bottle-to-Properties protocol

The Bottle-to-Properties protocol involves a lot of various steps. The overview of the protocol is shown in the table below.

	Bottles	Control bottles	Test bottles	
Preparation Route 1	Grinding	Control grinded flakes	Test grinded flakes	
	Washing	Control washed flakes	Washed test flakes	
	Air elutriation	Control flakes	Test flakes	
	Blending 1	Blend 1-A	Blend 1-B	Blend 1-C
	Extrusion	Extrusion A	Extrusion B	Extrusion C
	Crystallization	Crystallization A	Crystallization B	Crystallization C
Route 1	Solid stating 1	SSP 1-A1	SSP 1-B1	SSP 1-C1
	Blending 2	Blend 2-A1	Blend 2-B1	Blend 2-C1
	Plaque injection	Plaque A1	Plaque B1	Plaque C1

It was decided to test the impact on recycling with two concentrations of 2% and 5% and compare it to a reference.

Sample codes

Throughout this report different codes will be used to identify the various samples. The table below is an overview of these different codes.

PTI code	Description	Rem / Concentrations
31715 A1	Bottles - Control	Ramapet N1(S) bottles
31715 B1	Bottles – Test	PEF bottles
31715 r1	Ground flakes - Control	
31715 r2	Ground flakes – Test	
31715 r4	Washed flakes - Control	
31715 r5	Washed flakes – Test	
31715 r9	Extruded pellets A	100% control
31715 r10	Extruded pellets B	98% control – 2% test
31715 r11	Extruded pellets C	95% control - 5% Test
31715 r15	SSP pellets 1-A1	100% control
31715 r16	SSP pellets 1-B1	98% control – 2% test
31715 r17	SSP pellets 1-C1	95% control – 5% Test
31715 C	Plaques A1	50% SSP 1-A1 – 50% virgin
31715 D	Plaques B1	50% SSP 1-B1 – 50% virgin
31715 E	Plaques C1	50% SSP 1-C1 – 50% virgin

Sample testing

The following tests were performed. The test results and comments can be found at the end of each of the transformation steps of the protocol.

Preparation	Washing		Extrusion	SSP	Injection
Start bottles	Flakes before washing	Flakes after washing	EXT pellets	SSP pellets	Plaques
Color	Visual	Visual	Visual	Visual	Color
Haze	IV	IV	IV	IV	Haze
	Color	Color	Color	Color	
		Bulk density		AA	
				DSC	
				Fluorescence	
Quantity retained for the applicant					
5	50g	50g	50g	50g	5

As stated above samples retained for the applicant at each step.

Start samples

The **reference bottles** have been sourced by Avantium and delivered by ALPLA. The **test bottles with PEF** have been sourced by Avantium and delivered by DANONE. Five bottles of each variable have been retained for the EPBP.

Supplier	Brand name	Code
Artenius	Artenius	Flow
CEPSA	CepsaPET	SR08
Equipolymers	Lighter	C93
Indorama	RAMAPET	N1, N180 and N1(S)
M&G	Cleartuf	P82

According to Avantium, the **reference bottles** have been made with the RAMAPET N1(S) resin which is one of the EPBP approved resin.

Avantium has also sourced the virgin PET (RAMAPET N1(S)) for blending before molding plaques. RAMAPET N1(S) has been selected because this virgin PET resin needs to be the same as used for the production of the initial standard and test bottles.

Preparation

The starting reference and test bottles were sourced by Avantium.

Bottle evaluation

Color (L*, a* and b*) and haze values were measured on the control and test start bottles. 5 bottles of the control and test bottles were retained for the applicant.

Here are the L*a*b* and haze tests results:

Sample	PTI reference	Description	L*	a*	b*	Haze
1	31715 A1	Bottle - Control	95.30	-0.01	0.57	0.92
2	31715 B1	Bottle – Test	95.04	-0.05	0.90	1.27

For the control, the color and haze values have been measured in the body of the bottle. For the test bottle, because of the texturing and ribbing present on the body, the color and haze values have been measured on the shoulder of the bottle.

Grinding

All bottles (Control, Test) were ground separately to flakes with a 12 mm side size using a standard mechanical grinder.

Variable	Sample pictures	
31715 r1 Ground flakes Control		
31715 r2 Ground flakes Test		

No issues have been reported after the grinding.

Washing

The bottle flake materials were washed according to a standard European wash protocol with flakes friction. This includes pre-washing the material with caustic and detergents followed by the washing process with detergents. Both processes are carried out at elevated temperatures (min. 85°C). The material was thoroughly rinsed and dried. After washing, both flake samples were tested for colour, bulk density and IV and a small sample (50g) was retained for the applicant.

Variable	Sample pictures

31715 r4 Wash flakes Control		
31715 r5 Wash flakes Test		

No issues have been reported during the washing. No floating particles have been collected.

For the test variable, the wash water was also collected after pre-wash, main wash and hot rinsing for eventual analysis of the wash water.

Step	Test 1

All	
	Pre-wash / Main Wash / Hot Rinsing

Apart from some fines there is nothing to report.

Flake evaluation

The unwashed and washed flakes were evaluated for color and IV to determine the impact of the washing process. The flakes of the test sample are compared with the flakes of the control sample.

Intrinsic viscosity

The IV of the unwashed flakes was measured to have a reference IV for the next processing steps. The difference in IV between control and test sample should ideally be less than 0.02 dl/g. A higher difference should be explained.

Here are the results:

Before washing			After washing		
Sample	Description	IV [dl/g]	Sample	Description	IV [dl/g]
31715 r1	Ground flakes – Control	0.77	31715 r4	Washed flakes - control	0.77
31715 r2	Ground flakes – Test	0.74	31715 r5	Washed flakes – Test	0.74

The washing process has no impact on the IV of both the reference and the test flakes.

Bulk density

Bulk density of the flakes was measured, but is not subject to a specification. Here are the results:

Sample	Description	Bulk density [g/ml]

31715 r4	Washed flakes - Control	0.32
31715 r5	Washed flakes – Test	0.20

Color (L*, a*, b*)
The color of all flake samples – unwashed and washed – was measured in reflectance with a Minolta CM-3600d spectrophotometer or equivalent. The results are not subject to a specification, but are kept for reference purposes only.

Here are the L*a*b* tests results:

Sample	Description	L*	a*	b*
31715 r1	Ground flakes - Control	67.10	-0.68	-1.00
31715 r4	Washed flakes - Control	68.16	-0.85	-0.71
31715 r2	Ground flakes – Test	57.37	-0.78	0.90
31715 r5	Washed flakes – Test	63.16	-1.02	1.50

The washing process is resulting in brighter flakes (higher L*) for both variables. The b* value is also slightly higher for both washed variables.

Extrusion

The following blends were prepared and extruded:

Description	Description	Control	Test
31715 r6	Blend 1-A	100	0
31715 r7	Blend 1-B	98	2
31715 r8	Blend 1-C	95	5

The washed flakes were ground using a 4 mm screen before extrusion to allow good feeding of the material into the extruder. The washed bottle flakes were dried at the same conditions to a moisture level below 100 ppm moisture with a desiccant bed drying unit (minimum 3 hours at 160°C) and extruded at temperatures around 285°C into strands using a small tonnage Arburg press converted into a continuous extrusion mode. The extrudate was melt filtered with a 40/150/40 mesh melt filter pack (about 100 microns filtration). The extrudate was rapidly cooled using a water bath and fed into a pelletizer to produce amorphous pellets. Before entering the pelletizer the strands were air dried. The extrusion process was monitored for heat stability and the 40/150/40 mesh melt filter pack was changed between samples for examination. The pressure differences were noted between each material variable during processing.

The same processing conditions were used for all samples.
All processing conditions were recorded.

A small amount of each sample (50g) was retained for the applicant.

The drying of the different blends did not result in discolouring of the samples as proven by the pictures below:

Sample	Undried blends	Dried blends
r6		
r7		
r8		

The following extruded pellets have been produced from the blends:

Description	Extruded pellets	Description
Blend 1-A	31715 r9	Extruded pellets A
Blend 1-B	31715 r10	Extruded pellets B
Blend 1-C	31715 r11	Extruded pellets C

Sample	Extruded pellets	
r9		
r10		
r11		

Extrusion evaluation

The extruded pellets were tested for visual quality and IV. The pellets of the test samples were compared with the pellets of the control sample. All pellets should meet the following requirements.

Flake sticking and flake feeding
A small amount of the dried samples will be extracted from the dryer before they enter the extruder. This will allow us to evaluate the impact of the drying process on the agglomeration of the flake samples. Agglomeration should be below 1%.

After emptying the dryer, the hopper will be checked for flakes sticking to the hopper sidewall. Agglomeration should not lead to problems emptying the hopper by gravity without additional mechanical action. The cone of the hopper should have an angle of 60-70 degrees.

Stability pellets in extrusion process
No sticking, fumes or odours should be noticed when compared to control sample A. No additional thermal degradation, in the form of black specks or other inclusions should be present.

Filter contamination
Pressure build-up during pelletizing will be monitored and significant differences will be reported. However, if filterability is seen as a potential problem for the test samples as part of the test program, a separate filter test has to be done.

No problems have been reported during the processing of the 3 variables (1 control + 2 tests). For the processing parameters, please go in the Appendix at the end of the report.

Intrinsic viscosity
The IV of the amorphous pellets was measured. The IV drop of the test samples should be within 0.02 units of the IV drop of the control sample A.

Here are the results:

Sample	Description	IV [dl/g]
31715 r9	Extrusion A	0.754
31715 r10	Extrusion B	0.752
31715 r11	Extrusion C	0.750

All results are within the 0.02 units specifications.

Color (L*, a*, b*)
The color of the amorphous pellets was measured in reflectance with a Minolta CM-3600d spectrophotometer.

Here are the L*a*b* tests results:

Sample	Description	L*	a*	b*
31715 r9	Extrusion A	67.21	-1.07	2.83
31715 r10	Extrusion B	66.06	-1.25	4.27
31715 r11	Extrusion C	65.53	-0.82	6.25

The results are not subjected to a specification, but are kept for reference purposes only. When there is more PEF, the sample becomes darker (lower L* value) and more yellow (higher b* value).

Crystallization and solid stating

Crystallization and solid stating tests are important to evaluate the samples for speed of solid stating, the DSC melting point of pellets and fluorescence. These steps are also essential to prepare pellet samples for further investigations.

The test samples for Route 1 (plaques for color measurement) must be solid stated (SSP).

