Report

Project Title	EPBP and APR recycling evaluation of PEF as ML in PET bottles
Date	October 21, 2021
Issued To	Roy Visser – AVANTIUM
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Project Number	3244.31370

Project Background & Goals

AVANTIUM wants to evaluate the recyclability of PEF as a barrier layer in multilayer PET bottles. This material can be used for general bottle applications and as such it might end-up in the clear PET recycling stream. Therefore, it is important to evaluate the impact of the presence of this material on the PET recycling stream. The following TEST variable has been evaluated:

- 10% PEF as multilayer (core biased)

It is understood that this evaluation has been completed for AVANTIUM and that the goal is to submit the report to the EPBP to get an official endorsement. 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 then grouped at the end of the report in a second section called “Appendix”.

Summary of results

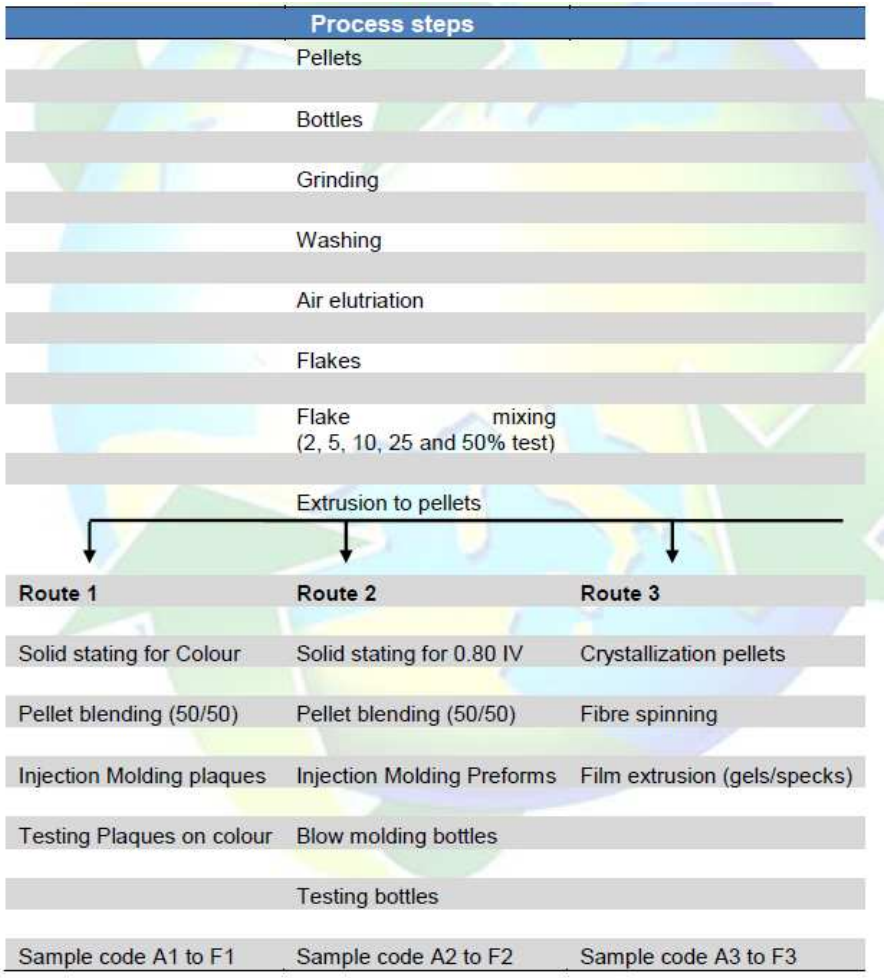
The impact of PEF on the clear PET recycling stream was evaluated according to Route 1 of the EPBP protocol. In this protocol we evaluated how the presence of this additive influence processing and performance properties during different steps such as extrusion, crystallization, SSP and plaque injection. It was decided to test the impact on recycling for 2 TEST flakes concentrations of **25%** and **50%**.

The CONTROL and the TEST variables have been processed the same way according to the EPBP Processing Guidelines. We have nothing special to report regarding the processing of TEST variable at 25% and 50% concentrations. This is validated by the fact that the EPBP specifications in term of IV, AA generation and SSP IV catch-up rate are met.

The evaluation of the plaques is showing that the **25% TEST** concentration variable do meet the EPBP specifications in terms of L*, a* and Haze. Unfortunately, the **50% TEST** concentration variable is not meeting the EPBP specification in terms of delta b*.

Bottle to Properties Protocol

The Bottle-to-properties protocol involves a lot of various steps which are outlined in the table below.