SSP for color measurement test (Route 1)
SSP for Route 1 was done for a fixed residence time of 8 hours at 205°C (reactor temperature). The test was used to determine solid stating speed, (and to prepare the samples for subsequent molding and color measurements).

The SSP treatment was carried out at 205°C (reactor temperature), which corresponds with a sample temperature between 190 and 195°C. The SSP time was measured from when the sample reached a minimum temperature of 180°C. The sample must reach the desired SSP temperature within the first 2 hours. To determine the SSP rate, a sample was taken at 2, 4, 6 and 8 hours to make an IV curve. Conditions for the control and test samples should be similar.

The processing conditions used for all samples must be identical. All processing conditions were recorded. A small amount of each sample (50g) was retained for the applicant.

Crystallization
Before solid stating the amorphous pellets were first crystallized. The crystallization was done in a vacuum oven at 160°C. It is important that the pellets are crystallized sufficiently so they will not stick in the following processing steps.

Sample	Solid stated pellets	
31715 r15 SSP 1-A1		
31715 r16 SSP 1-B1		
31715 r17 SSP 1-C1		

Solid stating evaluation

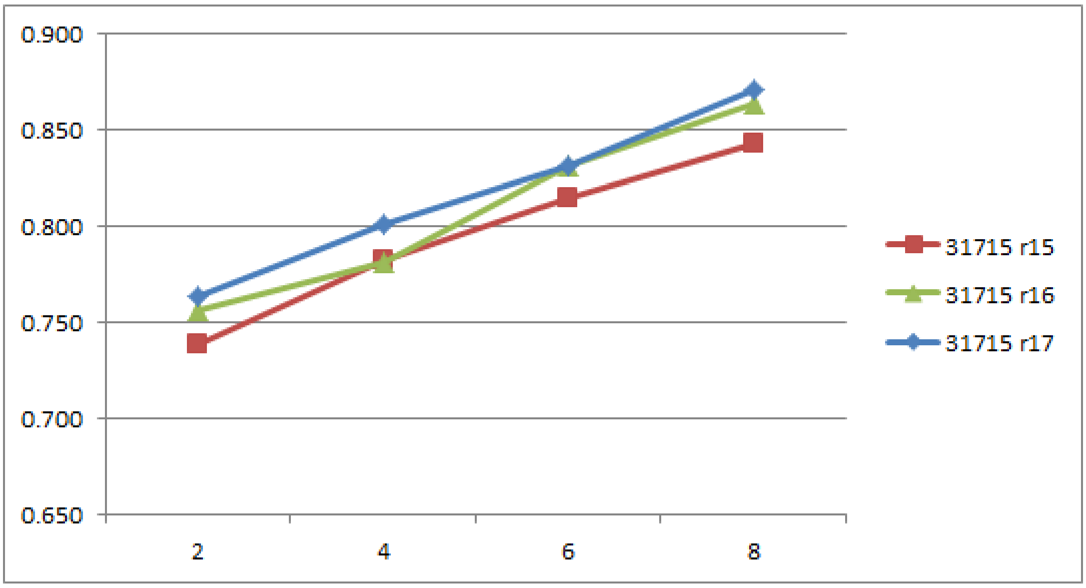
The solid stated pellets were tested for solid stating rate, the DSC melting point and fluorescence. The solid stated pellets of the test samples were compared with the solid stated pellets of the control sample. All solid stated pellets should meet the following requirements.

Intrinsic viscosity
The IV of the solid stated pellets was measured. For Route 1, the IV of the pellets is measured after 2, 4, 6 and 8 hours to make an IV curve.

Solid stating rate
The SSP rate is best calculated using a linear curve fit for the data points from 2 to 8 hours. The SSP rate of the test samples should not deviate more than 10% from the control sample.

Please find the results below:

Sample	2	4	6	8	Avg Hourly rate
31715 r15	0.739	0.783	0.815	0.843	0.017
31715 r16	0.756	0.781	0.832	0.864	0.018
31715 r17	0.764	0.801	0.832	0.871	0.018



The solid stating rate measured on the samples taken between 2 and 8 hours is similar for the control and the two test variables.

Color (L*, a*, b*)
The color of the SSP pellets was measured in reflectance with a Minolta CM-3600d spectrophotometer.

Here are the L*a*b* tests results:

Sample	Description	L*	a*	b*
31715 r15	SSP 1-A1	84.37	-1.59	2.64
31715 r16	SSP 1-B1	83.99	-1.51	3.68
31715 r17	SSP 1-C1	81.80	-1.09	5.07

The results are not subjected to a specification, but are kept for reference purposes only. The test pellets are again darker (less white, more yellow).

DSC
The melting point of the pellets in the second heating curve of the DSC measurement should be determined. This melting point for the test samples should not deviate more than 10°C from the control sample.

Sample	Description	T_g (°C)	T_c (°C)	T_m (°C)
31715 r15	SSP 1-A1 pellets	77.04	133.13	244.56
31715 r16	SSP 1-B1 pellets	80.72	150.43	240.81
31715 r17	SSP 1-C1 pellets	80.88	155.70	238.44

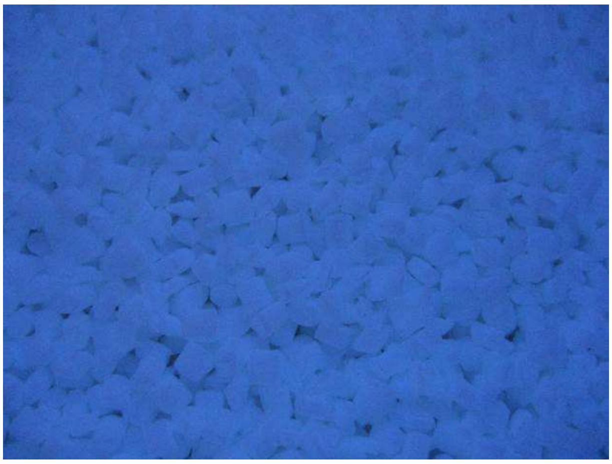
All results are within specifications.

Acetaldehyde Concentration (AA)
The acetaldehyde concentration was measured on the solid stated pellets. Test samples should not exhibit an AA increase of more than 35% compared to the control samples.

PTI code	Description	AA Content (ppm)	Standard Deviation
31715 r15	SSP 1-A1 pellets	0.57	0.10
31715 r16	SSP 1-B1 pellets	0.48	0.09
31715 r17	SSP 1-C1 pellets	0.42	0.04

The AA content of the two test samples is lower than the AA content on the reference sample.

Fluorescence
Flakes or pellets have been tested and checked visually with an UV lamp (385 nm). No significant fluorescence is allowed. No fluorescence was noted.

Sample	Solid stated pellets
31715 r15	
31715 r16	
31715 r17	

Plaque injection (Route 1)

Plaques were produced to allow a good colour measurement on a flat surface. The results are used to evaluate the impact of the recycling process on colour and haze. The plaques of the test samples are compared with the plaques of the control sample. All plaques should meet the following requirements.

The first step is to produce test plaques with a thickness of 3.0 mm using the reference virgin pellets and to measure the colour and haze in transmittance. All control and test samples were blended with 50% of the virgin PET pellets and moulded at the following conditions:

- Melt temperature setting: 275 – 285°C
- Mould temperature: 15 – 18°C
- Melt residence time: Between 4 – 6 minutes

The following blends have been prepared and injected into plaques:

Blend	Description	50%	50%	Plaque	Plaque
31715 r18	Blend 2-A1	Virgin PET	SSP 1-A1	31715 C	Plaque A1
31715 r19	Blend 2-B1	Virgin PET	SSP 1-B1	31715 D	Plaque B1
31715 r20	Blend 2-C1	Virgin PET	SSP 1-C1	31715 E	Plaque C1

Five plaques of each sample were retained for the applicant.
The pictures of the plaques are located on the next page.

Sample	Plaques
31715C **Plaque A1**	
31715D **Plaque B1**	
31715E **Plaque C1**	

Plaque evaluation

Plaques were produced to allow a good colour measurement on a flat surface. The results are used to evaluate the impact of the recycling process on colour and haze. The plaques of the test samples are compared with the plaques of the control sample. All plaques should meet the following requirements.

Colour and haze

The colour of the plaques was measured with a Minolta CM-3600d spectrophotometer. The following requirements need to be met:

- L* = 87 minimum
- a* = -3 minimum
- delta b* = 1.5 maximum (between control sample and the test sample)

The percentage of haze should be measured at 550 nm. A maximum of 8% haze is allowed.

Here are the L*a*b* and haze tests results:

Sample	Description	L*	a*	b*	Delta b*	Haze
31715 C	Plaques A1	93.39	-0.52	3.21	-	2.71
31715 D	Plaques B1	93.35	-0.74	4.17	0.96	2.39
31715 E	Plaques C1	92.98	-0.84	**5.33**	**2.12**	2.14

The Test 1/Plaque B1 variable (PET bottles with 2% concentration of PEF) meets the EPBP color and haze specification.

The Test 2/Plaque C1 variable (PET bottles with 5% concentration of PEF) does not meet the EPBP specification in terms of delta b* but meets EPBP specification in terms of haze.

APPENDIX 1: Extrusion conditions

PTI code	Description
31715 r9	Extruded Pellets A
31715 r10	Extruded Pellets B
31715 r11	Extruded Pellets C

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
31715 r9	21/8/14	Stéphane Morier	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	19.5	51.2	8.5	160.0

Operator (s)

Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	280
Barrel zone 2	275
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	10.0
Filter Pressure (bar)	50.0

Granulation

Cooling bath flow setting [Div]	0.2
Granulator feed roller pressure [bar]	3.0
Granulator speed setting [Div.]	42.5

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
31715 r10	21/8/14	Stéphane Morier	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	21.1	37.4	5.2	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	279
Barrel zone 2	275
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	10.0
Filter Pressure (bar)	50.0

Granulation

Cooling bath flow setting [Div]	0.2
Granulator feed roller pressure [bar]	3.0
Granulator speed setting [Div.]	42.5

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
31715 r11	22/8/14	Stéphane Morier	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	20.3	50.3	8.9	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	280
Barrel zone 2	275
Barrel zone 3	274
Barrel zone 4	274
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	10.0
Filter Pressure (bar)	50.0

Granulation

Cooling bath flow setting [Div]	0.2
Granulator feed roller pressure [bar]	3.0
Granulator speed setting [Div.]	42.5

APPENDIX 2: SSP conditions

PTI code	Description
31715 r15	SSP Pellets 1-A1
31715 r16	SSP Pellets 1-B1
31715 r17	SSP Pellets 1-C1

		1-A1	1-B1	1-C1
Nitrogen flow	**l/h**	1500	1500	1500
Nitrogen temp.	**°C**	205	205	205
Wall temp.	**°C**	205	205	205
Reactor temp.	**°C**	189	189	189
Process time	**hours**	8:00	8:00	8:00

APPENDIX 3: Plaque injection conditions

PTI code	Description
31715 C	Plaque A1
31715 D	Plaque C1
31715 E	Plaque D1

Injection Setups

Request	Date	Project Engineer	Variable
31715 C	9/2/14	Stéphane Morier	Plaque A1

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	21.1	50.2	9.8	20.0	160.0

Operator (s)
Jean-Claude Baumgartner

Injection Process Set Points

	Injection Pressures (bar)	Injection Flowrates (ccm/s)	End Step (ccm)
1	1000.0	15.00	13.00
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Switch over Point (ccm): 2.10

Plastification

Dosage (ccm)	17.80
Circum.Speed (m/min)	10.00
Back Pressure (bar)	35.0
Decomp. Flow (ccm/s)	10.0
Decomp. Volume (ccm)	1.5

	Hold Times (s)	Hold Pressures [bar]
1	0.00	1100.00
2	2.00	1100.00
3	14.00	600.00
4	4.00	50.00
5		
6		

Holding Flowrate (ccm/s):

Injection Process Actual Values

Temperatures (°C)

T 801	278	T 805	278	Cylinder Tip
T 802	280	T 831		
T 803	278	T 832		
T 804	278	T 833		

Pressures and Volumes

Peak pressure (bar)	1115.86
Switch over pr. (bar)	1115.86
Cushion (ccm)	1.69

Times (s)

Injection	3.44
Dosage	2.71
Cooling	4.25
Cycle	32.15

Quality Data

	Avg.	Std. Dev.
TIR @ End Cap (mm)		0.0000
TIR @ Transition (mm)		0.0000
Part Weight (g)	10.0900	0.0000

Injection Setups

Request	Date	Project Engineer	Variable
31715 D	9/3/14	Stéphane Morier	Plaque B1

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	20.7	55.1	10.9	20.0	160.0

Operator (s)
Jean-Claude Baumgartner

Injection Process Set Points

	Injection Pressures (bar)	Injection Flowrates (ccm/s)	End Step (ccm)
1	1000.0	15.00	13.00
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Switch over Point (ccm): 2.10

Plastification

Dosage (ccm)	17.80
Circum.Speed (m/min)	10.00
Back Pressure (bar)	35.0
Decomp. Flow (ccm/s)	10.0
Decomp. Volume (ccm)	1.5

	Hold Times (s)	Hold Pressures [bar]
1	0.00	1100.00
2	2.00	1100.00
3	14.00	600.00
4	4.00	50.00
5		
6		

Holding Flowrate (ccm/s):

Injection Process Actual Values

Temperatures (°C)

T 801	278	T 805	278	Cylinder Tip
T 802	279	T 831		
T 803	278	T 832		
T 804	278	T 833		

Pressures and Volumes

Peak pressure (bar)	1133.00
Switch over pr. (bar)	1132.00
Cushion (ccm)	1.73

Times (s)

Injection	3.45
Dosage	2.70
Cooling	4.25
Cycle	32.16

Quality Data

TIR @ End Cap (mm)	
Avg.	
Std. Dev.	0.0000
TIR @ Transition (mm)	
Avg.	
Std. Dev.	0.0000
Part Weight (g)	
Avg.	10.0900
Std. Dev.	0.0000

Injection Setups

Request	Date	Project Engineer	Variable
31715 E	9/3/14	Stéphane Morier	Plaque C1

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	22.1	49.9	10.7	20.0	160.0

Operator (s)
Jean-Claude Baumgartner

Injection Process Set Points

	Injection Pressures (bar)	Injection Flowrates (ccm/s)	End Step (ccm)
1	1000.0	15.00	13.00
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Switch over Point (ccm): 2.15

	Hold Times (s)	Hold Pressures [bar]
1	0.00	1100.00
2	2.00	1100.00
3	14.00	600.00
4	4.00	50.00
5		
6		

Holding Flowrate (ccm/s):

Plastification

Dosage (ccm)	17.80
Circum.Speed (m/min)	10.00
Back Pressure (bar)	35.0
Decomp. Flow (ccm/s)	10.0
Decomp. Volume (ccm)	1.5

Injection Process Actual Values

Temperatures (°C)

T 801	278	T 805	278	Cylinder Tip
T 802	280	T 831		
T 803	278	T 832		
T 804	278	T 833		

Pressures and Volumes

Peak pressure (bar)	1125.57
Switch over pr. (bar)	1124.71
Cushion (ccm)	1.79

Times (s)

Injection	3.42
Dosage	2.69
Cooling	4.25
Cycle	32.12

Quality Data

	Avg.	Std. Dev.
TIR @ End Cap (mm)		0.0000
TIR @ Transition (mm)		0.0000
Part Weight (g)	10.0800	0.0000

PTI-ℰ

PTI-Europe SARL, Parc Technologique Y Parc, Rue Galilée 15, CH-1400 Yverdon-les-Bains, Switzerland

UPDATED REPORT - SIMPLIFIED

Issue Date:	**September 25th, 2014**	
Issued To:	**Jesper van Berkel**	**Avantium**
Issued By:	**Stéphane Morier**	**PTI-Europe**
Subject:	**PEF recycling: Feasibility study into bottle application of rPET bottle with 2% and 5% of PEF**	
NS Project:	**3244.9798 & 3244.10040**	
Proposal number:	**SMO 241013 001B & SMO 091213 001**	

Dear Mr. van Berkel,

We are pleased to provide you this report for the feasibility study during injection moulding. This report has been updated twice and now includes typical data on the PET version of the PTI generic 1.5l CSD container and additional color measurements results.

Introduction

In this recycling study the aim was to blend two test variables of PET and PEF flakes with the ratios 95/5 and 98/2, extrude, solid state and inject preforms with different injection conditions in order to evaluate the impact of the processing on the haziness of the preforms.

Because of the limited amount of material available, no washing was included in the plan.

Overview of the feasibility study

Bottles	RAMAPET N1S bottles	PEF bottles
Grinding	RAMAPET N1S grinded flakes	PEF grinded flakes
Blending	Blend 1-Sample A 95% control 5% PEF	Blend 1-Sample B 98% control 2% PEF
Extrusion	Extrusion Sample A	Extrusion Sample B
Crystallization	Crystallization Sample A	Crystallization Sample B
Solid stating	SSP Sample A	SSP Sample B
Blending	Blend 2-Sample C 50% virgin PET 50% Sample A	Blend 2-Sample D 50% virgin PET 50% Sample B
Preform injection	Preform 31620 C	Preform 31620 D

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Start bottles

The test PEF bottles to start the protocol are those retained from the July trial performed at PTI. As for the 3rd recycling protocol, the control RAMAPET N1S bottles have been delivered by Danone.

No retain of start bottles has been made for this campaign.

Grinding

The control bottles and test bottles have been ground separately to flakes with a 4 mm Ø size using a standard mechanical grinder.

No retain of grinded flakes has been made for this campaign.

Extrusion

The following blends have been prepared and extruded (7 kg of each):

Variables	Description	Control	Test PEF
Variable 31620 r3	Blend 1-Sample A	95 %	5 %
Variable 31620 r4	Blend 1-Sample B	98 %	2 %

The bottle flakes have been dried at the same conditions to a moisture level below 100 ppm moisture with a desiccant bed drying unit (minimum 3 hours at 160°C) and extruded at temperatures around 275°C into strands using a small tonnage Arburg press converted into a continuous extrusion mode. The extrudate has been melt filtered with a special “APR type” filter 40/250/40 mesh melt filter pack (nominal 40 microns) which is “thinner” than the standard EPBP filter. The extrudate has been rapidly cooled using a water bath and fed into a pelletizer to produce amorphous pellets. Before entering the pelletizer the strands have been air dried. The extrusion process has been monitored for heat stability and the 40/250/40 mesh melt filter pack has been changed between samples for examination.

The same processing conditions have been used for all samples. All processing conditions have been recorded and can be found in the appendix at the end of this report.

The following extruded pellets have been produced from the blends:

Variables	Description	Control	Test PEF
Variable 31620 r7	Extrusion A	95 %	5 %
Variable 31620 r8	Extrusion B	98 %	2 %

A small amount of each sample (50g) has been retained for the applicant.

Sample	Extruded pellets	
31620 r7		
31620 r8		

Extrusion evaluation

The extruded pellets were tested for visual quality and IV.

Flake sticking and flake feeding

A small amount of the dried samples have been extracted from the dryer before they enter the extruder. This has allowed us to evaluate the impact of the drying process on the agglomeration of the flake samples. Agglomeration should be below 1%.

After emptying the dryer, the hopper has been checked for flakes sticking to the hopper sidewall. Agglomeration should not lead to problems emptying the hopper by gravity without additional mechanical action. The cone of the hopper should have an angle of 60-70 degrees.

Stability pellets in extrusion process

No sticking, fumes or odours should be noticed when compared to a control sample. No additional thermal degradation, in the form of black specks or other inclusions should be present.

Filter contamination

Pressure build-up during pelletizing has been monitored and no significant differences have to be reported. However, if filterability is seen as a potential problem for the test samples as part of the test program, a separate filter test has to be done.

No problem has been reported during the processing of these 2 tests variables (no control). Once the job was completed, we noticed some flake sticking on the hopper walls for both variables. For the processing parameters, please go in the Appendix at the end of the report.

Intrinsic viscosity

The IV of the amorphous pellets was measured. Here are the results:

Sample	Description	IV [dl/g]
31620 r7	Extrusion A	0.768
31620 r8	Extrusion B	0.764

As there is no control samples the resulting values are reported for information. The resulting IV is similar for both variables.

Color (L*, a*, b*)

The color of the amorphous pellets was measured. Here are the tests results:

Sample	Description	L*	a*	b*
31620 r7	Extrusion A	64.06	-1.47	4.00
31620 r8	Extrusion B	65.34	-1.29	3.15

Crystallization and solid stating

Crystallization
Before solid stating the amorphous pellets have first been crystallized. The crystallization was done in a vacuum oven at 160℃. It is important that the pellets are crystallized sufficiently so they will not stick in the following processing steps.

The IV of the crystallized pellets has been measured.

Here are the results:

Sample	Description	IV [dl/g]
31620 r9	Crystal A	0.730
31620 r10	Crystal B	0.729

The resulting IV is similar for both variables.