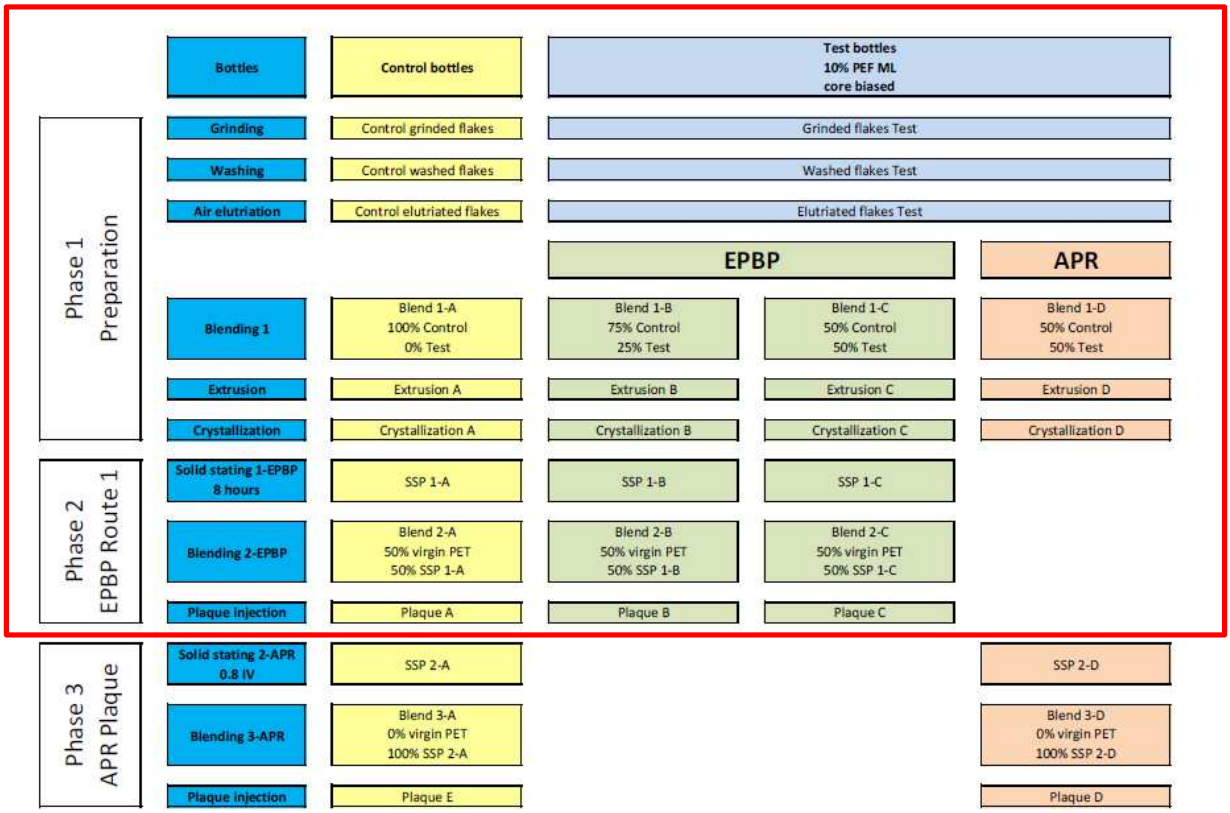


Process steps		
	Pellets	
	Bottles	
	Grinding	
	Washing	
	Air elutriation	
	Flakes	
	Flake mixing (2, 5, 10, 25 and 50% test)	
	Extrusion to pellets	
Route 1	**Route 2**	**Route 3**
Solid stating for Colour	Solid stating for 0.80 IV	Crystallization pellets
Pellet blending (50/50)	Pellet blending (50/50)	Fibre spinning
Injection Molding plaques	Injection Molding Preforms	Film extrusion (gels/specks)
Testing Plaques on colour	Blow molding bottles	
	Testing bottles	
Sample code A1 to F1	Sample code A2 to F2	Sample code A3 to F3

It was decided to test the impact on recycling with 2 combinations of concentration of the TEST variable and compare it to the CONTROL variable (see overview below – red square).

PTI has carried out the testing of all samples according to fixed conditions agreed with the EPBP. Details of these conditions, together with agreed deviations on the protocol, are detailed in the following pages.

Overview of the combined EPBP (Route 1) and APR (CG) protocols



Sample codes

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

PTI code	Description	Rem. / Concentrations
32669 A1	CONTROL bottles	PET
32669 A2	TEST bottles	PET + 10% PEF
32669 r1	grinded CONTROL bottles	
32669 r2	grinded TEST bottles	
32669 r3	Washed control flakes	
32669 r4	Washed TEST flakes	
32669 r11	Extruded pellets A	100 % CONTROL
32669 r12	Extruded pellets B	75% CONTROL +25% TEST (EPBP)
32669 r13	Extruded pellets C	50% CONTROL + 50% TEST (EPBP)
32669 r14	Extruded pellets D	50% CONTROL + 50% TEST (for APR)
32669 r15	Crystallized pellets A	100 % CONTROL
32669 r16	Crystallized pellets B	75% CONTROL +25% TEST (EPBP)
32669 r17	Crystallized pellets C	50% CONTROL + 50% TEST (EPBP)
32669 r18	Crystallized pellets D	50% CONTROL + 50% TEST (for APR)
32669 r19	SSP pellets 1-A	100 % CONTROL
32669 r20	SSP pellets 1-B	75% CONTROL +25% TEST (EPBP)
32669 r21	SSP pellets 1-C	50% CONTROL + 50% TEST (EPBP)
32669 C	Plaque A	50% virgin – 50% SSP 1-A
32669 D	Plaque B	50% virgin – 50% SSP 1-B
32669 E	Plaque C	50% virgin – 50% SSP 1-C