Solid stating
The SSP treatment has been carried out at 205℃ (re actor temperature), which corresponds with a sample temperature between 190 and 195℃. The SSP time has been measured from when the sample reaches a minimum temperature of 180℃. The duration was the same than for the control variable of the previous trial and similar for both variables. All processing conditions were recorded and can be found in the Appendix at the end of this document.

2 SSP runs have been completed → 1 per variable

A small amount of each sample (50g) has been retained for the applicant.

Solid stating evaluation

The solid stated pellets were tested for SIV. Here are the results:

Sample	Description	IV [dl/g]
31620 r11	SSP A1	0.869
31620 r12	SSP B1	0.866

The resulting IV is similar for both variables.

Color (L*, a*, b*)
The color of the solid stated pellets was measured. Here are the tests results:

Sample	Description	L*	a*	b*
31620 r11	SSP A1	81.62	-1.63	2.90
31620 r12	SSP B1	82.72	-1.60	2.28

Sample	Solid stated pellets	
31620 r11 SSP A1		
31620 r12 SSP B1		

Preform processing

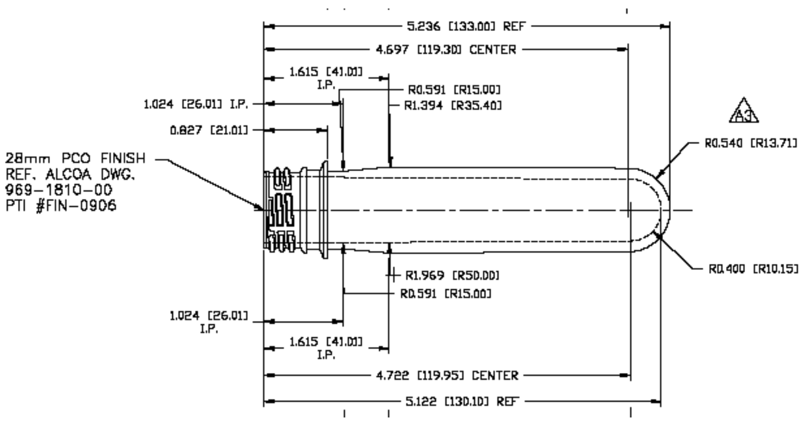
Different sub-variables of preforms have been processed during the trial for internal evaluation. For both 31620C and 31620D, only the sub-variables with the same "standard" moulding conditions used for the previous trial campaign have been retained and are fully documented in this report. The respective processing sheets can be found in the Appendix at the end of the report.

The following ~10-12 kg blends have been prepared:

Variable	Name	Description	Preform
31620 r13	Blend 2 – Sample C	50% virgin PET - 50% SSP A1	31620 C
31620 r14	Blend 2 – Sample D	50% virgin PET – 50% SSP B1	31620 D

The virgin PET which has been used for blending is M&G Cleartuf P82 which is one of the resins from the EPBP approved list.

All samples have been injection moulded into preforms on our mono-cavity Arburg press. They have been injection molded in a 43g preform with a PCO 28mm neck finish (see drawing below). Before molding the pellets were dried for a minimum of 4 hours at 160℃ to obtain a moisture level below 50 ppm.



Intrinsic viscosity

The IV of the preforms was measured. Here are the results:

Sample	Description	IV [dl/g]
31620 C	Preform C	0.821
31620 D	Preform D	0.827

Color (L*, a*, b*) and haze

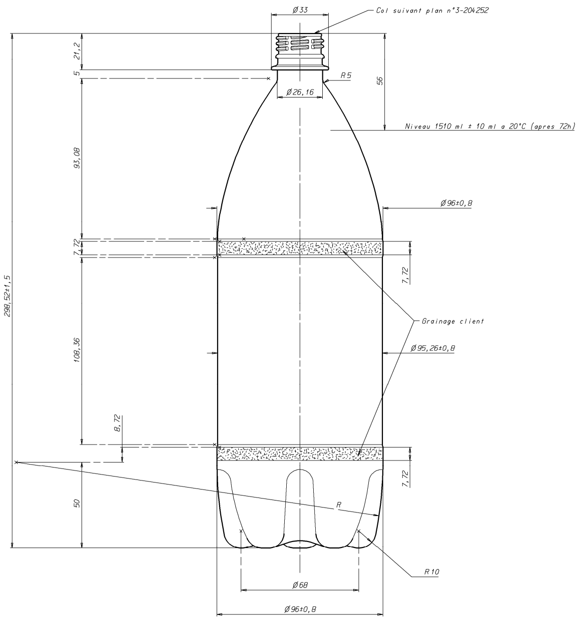
The color and haze of the preforms was measured. Here are the tests results:

Sample	Description	L*	a*	b*	Haze
31620 C	Preform C	88.89	-0.63	3.31	19.42
31620 D	Preform D	89.67	-0.64	2.64	19.01

Bottle blowing

Most preform samples have been blown into a 1.5L straight wall bottle (see drawing below) on a SBO1 blow molder.

Because of the limited amount of preforms available and the fact that we have to produce a sufficient number of bottles for lab testing, these bottles have been blown with the base process that has been validated during the September trials. A temperature check has been done for each of the sub-variables. We have blown as many good bottles as possible for each of the sub-variables.



Different sub-variables of preforms have been blown into bottles during the trial for internal evaluation. For both 31620C and 31620D, only the sub-variables 3 and 3A "Standard" have been retained and are fully documented in this report.

Variable	PTI reference	Quantity
31638 A1	31620 C (Sub-variables 3 and 3A "Standard")	101
31638 B1	31620 D (Sub-variable 3 "Standard")	97

The processing sheets can be found in the annex at the end of this document.

Bottle evaluation

The following test plan has been agreed and executed:

For Variable	Description
31638 A1 31638 B1 PTI generic data*	Full EPBP like test plan including: Color and haze, Bottle dimensions, material distribution, section weights, weight & capacity, thermal stability, burst test, top load empty, drop test. And CO_2 retention testing via FTIR.

* Because we did not have the chance to include a control variable in this trial, the test results performed on bottles containing PEF are compared to available PTI generic data. By PTI generic data we mean:

Data collected on bottles made with commercial PET CSD grade with an IV of 0.80 dL/g ± 0.02. Relevant individual or average data collected on bottles blown in different campaigns with a similar material repartition to the bottles with PEF content made during this trial.

Here are the results:

Color measurement (L*, a*, b*)

The color of all bottle samples will be measured in transmittance with a Minolta CM-3600d spectrophotometer or equivalent. Comparison between samples will be done using the same equipment. The results are not subject to a specification, but are kept for reference purposes only.

Haze measurement

This test is used to determine the amount of haze in a bottle sidewall. This is an indication of how effectively the material was processed and/or the material's ability to be processed.
The haze measurement is also carried out with the Minolta CM3600d in transmittance mode. The results are not subject to a specification, but are kept for reference purposes only.
In addition to that, all bottles will be measured for dimensions, weight, material distribution, thermal stability, stress crack, burst test, drop test etc.. The following bottle tests and test conditions are described in the 2004 ISBT Bottle Test Manual. The bottles of the test samples are compared with the bottles of the control sample. All bottles should meet the following requirements.

Variable	L*	a*	b*	Haze
31638 A1	94.83	-0.01	1.16	1.26
31638 B1	95.25	-0.02	0.77	0.48
PTI generic	95.41	-0.01	0.53	0.63

Container dimensions

Evaluate the critical dimensions (e.g. height, major diameters such as shoulder and heel, label diameter) of the bottle to ensure compliance with the manufacturer's drawing and ease of handling during the filling and capping operations. The purpose of this test is to determine if bottle dimensions are within specifications or not.

Sum up chart (all variables)

Variable	Base push-up	Heel	Lower label	Middle label	Upper label	Shoulder	Bottle height	Neckring height
31638 A1	-5.70	96.17	95.40	95.22	95.18	95.19	298.15	276.91
31638 B1	-5.66	96.21	95.41	95.22	95.18	95.20	298.19	276.94

Variable	Base Push-Up	Heel	Lower Label	Middle Label	Upper Label	Shoulder	Bottle Height	Neckring Height
PTI Generic	-5.48	96.17	95.41	95.34	95.3	95.29	298.42	277.2

No significant differences can be reported from the container dimensions. The statement is also valid when compared to PTI generic data.

Detailed charts (per variable)

3244 NS 10040	Base Push-Up	Heel	Lower Label	Middle Label	Upper Label	Shoulder	Bottle Height	Neckring Height
31638 A1	-6.00 mm	48.00 mm	60.00 mm	115.00 mm	165.00 mm	180.00 mm	298.52 mm	277.32 mm
Sample Nr.	[mm]							
1	-5.77	96.15	95.25	95.22	95.19	95.19	298.19	276.94
2	-5.75	96.19	95.34	95.21	95.18	95.18	298.16	276.88
3	-5.70	96.18	95.41	95.22	95.18	95.19	298.14	276.77
4	-5.38	96.16	95.56	95.23	95.19	95.20	298.16	276.97
5	-5.52	96.16	95.41	95.23	95.19	95.20	298.21	276.97
6	-5.71	96.17	95.40	95.22	95.18	95.19	298.14	276.91
7	-5.82	96.18	95.40	95.19	95.17	95.17	298.11	276.91
8	-5.85	96.19	95.41	95.20	95.16	95.18	298.11	276.86
9	-5.78	96.19	95.42	95.21	95.17	95.18	298.11	276.89
10	-5.59	96.17	95.41	95.22	95.18	95.18	298.19	276.94
11	-5.75	96.20	95.42	95.22	95.20	95.20	298.16	276.91
12	-5.80	96.17	95.38	95.20	95.17	95.18	298.14	276.94
Minimum	-5.85	96.15	95.25	95.19	95.16	95.17	298.11	276.77
Maximum	-5.38	96.20	95.56	95.23	95.20	95.20	298.21	276.97
Average	-5.70	96.17	95.40	95.22	95.18	95.19	298.15	276.91
Std Deviation	0.14	0.01	0.07	0.01	0.01	0.01	0.03	0.06

Nominal Spec.	-6.00	95.25	95.25	95.25	95.25	96.00	298.52	277.32
Low Spec.	-7.50	94.45	94.45	94.45	94.45	95.20	297.02	275.82
High Spec.	-4.50	96.05	96.05	96.05	96.05	96.80	300.02	278.82

3244 NS 10040	Base Push-Up	Heel	Lower Label	Middle Label	Upper Label	Shoulder	Bottle Height	Neckring Height
31638 B1	-6.00 mm	48.00 mm	60.00 mm	115.00 mm	165.00 mm	180.00 mm	298.52 mm	277.32 mm
Sample Nr.	[mm]							
1	-5.60	96.19	95.39	95.21	95.17	95.19	298.16	276.81
2	-5.69	96.20	95.42	95.21	95.18	95.19	298.16	276.94
3	-5.76	96.21	95.38	95.20	95.17	95.18	298.14	276.91
4	-5.65	96.19	95.42	95.22	95.19	95.20	298.21	277.01
5	-5.71	96.20	95.41	95.22	95.18	95.20	298.21	276.97
6	-5.62	96.21	95.45	95.20	95.18	95.19	298.16	276.97
7	-5.62	96.22	95.43	95.22	95.17	95.20	298.19	276.81
8	-5.58	96.18	95.42	95.21	95.18	95.20	298.21	277.01
9	-5.66	96.21	95.44	95.23	95.18	95.20	298.19	276.97
10	-5.64	96.22	95.30	95.22	95.19	95.20	298.21	276.94
11	-5.70	96.23	95.44	95.23	95.19	95.20	298.19	276.97
12	-5.73	96.22	95.42	95.23	95.19	95.21	298.16	276.94
Minimum	-5.76	96.18	95.30	95.20	95.17	95.18	298.14	276.81
Maximum	-5.58	96.23	95.45	95.23	95.19	95.21	298.21	277.01
Average	-5.66	96.21	95.41	95.22	95.18	95.20	298.19	276.94
Std Deviation	0.06	0.01	0.04	0.01	0.01	0.01	0.03	0.07

Nominal Spec.	-6.00	95.25	95.25	95.25	95.25	96.00	298.52	277.32
Low Spec.	-7.50	94.45	94.45	94.45	94.45	95.20	297.02	275.82
High Spec.	-4.50	96.05	96.05	96.05	96.05	96.80	300.02	278.82

Material distribution

Successful performance of a container is related to many critical properties that are dependent on the bottle wall thickness profile consistency (e.g., CO2 permeation rate, O2 ingress, water vapor transmission rate, volume change, topload strength). The purpose of this test is to measure wall thickness in distinct regions of plastic bottles in order to monitor and compare with physical performance.

Sum up chart (all variables)

Variable	Gate	Base	Heel	Lower label	Middle label	Upper label	Shoulder
31638 A1	3.01	0.24	0.27	0.24	0.25	0.25	0.25
31638 B1	3.02	0.24	0.29	0.26	0.26	0.27	0.27

Variable	Gate	Base	Heel	Lower Label	Middle Label	Upper Label	Shoulder
PTI Generic	3.08	0.24	0.3	0.27	0.27	0.27	0.27

No significant differences can be reported from the container material distribution. The statement is also valid when compared to PTI generic data.

Detailed charts (per variable)

		AVERAGE THICKNESS					
3244 N S 10040	Gate	Base	Heel	Lower Label	Middle Label	Upper Label	Shoulder
31638 A1	-5.00 mm	0.00 mm	48.00 mm	60.00 mm	115.00 mm	165.00 mm	180.00 mm
Sample Nr.	[mm]						
1	2.948	0.231	0.275	0.247	0.249	0.254	0.254
2	3.023	0.237	0.274	0.245	0.249	0.254	0.254
3	3.000	0.239	0.274	0.245	0.250	0.255	0.255
4	3.123	0.232	0.275	0.243	0.246	0.253	0.253
5	3.088	0.233	0.274	0.242	0.245	0.251	0.251
6	2.989	0.230	0.274	0.243	0.252	0.255	0.255
7	2.927	0.240	0.273	0.242	0.249	0.254	0.254
8	2.962	0.243	0.273	0.243	0.246	0.251	0.251
9	2.962	0.239	0.273	0.245	0.248	0.253	0.253
10	3.023	0.232	0.272	0.243	0.247	0.252	0.251
11	3.026	0.239	0.271	0.241	0.252	0.252	0.253
12	3.026	0.231	0.275	0.244	0.245	0.251	0.251
Minimum	2.927	0.230	0.271	0.241	0.245	0.251	0.251
Maximum	3.123	0.243	0.275	0.247	0.252	0.255	0.255
Average	3.007	0.236	0.274	0.244	0.248	0.253	0.253
Std Deviation	0.058	0.004	0.001	0.002	0.002	0.001	0.001

		AVERAGE THICKNESS					
3244 N S 10040	Gate	Base	Heel	Lower Label	Middle Label	Upper Label	Shoulder
31638 B1	-5.00 mm	0.00 mm	48.00 mm	60.00 mm	115.00 mm	165.00 mm	180.00 mm
Sample Nr.	[mm]						
1	3.049	0.241	0.289	0.257	0.260	0.266	0.266
2	3.038	0.239	0.290	0.257	0.266	0.267	0.267
3	2.956	0.241	0.291	0.258	0.261	0.266	0.266
4	3.089	0.248	0.289	0.257	0.263	0.267	0.267
5	2.984	0.238	0.290	0.257	0.259	0.264	0.264
6	3.007	0.237	0.288	0.256	0.263	0.265	0.265
7	3.016	0.242	0.288	0.254	0.256	0.262	0.263
8	3.033	0.238	0.289	0.257	0.259	0.265	0.266
9	3.021	0.242	0.288	0.256	0.258	0.264	0.264
10	3.115	0.234	0.287	0.254	0.260	0.264	0.264
11	2.972	0.235	0.285	0.254	0.262	0.264	0.265
12	2.975	0.241	0.287	0.255	0.261	0.265	0.265
Minimum	2.956	0.234	0.285	0.254	0.256	0.262	0.263
Maximum	3.115	0.248	0.291	0.258	0.266	0.267	0.267
Average	3.021	0.240	0.288	0.256	0.261	0.265	0.265
Std Deviation	0.048	0.004	0.002	0.001	0.003	0.001	0.001

Section weights

A bottle has a unique material distribution profile depending on the bottle gram weight and processing technique. Consistency of weight distribution is an important factor in bottle performance. The purpose of bottle sectioning is to allow measurement of a specific cylindrical segment (such as shoulder, panel and base) of a bottle.

This procedure is used to quantify the overall distribution of material in a bottle by cutting the bottle with hot wires into standard sections and comparing the weight of the pieces with reference values. Main objective to weight section measurement is to build a reference for on-production site measurement, allowing quick quality control for material distribution.

Detailed charts (per variable)

3244 NS 10040	Sample Weight	Bottom	Lower Label	Upper Label	Top
31638 A1		0 - 55	55 - 115	115 - 178	178 - Top
Sample Nr.	[g]				
1	42.35	12.50	6.80	6.73	16.32
2	42.34	12.45	6.78	6.74	16.37
3	42.34	12.30	6.86	6.72	16.46
4	42.34	12.40	6.88	6.71	16.35
5	42.34	12.36	6.84	6.75	16.39
6	42.34	12.32	6.78	6.72	16.52
7	42.34	12.25	6.84	6.79	16.46
8	42.33	12.43	6.76	6.73	16.41
9	42.34	12.28	6.74	6.78	16.54
10	42.34	12.44	6.80	6.73	16.37
11	42.33	12.43	6.81	6.73	16.36
12	42.34	12.33	6.85	6.77	16.39
Minimum	42.33	12.25	6.74	6.71	16.32
Maximum	42.35	12.50	6.88	6.79	16.54
Average	42.34	12.37	6.81	6.74	16.41
Std Deviation	0.01	0.08	0.04	0.03	0.07

3244 NS 10040 31638 B1	Sample Weight	Bottom	Lower Label	Upper Label	Top
		0 - 55	55 - 115	115 - 178	178 - Top
Sample Nr.	[g]				
1	42.32	12.25	6.72	6.75	16.60
2	42.31	11.84	6.94	6.79	16.74
3	42.32	12.08	6.88	6.79	16.57
4	42.33	12.12	6.83	6.82	16.56
5	42.32	12.25	6.84	6.77	16.46
6	42.33	12.21	6.78	6.81	16.53
7	42.32	12.41	6.81	6.72	16.38
8	42.33	12.17	6.88	6.80	16.48
9	42.32	12.08	6.89	6.77	16.58
10	42.33	12.05	6.87	6.78	16.63
11	42.31	11.97	6.86	6.81	16.67
12	42.33	12.07	6.85	6.81	16.60
Minimum	42.31	11.84	6.72	6.72	16.38
Maximum	42.33	12.41	6.94	6.82	16.74
Average	42.32	12.13	6.85	6.79	16.57
Std Deviation	0.01	0.15	0.06	0.03	0.10

The two variables of bottles with PEF content have similar section weights.

Variable	Sample Weight	Bottom	Lower label	Upper label	Top
		0-55	55-115	115-178	178 - Top
PTI Generic	42.29	13.29	6.66	6.71	15.62

Although the 2 variables of bottles with PEF content were similar in terms of material repartition, there is a shift of ~1g of material between the top and the base when compared to PTI generic data.

Weight & Capacity

Plastic bottles must meet the specific capacity requirements of the country(s) in which the bottles will be used. Additionally, bottle weight can impact a number of performance attributes. The purpose of this test is to determine the weight of a bottle along with fill point and overflow capacity.

Detailed charts (per variable)

3244 NS 10040 31638 A1	Tara Weight	Brimful Capacity	Fillful Capacity	Brimfull Capacity	Fillful Capacity
Sample Nr.	[g]			[ml]	
1	42.36	1556.04	1502.44	1559.69	1505.97
2	42.36	1556.24	1502.24	1559.89	1505.77
3	42.35	1555.95	1502.35	1559.60	1505.88
4	42.36	1555.64	1501.54	1559.29	1505.06
5	42.36	1555.54	1501.64	1559.19	1505.16
6	42.35	1555.95	1502.15	1559.60	1505.67
7	42.34	1555.26	1501.56	1558.91	1505.08
8	42.34	1555.36	1501.76	1559.01	1505.28
9	42.36	1555.74	1501.74	1559.39	1505.26
10	42.35	1555.75	1502.05	1559.40	1505.57
11	42.35	1556.15	1502.05	1559.80	1505.57
12	42.34	1555.66	1501.66	1559.31	1505.18
Minimum	42.34	1555.26	1501.54	1558.91	1505.06
Maximum	42.36	1556.24	1502.44	1559.89	1505.97
Average	42.35	1555.77	1501.93	1559.42	1505.45
Std Deviation	0.01	0.30	0.32	0.30	0.32

3244 NS 10040 31638 B1	Tara Weight	Brimful Capacity	Fillful Capacity	Brimfull Capacity	Fillful Capacity
Sample Nr.	[g]			[ml]	
1	42.32	1556.58	1502.48	1559.94	1505.73
2	42.32	1556.78	1502.68	1560.14	1505.93
3	42.31	1556.59	1502.89	1559.95	1506.14
4	42.31	1557.39	1503.39	1560.75	1506.64
5	42.31	1556.89	1502.99	1560.25	1506.24
6	42.32	1556.48	1502.78	1559.84	1506.03
7	42.32	1556.38	1502.68	1559.74	1505.93
8	42.31	1556.59	1502.69	1559.95	1505.94
9	42.32	1556.68	1502.98	1560.04	1506.23
10	42.31	1556.79	1503.09	1560.15	1506.34
11	42.31	1557.09	1503.29	1560.45	1506.54
12	42.31	1556.69	1502.79	1560.05	1506.04
Minimum	42.31	1556.38	1502.48	1559.74	1505.73
Maximum	42.32	1557.39	1503.39	1560.75	1506.64
Average	42.31	1556.74	1502.89	1560.10	1506.14
Std Deviation	0.01	0.28	0.27	0.28	0.27

Variable	Brimfull Capacity	Fillful Capacity
PTI Generic	1562	1507

The two variables of bottles have similar fillfull and brimfull capacities which are aligned with PTI generic data.