Sample testing

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

Start bottles	Flakes before washing	Flakes after washing	Extruded pellets	Crystallized pellets	SSP pellets	Plaques
Color	Visual	Visual	Visual	IV	Visual	Color
Haze	IV	IV	IV		IV – SSP rate	Haze
IV	Color	Color	Color		Color	
		Bulk Density			AA	
					DSC	
					Fluorescence	

Start Material

AVANTIUM has supplied PTI with the 2 variables of CONTROL and TEST 19.7g preforms. PTI has then blow molded the preforms into 500ml CSD bottles, in the following quantities:

Description	PTI ID	Total Weight
CONTROL bottles	32669 A1	~ 54 kg
TEST bottles	32669 A2	~ 24 kg

32669 A1	32669 A2
	
CONTROL Bottles	TEST bottles

In addition, AVANTIUM has supplied ~ 20kg of virgin PET resin (RAMAPET 1708CC) for further blending and plaque injection steps.

Material evaluation

Color (L*, a* and b*), and haze values were measured. Three samples of each variable were retained for the applicant. Here are the test results:

PTI reference	Description	L*	a*	b*	Haze	IV (dL/g)
32669 A1	CONTROL Bottles	95.09	0.00	0.67	0.75	0.76
32669 A2	TEST bottles	94.92	0.00	0.78	1.40	0.78

Five samples of each variable were retained for AVANTIUM.

Grinding

All variables were ground separately to flakes with a 12mm side size using a standard mechanical grinder. Nothing relevant was observed during the grinding step.

Variable	Sample pictures	
32669 r1 Grind Control		
32669 r2 Grind Test		

Washing

The 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.

Variable	Sample pictures	
32669 r3 Wash Control		

32669 r4 Wash Test		

- 45.5 kg of CONTROL material has been washed resulting in 45kg of washed CONTROL material
- 20.8 kg of TEST material has been washed resulting in 19.4 kg of washed TEST material

After washing, both flake samples were tested for colour, bulk density and IV and a small sample (50g) was retained for the applicant.

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

Variable	Steps
Control	
TEST	
	Pre-wash / Main Wash / Hot Rinsing

The pre wash, wash and hot rinsing water retains are similar for all variables. There is nothing to report. No contamination of the washing line has been reported.

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.

Here are the results:

Before washing			**After washing**		
Sample	Description	**IV [dl/g]**	Sample	Description	**IV [dl/g]**
32669 r1	Grind CONTROL	0.76	32669 r3	Wash CONTROL	0.77
32669 r2	Grind TEST	0.77	32669 r4	Wash TEST	0.77

Washing has no impact on IV for both variables.

Bulk density

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

Sample	**Description**	**Bulk density [g/ml]**
32669 r3	Wash CONTROL	0.30
32669 r4	Wash TEST	0.19

Although all the flakes have been grinded out of the same bottle design, we want to highlight the lower bulk density of the TEST variable for future reference.

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*
32669 r1	Grind CONTROL	62.65	-0.47	-0.18
32669 r3	Wash CONTROL	65.71	-0.64	0.12
32669 r2	Grind TEST	62.87	-0.38	-0.61
32669 r4	Wash TEST	65.82	-0.53	-0.41

The washing process has a very limited impact on the L*, a* and b* color values for the CONTROL and TEST variables. The washed flakes have a slightly higher L* and very similar a* and b* than the grinded flakes.

Air Elutriation

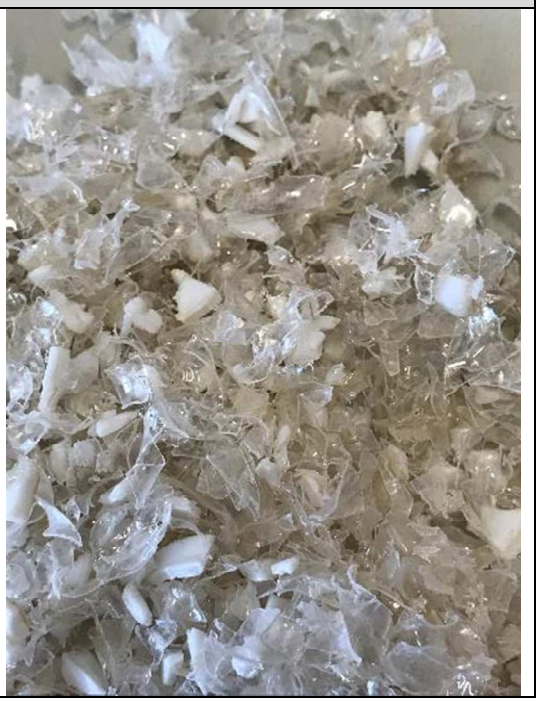
The clean and dried flakes have been separated through a laboratory scale elutriator to separate light and thin fractions such as barrier multilayer layers. The air elutriation flow has been regulated to obtain a removal rate of 0.1% on the Control flakes. The same settings have then been used for the test flakes.

CONTROL (32669 r5)	TEST (32669 r6)
	
36g removed	810g removed

Only PET fines have been removed for the CONTROL variable. When it comes to TEST variable, what has been collected are thin flakes where it is not possible at this step to identify the structure (1, 2 or 3 layers) and composition (PET, PEF or PET/PEF).

Oven Test

The removal rate has then been estimated by an oven test, where 200 g of the Control & Test flakes were heated at 220°C for 1 hour.