Thermal stability test

CO2 gas in carbonated beverages exerts a pressure on the bottle walls. As temperature increases, pressure increases, causing the bottle to expand and creep (permanently deform under the influence of an applied stress). Excessive creep will cause the beverage fill level to drop, which will negatively affect package appearance and affect how the bottle fits into a carrier shell, sits on a shelf, or fits into a vending machine. The purpose of this test is to measure a bottle's resistance to creep.

The difference between the test sample and the control sample should be less than 10%.

Detailed charts (per variable)

3244 NS 10040	Base Push-Up		Heel		Lower Label		Middle Label		Upper Label		Shoulder		Neckring Height	
31638 A1	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation
Sample Nr.	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]
1	-3.81	-51.44	98.04	1.93	97.95	2.76	97.94	2.77	97.93	2.81	97.34	2.21	280.23	1.17
2	-4.03	-42.68	98.06	1.91	97.92	2.64	97.82	2.66	97.79	2.68	97.20	2.07	280.14	1.16
3	-4.10	-39.02	97.97	1.83	97.82	2.47	97.74	2.57	97.72	2.60	97.13	1.99	279.79	1.08
4	-3.97	-35.52	97.82	1.69	97.67	2.16	97.63	2.47	97.68	2.55	97.05	1.90	279.84	1.02
5	-4.12	-33.98	97.82	1.69	97.68	2.33	97.71	2.54	97.72	2.58	97.08	1.95	279.78	1.00
6	-4.14	-37.92	97.84	1.70	97.67	2.32	97.59	2.43	97.58	2.45	96.99	1.85	279.74	1.01
7	-4.21	-38.24	97.97	1.83	97.80	2.46	97.71	2.57	97.67	2.57	97.09	1.98	279.87	1.06
8	-4.23	-38.30	98.02	1.87	97.85	2.49	97.69	2.54	97.70	2.60	97.11	2.00	279.89	1.08
9	-4.15	-39.28	98.00	1.84	97.82	2.45	97.66	2.51	97.69	2.58	97.09	1.97	279.86	1.06
10	-4.08	-37.01	97.87	1.74	97.71	2.36	97.49	2.33	97.66	2.54	97.04	1.92	279.87	1.05
11	-4.25	-35.29	97.92	1.76	97.73	2.36	97.59	2.42	97.53	2.40	96.96	1.81	279.69	1.00
12	-4.17	-39.09	97.86	1.72	97.66	2.34	97.53	2.39	97.62	2.51	97.02	1.89	279.74	1.00
Minimum	-4.25	-51.44	97.82	1.69	97.66	2.16	97.49	2.33	97.53	2.40	96.96	1.81	279.69	1.00
Maximum	-3.81	-33.98	98.06	1.93	97.95	2.76	97.94	2.77	97.93	2.81	97.34	2.21	280.23	1.17
Average	-4.11	-38.98	97.93	1.79	97.77	2.43	97.67	2.52	97.69	2.57	97.09	1.96	279.87	1.06
Std Deviation	0.12	4.53	0.09	0.09	0.10	0.16	0.12	0.12	0.10	0.10	0.10	0.10	0.16	0.06

3244 N S 10040	Base Push-Up		Heel		Lower Label		Middle Label		Upper Label		Shoulder		Neckring Height	
31638 B1	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation	After TS	Variation
Sample Nr.	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]	[mm]	[%]
1	-4.01	-39.65	98.09	1.93	97.91	2.57	97.65	2.50	97.61	2.50	97.03	1.90	279.87	1.10
2	-4.12	-38.11	97.88	1.71	97.66	2.29	97.47	2.32	97.52	2.40	96.94	1.81	279.78	1.01
3	-4.15	-38.80	97.74	1.56	97.53	2.20	97.41	2.26	97.52	2.41	96.92	1.79	279.69	1.00
4	-4.22	-33.89	97.89	1.73	97.65	2.29	97.38	2.22	97.47	2.34	96.85	1.70	279.51	0.90
5	-4.26	-34.04	97.86	1.70	97.64	2.29	97.45	2.29	97.55	2.43	96.94	1.80	279.74	0.99
6	-4.27	-31.62	97.93	1.75	97.74	2.35	97.61	2.47	97.72	2.60	97.09	1.96	279.89	1.04
7	-4.19	-34.13	97.94	1.76	97.73	2.35	97.55	2.39	97.63	2.52	97.00	1.86	279.74	1.05
8	-4.11	-35.77	97.85	1.70	97.64	2.27	97.49	2.34	97.59	2.47	96.99	1.84	279.74	0.98
9	-4.18	-35.41	97.83	1.66	97.63	2.25	97.49	2.33	97.52	2.40	96.95	1.80	279.87	1.04
10	-4.21	-33.97	97.95	1.76	97.74	2.49	97.50	2.34	97.58	2.45	96.98	1.84	279.73	1.00
11	-4.31	-32.25	97.91	1.72	97.68	2.29	97.43	2.26	97.49	2.36	96.91	1.76	279.66	0.96
12	-4.28	-33.88	97.75	1.57	97.53	2.16	97.39	2.22	97.50	2.37	96.88	1.73	279.69	0.98
Minimum	-4.31	-39.65	97.74	1.56	97.53	2.16	97.38	2.22	97.47	2.34	96.85	1.70	279.51	0.90
Maximum	-4.01	-31.62	98.09	1.93	97.91	2.57	97.65	2.50	97.72	2.60	97.09	1.96	279.89	1.10
Average	-4.19	-35.12	97.89	1.71	97.67	2.32	97.49	2.33	97.56	2.44	96.96	1.82	279.74	1.00
Std Deviation	0.09	2.53	0.09	0.10	0.10	0.11	0.08	0.09	0.07	0.08	0.07	0.07	0.11	0.05

PTI Generic	-4.00	-30.00	98.00	2.00	-	-	98.00	2.00	-	-	98.00	2.00	-	1.00

The two variables of bottles are similarly thermically stable. The results are aligned with PTI generic data.

Burst test

Bottles are subjected to rapidly increasing pressure during the filling operation. The purpose of this test is to determine the failure point of the PET bottle when pressurized under specific conditions.

The difference between the test sample and the control sample should be less than 10%.

Sum up chart (all variables)

Variable	Pressure [bar]	Expansion [ml]	Expansion [%]	Location of failure
31638 A1	11.5	565	38	Sidewall
31638 B1	11.8	594	40	Sidewall
PTI Generic	11.0	565	40	Sidewall

The failure mode in the sidewall is correct. There is no significant difference to report between the variables. The burst resistance is acceptable and aligned with PTI generic data for this bottle.

Detailed charts (per variable)

3244 NS 10040 31638 A1 Sample Nr.	Pressure [bar]	Expansion [ml]	Expansion [%]	Location of failure
1	11.9	550	36.7	Sidewall
2	11.0	513	34.2	Sidewall
3	10.9	499	33.2	Sidewall
4	11.4	700	46.7	Sidewall
5	11.2	567	37.8	Sidewall
6	11.7	665	44.4	Sidewall
7	11.6	575	38.3	Sidewall
8	11.3	526	35.1	Sidewall
9	11.4	545	36.4	Sidewall
10	12.2	453	30.2	Sidewall
11	11.8	598	39.9	Sidewall
12	12.0	588	39.2	Sidewall
Minimum	10.9	453	30.2	
Maximum	12.2	700	46.7	
Average	11.53	564.92	37.68	
Std Deviation	0.40	68.55	4.59	

3244 NS 10040 31638 B1 Sample Nr.	Pressure [bar]	Expansion [ml]	Expansion [%]	Location of failure
1	11.6	620	41.4	Sidewall
2	11.8	652	43.5	Sidewall
3	11.7	589	39.3	Sidewall
4	11.9	559	37.3	Sidewall
5	11.9	624	41.6	Sidewall
6	11.8	609	40.6	Sidewall
7	11.8	618	41.2	Sidewall
8	11.7	561	37.4	Sidewall
9	11.3	437	29.2	Sidewall
10	11.9	641	42.7	Sidewall
11	12.0	600	40.0	Sidewall
12	12.0	620	41.3	Sidewall
Minimum	11.3	437	29.2	
Maximum	12.0	652	43.5	
Average	11.78	594.17	39.63	
Std Deviation	0.19	56.93	3.78	

Vertical load (empty)

Empty bottles must be able to withstand a top load pressure during normal warehousing. The purpose of this test is to observe whether empty bottles (vented) can sustain top load without failure.

The difference between the test sample and the control sample should be less than 10%.