CONTROL (32669 r5)	TEST (32669 r6)
	

A slight discoloration (yellowing) has been observed on the TEST variable. The Oven test results demonstrates that the PEF layer has not been completely separated from PET by the grinding, washing and air elutriation steps.

The yellow particles are very thin and brittle, and some still stick to PET after this crystallization step.

Extrusion

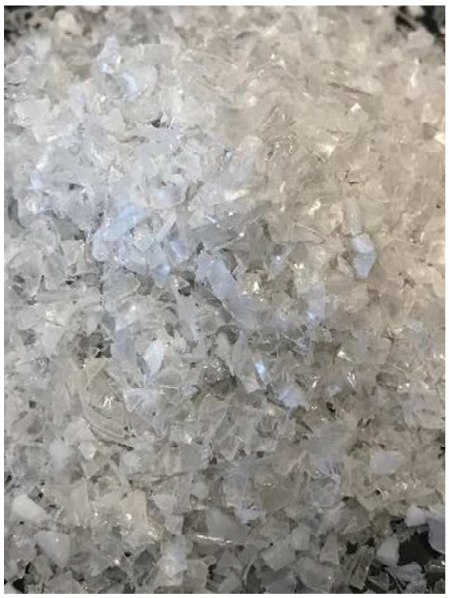
The following blends were prepared and extruded:

Description	Description	Control	Test
32669 r7	Blend 1-A	100 %	-
32669 r8	Blend 1-B	75%	25%
32669 r9	Blend 1-C	50%	50%
32669 r10	Blend 1-D	50%	50%

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 then dried at the same conditions to a moisture level below 100 ppm 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 was melt filtered with a **40/250/40** mesh melt filter pack (about 60 microns filtration) which was an approved deviation to the standard EPBP protocol. 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 40/250/40 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 demonstrated by the below pictures:

Sample	Undried flakes (4 mm)	Dried flakes (4 mm)
32669 r7 Blend 1-A		
32669 r8 Blend 1-B		

32669 r9 Blend 1-C		
32669 r10 Blend 1-D		

The following extruded pellets have been produced from the above 4mm flakes:

Description	Extruded pellets	Description
Blend 1-A	32669 r11	Extrusion A
Blend 1-B	32669 r12	Extrusion B
Blend 1-C	32669 r13	Extrusion C
Blend 1-D	32669 r14	Extrusion D

Sample	Extruded Pellets	
32669 r11 Extrusion A		
32669 r12 Extrusion B		

32669 r13 Extrusion C		
32669 r14 Extrusion D		

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.

Filters pictures	
	
Filter after 32669 r11 (Extrusion A)	**Filter after 32669 r12 (Extrusion B)**

	
Filter after 32669 r13 (Extrusion C)	**Filter after 32669 r14 (Extrusion D)**

The extrusion process went very well with no flakes sticking, feeding issues, fumes or strange odors. No residues have been found on the filters after the processing of each variable described above.

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.

Here are the results:

Sample	Description	IV [dl/g]
32669 r11	Extrusion A	0.75
32669 r12	Extrusion B	0.75
32669 r13	Extrusion C	0.76
32669 r14	Extrusion D	0.75

The TEST variables Extrusion B, C and D are within specifications.

Color (L*, a*, b*)

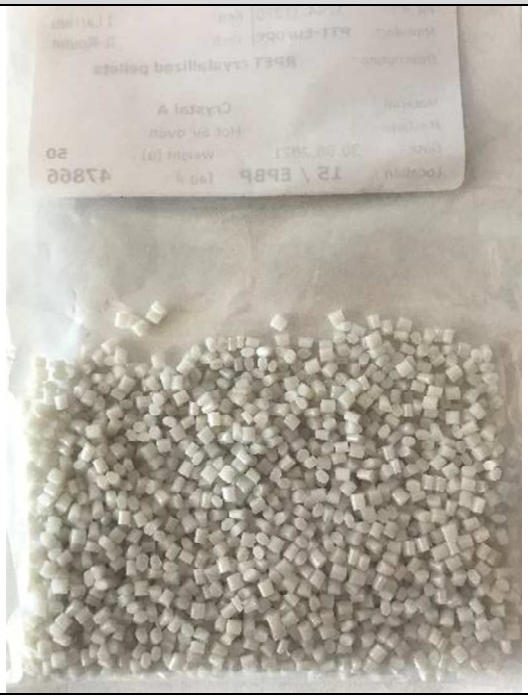
The color of the amorphous pellets was measured in reflectance with a Minolta CM-3600d spectrophotometer. Here are the L*a*b* tests results:

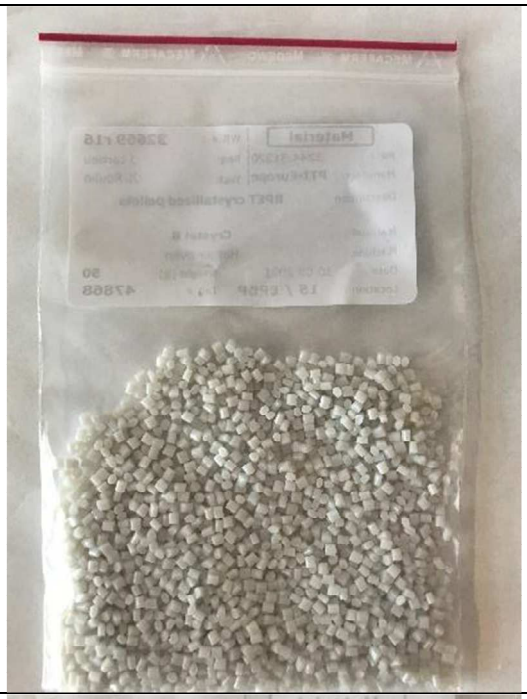
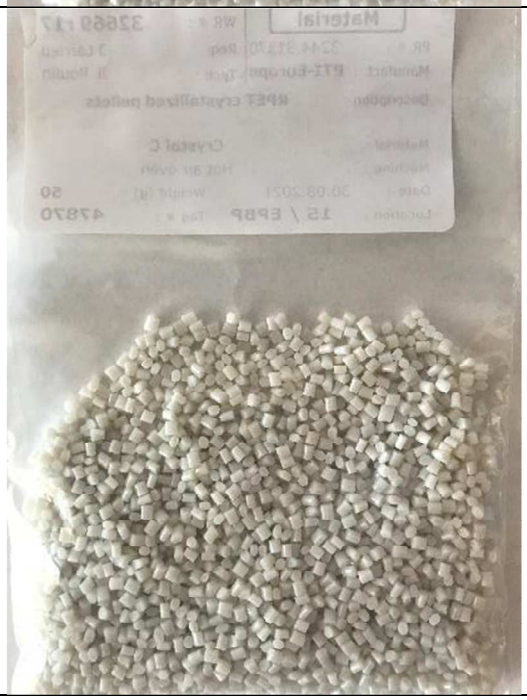
Sample	Description	L*	a*	b*
32669 r11	Extrusion A	60.72	-0.50	2.65
32669 r12	Extrusion B	60.65	-0.40	3.99
32669 r13	Extrusion C	61.03	-0.22	5.03
32669 r14	Extrusion D	61.11	-0.17	5.31

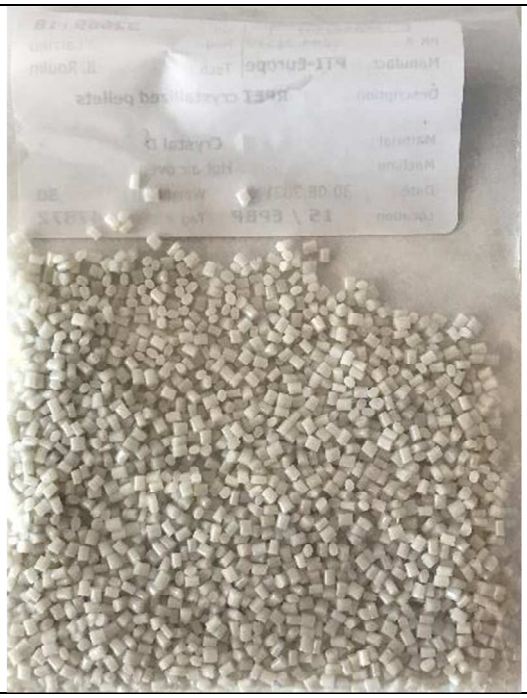
The results are not subjected to a specification but are kept for reference purposes only. When compared to the CONTROL extruded pellets, all test variables are showing higher b* values. The delta corresponds to the increase TEST variable concentration.

Crystallization

Before solid stating, the amorphous pellets were first crystallized. The crystallization was done in a convection oven at 175°C. It is important that the pellets are crystallized sufficiently so they will not stick in the following processing steps.

Sample	Crystallized pellets	
32669 r15 Crystal A		

32669 r16 Crystal B		
32669 r17 Crystal C		

32669 r18 Crystal D		

Intrinsic viscosity

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

Sample	Description	IV [dl/g]
32669 r15	Crystal A	0.74
32669 r16	Crystal B	0.75
32669 r17	Crystal C	0.75
32669 r18	Crystal D	0.75

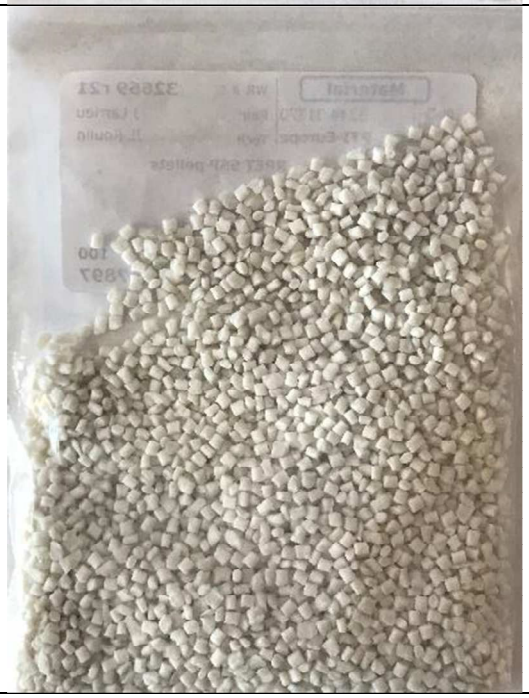
No IV drop across the different process steps up to crystallization has to be reported when compared to start IV measured on bottles.