Detailed charts (per variable)

3244 NS 10040 31638 A1 Sample Nr.	Max Load (Peak) [N]	Elongation [mm]	Load at 3.75 mm [N]	Location of failure
1	181.02	1.44	171.83	Feet then upper, middle and lower label panel *
2	183.14	1.51	176.29	Feet then upper, middle and lower label panel *
3	199.15	1.58	196.78	Feet then upper, middle and lower label panel *
4	231.73	1.71	226.73	Feet then upper, middle and lower label panel *
5	225.95	1.75	222.17	Feet then upper, middle and lower label panel *
6	235.69	1.66	230.68	Feet then upper, middle and lower label panel *
7	187.87	1.58	175.79	Feet then upper, middle and lower label panel *
8	225.26	1.70	218.47	Feet then upper, middle and lower label panel *
9	248.86	2.00	238.77	Feet then upper, middle and lower label panel *
10	256.15	1.82	253.82	Feet then upper, middle and lower label panel *
11	260.17	1.94	254.43	Feet then upper, middle and lower label panel *
12	261.18	2.07	255.58	Feet then upper, middle and lower label panel *
Minimum	181.02	1.44	171.83	
Maximum	261.18	2.07	255.58	* Permanent
Average	224.68	1.73	218.45	
Std Deviation	30.12	0.20	31.35	

3244 NS 10040 31638 B1 Sample Nr.	Max Load (Peak) [N]	Elongation [mm]	Load at 3.75 mm [N]	Location of failure
1	255.29	2.09	248.84	Upper, middle and lower label panel *
2	240.66	2.06	234.12	Upper, middle and lower label panel *
3	246.18	2.09	239.51	Upper, middle and lower label panel *
4	189.70	1.73	178.05	Upper, middle and lower label panel *
5	228.61	1.92	220.20	Upper, middle and lower label panel *
6	215.33	1.85	215.51	Upper, middle and lower label panel *
7	243.65	1.78	242.25	Upper, middle and lower label panel *
8	266.12	2.29	254.95	Upper, middle and lower label panel *
9	256.60	2.07	251.56	Upper, middle and lower label panel *
10	239.55	1.97	228.96	Upper, middle and lower label panel *
11	249.70	2.11	241.89	Upper, middle and lower label panel *
12	246.73	1.99	245.39	Upper, middle and lower label panel *
Minimum	189.70	1.73	178.05	
Maximum	266.12	2.29	254.95	* Permanent
Average	239.84	2.00	233.44	
Std Deviation	20.56	0.16	21.20	

The top load resistance is similarly good for both test variables.

Variable	Max Load (Peak)	Elongation	Load at 3.75 mm
PTI Generic	225	2	210

The results are aligned with PTI generic data.

Drop test

An important feature of plastic bottles is their resistance to failure on drop impact. The purpose of this test is to determine the ability of the bottle to withstand free-fall impact forces.

The difference between the test samples and control in the case of 10 drop samples should not be more than 1 bottle failure.

Detailed charts (per variable)

	Drop Height [cm]	180		
3244 NS 10040 31638 A1 Sample Nr.	Temperature [°C]	Vert. Drop	Horiz. Drop	Failure Type / Location
1	22.0	Passed	Passed	-
2	22.0	Passed	Passed	-
3	22.0	Passed	Passed	-
4	22.0	Passed	Passed	-
5	22.0	Passed	Passed	-
6	22.0	Passed	Passed	-
7	22.0	Passed	Passed	-
8	22.0	Passed	Passed	-

3244 N S 10040 / 31638 A1	Drop Height [cm]	180		
Sample Nr.	Temperature [°C]	Vert. Drop	Horiz. Drop	Failure Type / Location
1	4.0	Passed	Passed	-
2	4.0	Passed	Passed	-
3	4.0	Passed	Passed	-
4	4.0	Passed	Passed	-
5	4.0	Passed	Passed	-
6	4.0	Passed	Passed	-
7	4.0	Passed	Passed	-
8	4.0	Passed	Passed	-

3244 N S 10040 / 31638 B1	Drop Height [cm]	180		
Sample Nr.	Temperature [°C]	Vert. Drop	Horiz. Drop	Failure Type / Location
1	22.0	Passed	Passed	-
2	22.0	Passed	Passed	-
3	22.0	Passed	Passed	-
4	22.0	Passed	Passed	-
5	22.0	Passed	Passed	-
6	22.0	Passed	Passed	-
7	22.0	Passed	Passed	-
8	22.0	Passed	Passed	-
9	22.0	Passed	Passed	-
10	22.0	Passed	Passed	-

3244 N S 10040 / 31638 B1	Drop Height [cm]	180		
Sample Nr.	Temperature [°C]	Vert. Drop	Horiz. Drop	Failure Type / Location
1	4.0	Passed	Passed	-
2	4.0	Passed	Passed	-
3	4.0	Passed	Passed	-
4	4.0	Passed	Passed	-
5	4.0	Passed	Passed	-
6	4.0	Passed	Passed	-
7	4.0	Passed	Passed	-
8	4.0	Passed	Passed	-
9	4.0	Passed	Passed	-
10	4.0	Passed	Passed	-

Both variables of test bottles have successfully passed the drop test both at 22℃ and at 4℃. It is also the case with “pure” PET bottles .

CO_2 retention testing (FTIR test)

This test will reveal any impact of the RPET on the shelflife of the bottle, i.e. on the capability of the bottle to retain CO_2. The FTIR method for carbonation retention testing is designed to accurately assess the carbonation loss-rate of a plastic beverage bottle and to extrapolate shelf-life to a predefined loss according to the specifications of the client (standard 17.5%). The amount of CO_2 is evaluated in a sample size of 10 test bottles over a 49 day period for non-refillable PET bottles, filling the bottles with known amount of dry ice and measuring the CO_2 concentration with an infrared light beam. Based on the calculated loss rate determined for this test, a shelf life can then be accurately calculated.

Standard conditions:
Filling level: 4 vol of CO_2 (dry ice)
Storage and measurement conditions: 22℃ / 50%RH
CO_2 loss at shelf life: 17.5%

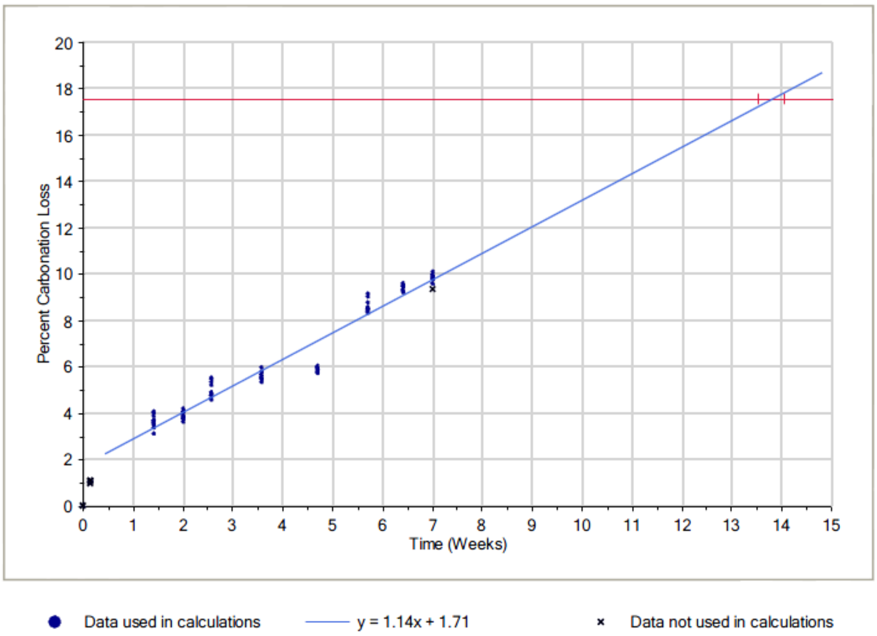
The test sample passes when the CO_2 loss is <5% less compared to the control sample. The test results are reported as such. No control bottles were available for testing.

Test Number: 31638A1

Test Results

Slope (Carbonation Loss):	1.14% per week
Intercept:	1.71%
Carbonation Loss Std:	17.5%
Shelf Life:	13.81 weeks (+/- 0.26)

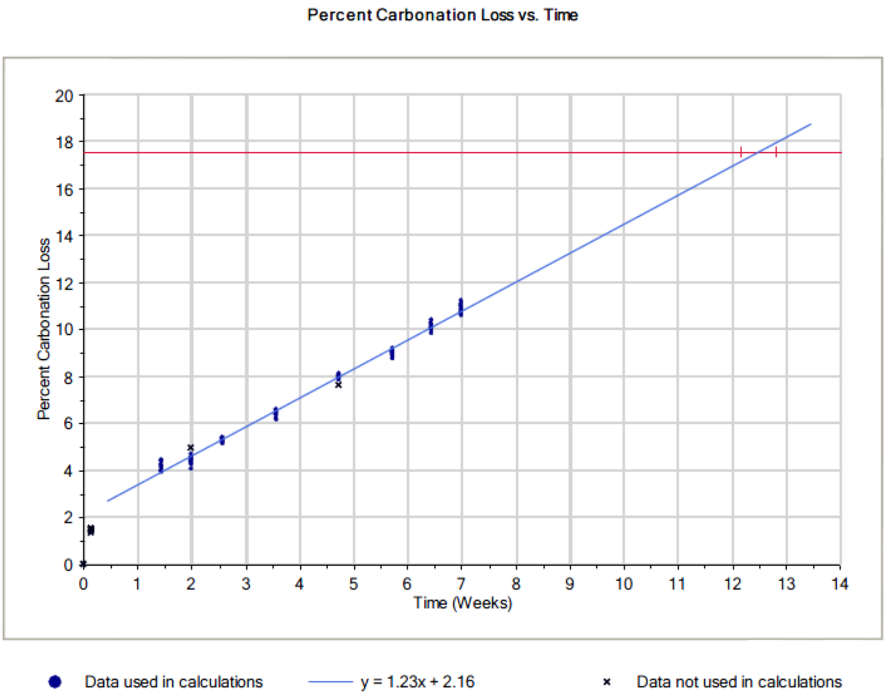
Percent Carbonation Loss vs. Time



Test Number:	31638B1

Test Results

Slope (Carbonation Loss):	1.23% per week
Intercept:	2.16%
Carbonation Loss Std:	17.5%
Shelf Life:	12.49 weeks (+/- 0.32)



The obtained values for shelflife and slope are similar to values measured on standard PET bottles.

Conclusions

Two variables have been processed during this trial campaign. They have been processed the same way in extrusion, SSP, injection and blowing with minor variations. After extrusion, we have noticed some flake sticking to the hopper walls for both variables.

We haven't noticed significant deviation between variables of blown containers. The container properties are good in terms of dimensions, material repartition, section weights, weight & capacity, thermal stability, vertical load and drop test. They are acceptable in terms of burst resistance.

APPENDIX 1: Extrusion conditions

PTI code	Description
31620 r7	Extrusion A
31620 r8	Extrusion B

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
31620 r7	14/11/13	Stéphane Morier	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	22.8	25.1	0.5	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	275
Barrel zone 2	275
Barrel zone 3	275
Barrel zone 4	274
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	11.0
Filter Pressure (bar)	60.0

Granulation

Cooling bath flow setting [Div]	0.2
Granulator feed roller pressure [bar]	2.5
Granulator speed setting [Div.]	42.5

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
31620 r8	15/11/13	Stéphane Morier	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	21.4	26.5	0.3	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	275
Barrel zone 2	275
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	274

Plastification

Circum.Speed (m/min)	11.0
Filter Pressure (bar)	60.0

Granulation

Cooling bath flow setting [Div]	0.2
Granulator feed roller pressure [bar]	2.5
Granulator speed setting [Div.]	42.5

The two variables have been extruded with the same process.

APPENDIX 2: SSP conditions

PTI code	Description
31620 r11	SSP Pellets A1
31618 r12	SSP Pellets B1

		A1	B1
Nitrogen flow	**l/h**	1500	1500
Nitrogen temp.	**°C**	205	205
Wall temp.	**°C**	205	205
Reactor temp.	**°C**	191	191
Process time	**hours**	8	8:11

APPENDIX 3: Injection Setups

PTI code	Description
31620 C	Blend 2 – Sample C
31620 D	Blend 2 – Sample D

Injection Setups

Request	Date	Project Engineer	Variable
31620 C	11/28/13	Stéphane Morier	43g generic preform

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	21.2	19.2	-4.4	15.0	160.0

Operator (s)
Jean-Claude Baumgartner

Injection Process Set Points

	Injection Pressures (bar)	Injection Flowrates (ccm/s)	End Step (ccm)
1	750.0	14.00	26.00
2	650.0	13.00	23.50
3	550.0	8.00	12.00
4	450.0	6.00	

Switch over Point (ccm): 7.00

	Hold Times (s)	Hold Pressures [bar]
1	0.00	380.00
2	2.00	300.00
3	6.50	50.00
4	0.50	50.00
5		
6		

Holding Flowrate (ccm/s):

Plastification

Dosage (ccm)	38.00
Circum.Speed (m/min)	8.00
Back Pressure (bar)	45.0
Decomp. Flow (ccm/s)	10.0
Decomp. Volume (ccm)	2.0

Injection Process Actual Values

Temperatures (°C)

T 801	275	T 805	276	Cylinder Tip
T 802	275	T 831		
T 803	276	T 832		
T 804	276	T 833		

Pressures and Volumes

Peak pressure (bar)	433.43
Switch over pr. (bar)	383.86
Cushion (ccm)	1.14

Times (s)

Injection	3.57
Dosage	6.96
Cooling	13.50
Cycle	32.82

Quality Data

TIR @ End Cap (mm)	Avg.	0.0300
	Std. Dev.	0.0000
TIR @ Transition (mm)	Avg.	0.0400
	Std. Dev.	0.0000
Part Weight (g)	Avg.	42.3200
	Std. Dev.	0.0000

Injection Setups

Request	Date	Project Engineer	Variable
31620 D	11/29/13	Stéphane Morier	43g generic preform

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	21.4	20.5	-3.3	15.0	160.0

Operator (s)
Jean-Claude Baumgartner

Injection Process Set Points

	Injection Pressures (bar)	Injection Flowrates (ccm/s)	End Step (ccm)
1	750.0	14.00	26.00
2	650.0	13.00	23.50
3	550.0	8.00	12.00
4	450.0	6.00	

Switch over Point (ccm): 7.00

	Hold Times (s)	Hold Pressures [bar]
1	0.00	380.00
2	2.00	300.00
3	6.50	50.00
4	0.50	50.00
5		
6		

Holding Flowrate (ccm/s):

Plastification

Dosage (ccm)	38.00
Circum.Speed (m/min)	10.00
Back Pressure (bar)	45.0
Decomp. Flow (ccm/s)	10.0
Decomp. Volume (ccm)	2.0

Injection Process Actual Values

Temperatures (°C)

T 801	276	T 805	275	Cylinder Tip
T 802	276	T 831		
T 803	275	T 832		
T 804	276	T 833		

Pressures and Volumes

Peak pressure (bar)	444.00
Switch over pr. (bar)	398.29
Cushion (ccm)	1.96

Times (s)

Injection	3.57
Dosage	6.39
Cooling	13.50
Cycle	32.80

Quality Data

TIR @ End Cap (mm)	Avg.	0.0400
	Std. Dev.	0.0000
TIR @ Transition (mm)	Avg.	0.0400
	Std. Dev.	0.0000
Part Weight (g)	Avg.	42.2900
	Std. Dev.	0.0000

Both variables have been processed the same way. There is nothing special to report on the visual quality of the preforms.

APPENDIX 4: Blowing Setups

PTI code	Description
31638 A1	31620 C (Sub-variables 3 and 3A “standard”)
31638 B1	31620 D (Sub-variable 3 « standard »)

Blowmolding Setups

Work Req #	31638 A 1	Project #	3244.10040	Date	13.12.2013	Description	Avantium : PEF bottle
Preform #	3523	Bottle #	4902	Finish #	906	Weight (g)	42.30
Machine	SBO 1						
Material	Variable 3 et 3A					Size	1500 ml

Mode

Mode	Manual
Bottles/Hour	1000
Spindle Loading	1 On 2

Stretch Rod Settings

SR Ø [mm]	14R
SR Speed [m/s]	1.000
P “0” (mm)	142.140
P “10” (mm)	294.700
Gap (mm)	2.00

Oven Setttings

Oven Spacing	19
Oven height	?
Oven Chain	Fast-
Vent (%)	90
Pref.window	
Pref. refl.flag	

Shims

Infeed shims	0
Outfeed shims	0
Transfer Arm shim	3.75

Blow Pressure/Timing

Flag Low Blow (mm)	200
Flag High Blow (mm)	360
High Blow Pressure (bar)	38.0
Low Blow Pressure (bar)	8.0
Low Blow Flow [Turn]	6.00
High Blow Flow [Turn]	10
Exhaust time Td1 [s]	0.60
Exhaust time Td2 [s]	
First High Blow Time Tsa [s]	
Exhaust Time Tda [s]	
Delay T1 [s]	
Delay T2 [s]	0.02

Aux 1 Set Pressure [bar]	
Aux 1 Reset Pressure[bar]	
Aux 1 Set Flow [Turn]	
Aux 1 Reset Flow [Turn]	
Aux 2 set Pressure [bar]	
Aux 2 Reset Pressure[bar]	

Heating

Heat Zones		Oven 2	Oven 1	Lamp Position
10(L)	0.0	Off	Off	○ In ○ Out ◉ Up
9(K)	0.0	Off	Off	◉ In ○ Out ○ Up
8(H)	44.0	On	On	◉ In ○ Out ○ Up
7(G)	64.0	On	On	◉ In ○ Out ○ Up
6(F)	55.0	On	On	◉ In ○ Out ○ Up
5(E)	50.0	On	On	◉ In ○ Out ○ Up
4(D)	50.0	On	On	◉ In ○ Out ○ Up
3(C)	50.0	On	On	◉ In ○ Out ○ Up
2(B)	60.0	On	On	◉ In ○ Out ○ Up
1(A)	50.0	On	On	◉ In ○ Out ○ Up

Overall [%] 58.0 Preform Temp (C°) 111.0

Timings [F3]

Stretch Down	24
Stretch Up	90
Nozzle Down	22
Nozzle Up 2T	99
Nozzle Up 1T	106
Aux 1 Set	
Aux 1 Reset	
Aux 2 Set	
Aux 2 Reset	

Mold Temperatures

	Setpoint Temp (°C)
Body	16
Base	16
Neck	N/A
Oven	N/A

Blowmolding Setups

Work Req #	31638 B 1	Project #	3244.10040	Date	13.12.2013	Description	Avantium : PEF Bottle sampling and testing
Preform #	3523	Bottle #	4902	Finish #	906	Weight (g)	42.30
Material	Variable 3					Size	1500 ml
						Machine	SBO 1

Mode

Mode	Manual
Bottles/Hour	1000
Spindle Loading	1 On 2

Stretch Rod Settings

SR Ø [mm]	14 R
SR Speed [m/s]	1.000
P "0" (mm)	142.140
P "10" (mm)	294.700
Gap (mm)	2.00

Oven Setttings

Oven Spacing	19
Oven height	+ 4 mm
Oven Chain	Fast-
Vent (%)	90
Pref.window	
Pref. refl.flag	

Shims

Infeed shims	0
Outfeed shims	0
Transfer Arm shim	3.75

Blow Pressure/Timing

Flag Low Blow (mm)	200	Aux 1 Set Pressure [bar]	
Flag High Blow (mm)	360	Aux 1 Reset Pressure[bar]	
High Blow Pressure (bar)	38.0	Aux 1 Set Flow [Turn]	
Low Blow Pressure (bar)	8.0	Aux 1 Reset Flow [Turn]	
Low Blow Flow [Turn]	5.00		
High Blow Flow [Turn]	10		
Exhaust time Td1 [s]	0.60	Aux 2 set Pressure [bar]	
Exhaust time Td2 [s]		Aux 2 Reset Pressure[bar]	
First High Blow Time Tsa [s]			
Exhaust Time Tda [s]			
Delay T1 [s]			
Delay T2 [s]	0.02		

Heating

Heat Zones		Oven 2	Oven 1	Lamp Position
10(L)	0.0	Off	Off	○ In ○ Out ◉ Up
9(K)	0.0	Off	Off	◉ In ○ Out ○ Up
8(H)	44.0	On	On	◉ In ○ Out ○ Up
7(G)	64.0	On	On	◉ In ○ Out ○ Up
6(F)	55.0	On	On	◉ In ○ Out ○ Up
5(E)	50.0	On	On	◉ In ○ Out ○ Up
4(D)	49.0	On	On	◉ In ○ Out ○ Up
3(C)	49.0	On	On	◉ In ○ Out ○ Up
2(B)	60.0	On	On	◉ In ○ Out ○ Up
1(A)	50.0	On	On	◉ In ○ Out ○ Up

Overall [%] 59.0 Preform Temp (C°) 113.5

Timings [F3]

Stretch Down	24
Stretch Up	90
Nozzle Down	22
Nozzle Up 2T	99
Nozzle Up 1T	106
Aux 1 Set	
Aux 1 Reset	
Aux 2 Set	
Aux 2 Reset	

Mold Temperatures

	Setpoint Temp (°C)
Body	16
Base	16
Neck	N/A
Oven	N/A

The two variables have been processed the same way with minor adaptation on the heating profile. The variables 31638 B1 has been processed with 1% more overall power at 113.5℃ instead of 111℃.