Solid stating (SSP)

Crystallized pellets were solid stated in a SSP reactor during 8h at 205°C (reactor temperature) which corresponds with a sample temperature between 190 and 195°C, under controlled nitrogen flow (see Appendix 2 for process conditions). 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.

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

Sample	SSP pellets (8h)	
32669 r19 SSP 1-A		

32669 r20 SSP 1-B		
32669 r21 SSP 1-C		

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* and b* tests results:

Sample	Description	L*	a*	b*
32669 r19	SSP 1-A	78.83	-1.04	1.67
32669 r20	SSP 1-B	78.19	-0.92	2.60
32669 r21	SSP 1-C	77.90	-0.65	3.84

The results are not subjected to a specification but are kept for reference purposes only. The higher b* values confirm a yellowing of the two TEST SSP pellets variables.

Acetaldehyde Concentration (AA)

The acetaldehyde concentration was measured on the solid stated pellets. As specification, Test samples should not exhibit an AA increase of more **than 35%** compared to the control sample. Results are presented below:

PTI code	Description	AA Content (ppm)	Standard Deviation
32669 r19	SSP 1-A	0.68	0.04
32669 r20	SSP 1-B	0.55	0.02
32669 r21	SSP 1-C	0.57	0.03

All variables are within EPBP specifications regarding AA generation during extrusion process.

DSC

The melting point (Tm) 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.

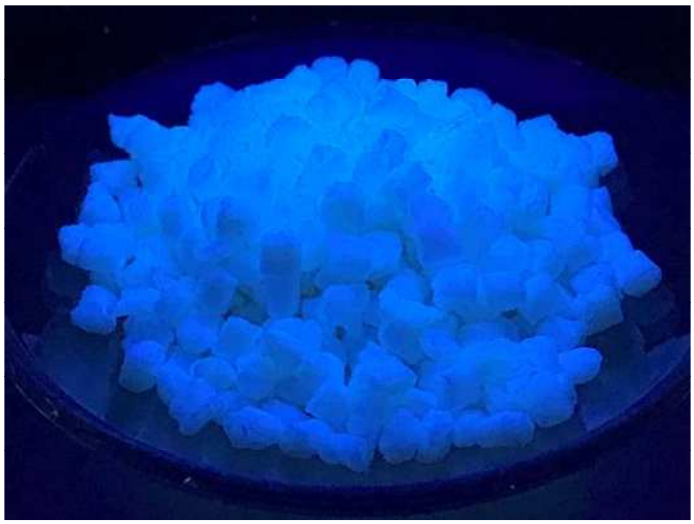
Results are presented below:

Sample	Description	T_g (°C)	T_c (°C)	T_m (°C)
32669 r19	SSP 1-A	81.0	145.4	243.5
32669 r20	SSP 1-B	81.4	148.2	241.3
32669 r21	SSP 1-C	82.0	152.6	240.3

The Tm for both TEST variables are within EPBP specifications.

Fluorescence

Pellets have been tested and checked visually with an UV lamp (385 nm). No significant fluorescence is allowed.

Sample	Solid stated pellets
32669 r19 SSP 1-A	
32669 r20 SSP1-B	

32669 r21 SSP1-C	

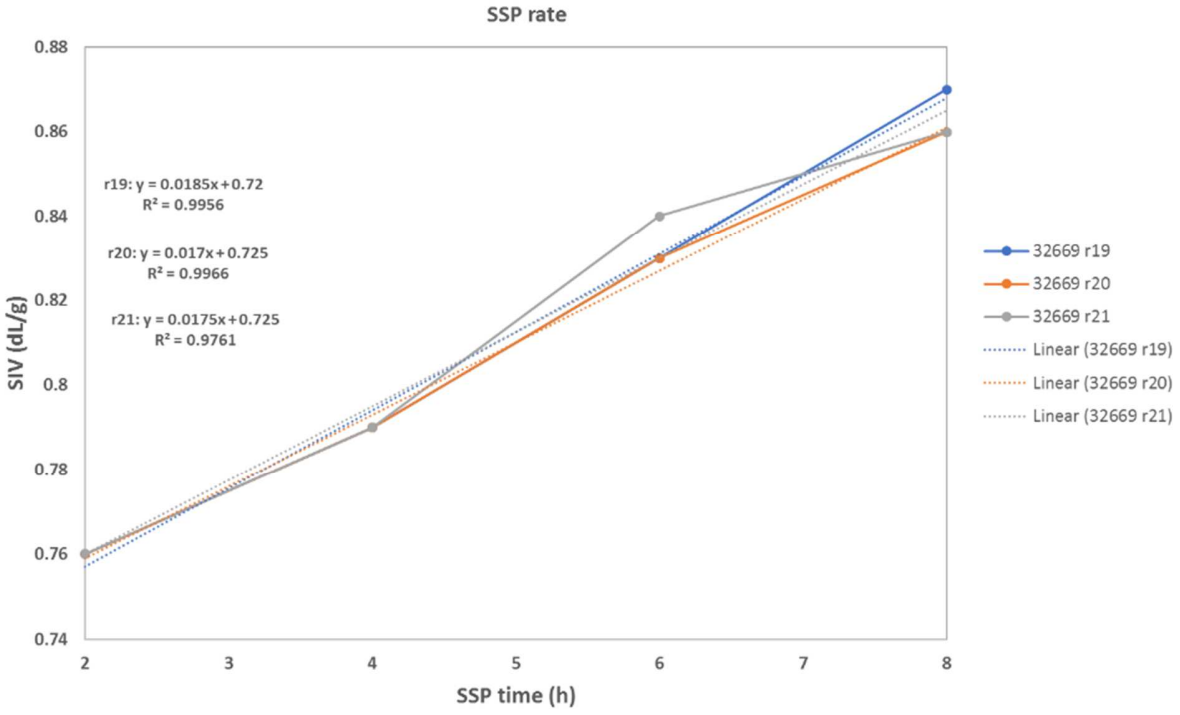
No significant fluorescence was reported.

SSP rate

To determine the SSP rate, a sample was taken at 2, 4, 6 and 8 hours to make an IV curve. The solid stated pellets of the TEST sample were compared with the solid stated pellets of the REF sample. 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 sample should not deviate more than **10%** from the CONTROL sample.

Please find the results below:

PTI ID	T=0 (Cryst.)	2h	4h	6h	8h	Slope	Delta (vs. Ref)
32669 r19	0.74	0.76	0.79	0.83	0.87	0.0185	-
32669 r20	0.75	0.76	0.79	0.83	0.86	0.0170	**8 %**
32669 r21	0.75	0.76	0.79	0.84	0.86	0.0175	**6 %**



The SSP rates for both TEST variables are within the EPBP specification with a deviation below 10% vs CONTROL.

Plaque injection (Route 1)

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:

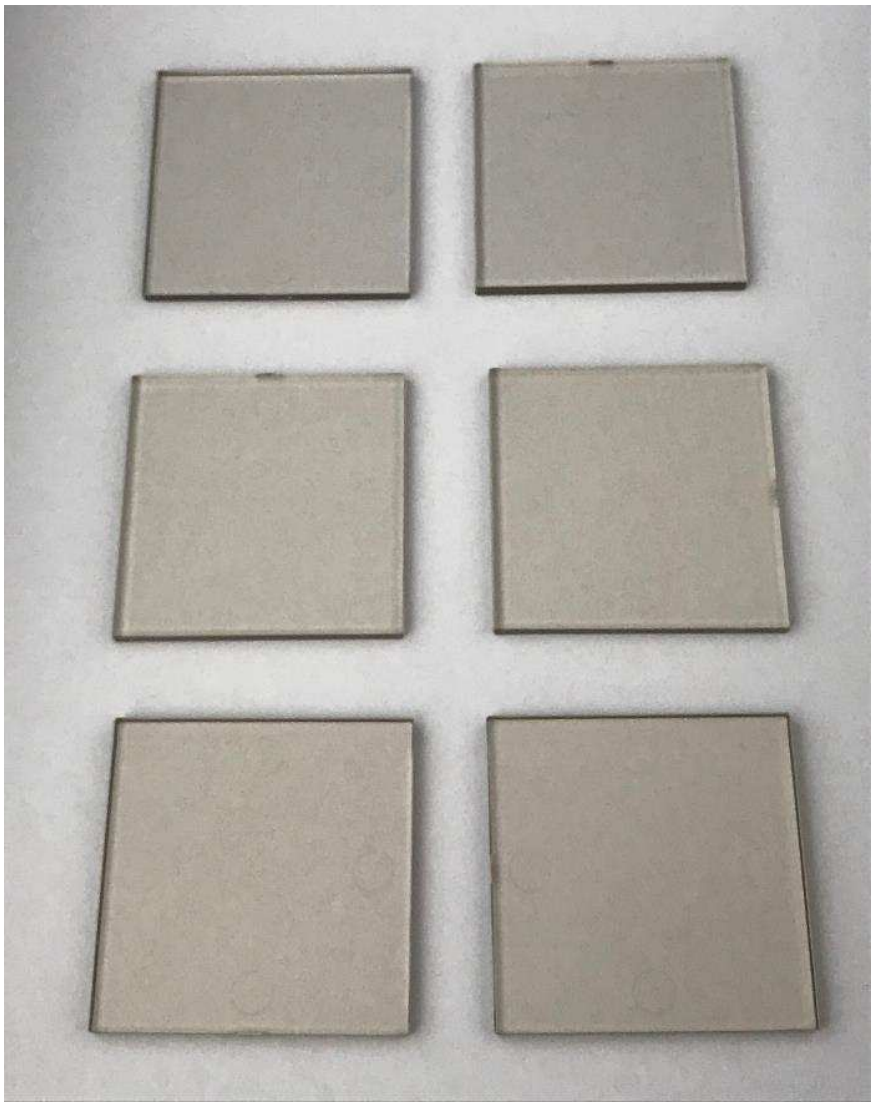
- Melt temperature setting: 275 – 285°C
- Mould temperature: 15 – 18°C
- Melt residence time: Between 4 – 6 minutes

The following blends have been prepared and injected into plaques:

Description	50%	50%	Sample	Plaque
Blend 2-A	Virgin PET	SSP 1-A	32669 C	Plaque A
Blend 2-B	Virgin PET	SSP 1-B	32669 D	Plaque B
Blend 2-C	Virgin PET	SSP 1-C	32669 E	Plaque C

For each of the variables, we have executed 120 injection cycles, the plaques N°61 to 90 have been checked and retained for the project, out of them five plaques of each sample were retained for the applicant.

Plaque injection process sheets are available in Appendix 3.

Sample	Plaques
32669 C **Plaque A**	
32669 D **Plaque B**	
32669 E **Plaque C**	

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:

Color and haze
The color 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 and 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* vs Control	Haze (%)
32669 C	Plaque A	91.79	-0.56	4.09	-	3.26
32669 D	Plaque B	91.46	-0.68	5.16	1.07	3.39
32669 E	Plaque C	91.10	-0.73	6.14	**2.05**	3.79

All the plaques fulfill the requirement of the EPBP in terms of minimum L*.
All the plaques fulfill the requirement of the EPBP in terms of minimum a*.
All the plaques fulfill the requirement of the EPBP in terms of maximum Haze.

Plaque C variable do not fulfill the EPBP specifications with a $\Delta b^* > 1.5$.

Appendix 1: Extrusion conditions

PTI code	Description
32669 r11	Extrusion A
32669 r12	Extrusion B
32669 r13	Extrusion C
32669 r14	Extrusion D

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
32669 r11	20/8/21	Jérôme Larrieu	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	21.5	62.1	13.4	160.0

Operator (s)

Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	285
Barrel zone 2	279
Barrel zone 3	274
Barrel zone 4	274
Filter Nozzle Body	274
Filter Nozzle Tip	274

Plastification

Circum.Speed (m/min)	7.0
Filter Pressure (bar)	70.0

Granulation

Cooling bath flow setting [Div]	1
Granulator feed roller pressure [bar]	3
Granulator speed setting [Div.]	48

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
32669 r12	23/8/21	Jérôme Larrieu	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	23.1	46.3	10.8	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	285
Barrel zone 2	280
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	274

Plastification

Circum.Speed (m/min)	7.0
Filter Pressure (bar)	60.0

Granulation

Cooling bath flow setting [Div]	1
Granulator feed roller pressure [bar]	3
Granulator speed setting [Div.]	48

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
32669 r13	24/8/21	Jérôme Larrieu	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	23.2	48.6	11.3	160.0

Operator (s)
Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	284
Barrel zone 2	279
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	7.0
Filter Pressure (bar)	55.0

Granulation

Cooling bath flow setting [Div]	1
Granulator feed roller pressure [bar]	3
Granulator speed setting [Div.]	48

Extrusion Setups Report

PTI-Europe

Work Request	Date	Project Engineer	Variable
32669 r14	25/8/21	Jérôme Larrieu	Extrusion

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Dryer (°C)
#180955 Arburg	22.8	47.9	10.7	160.0

Operator (s)

Jean-Claude Baumgartner

Extrusion Process

Barrel and Filter Temperatures

Zone description	Actual Temp. (°C)
Barrel zone 1	285
Barrel zone 2	280
Barrel zone 3	275
Barrel zone 4	275
Filter Nozzle Body	275
Filter Nozzle Tip	275

Plastification

Circum.Speed (m/min)	7.0
Filter Pressure (bar)	55.0

Granulation

Cooling bath flow setting [Div]	1
Granulator feed roller pressure [bar]	3
Granulator speed setting [Div.]	48

Appendix 2: SSP conditions

PTI code	Description
32669 r19	SSP pellets 1-A
32669 r20	SSP pellets 1-B
32669 r21	SSP pellets 1-C

		SSP 1-A	SSP 1-B	SSP 1-C
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
32669 C	Plaque A
32669 D	Plaque B
32669 E	Plaque C

Injection Setups

Request	Date	Project Engineer	Variable
32669 C	9/13/21	Jérôme Larrieu	Plaque A

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	22.3	51.9	11.4	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	13.50
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Plastification	
Dosage (ccm)	18.50
Circum.Speed (m/min)	10.00
Back Pressure (bar)	50.0
Decomp. Flow (ccm/s)	20.0
Decomp. Volume (ccm)	2.0

	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		

Switch over Point (ccm): 2.50

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	277	T 832		
T 804	277	T 833		

Pressures and Volumes

Peak pressure (bar)	1128.86
Switch over pr. (bar)	1127.14
Cushion (ccm)	2.15

Times (s)

Injection	3.51
Dosage	2.82
Cooling	4.25
Cycle	32.17

Quality Data

TIR @ End Cap (mm)	
Avg.	
Std. Dev.	0.0000
TIR @ Transition (mm)	
Avg.	
Std. Dev.	0.0000
Part Weight (g)	
Avg.	10.0600
Std. Dev.	0.0000

Injection Setups

Request	Date	Project Engineer	Variable
32669 D	9/14/21	Jérôme Larrieu	Plaque B

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	22.8	50.8	11.5	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	13.50
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Switch over Point (ccm): 2.50

	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)	18.50
Circum.Speed (m/min)	10.00
Back Pressure (bar)	50.0
Decomp. Flow (ccm/s)	20.0
Decomp. Volume (ccm)	2.0

Injection Process Actual Values

Temperatures (°C)

T 801	277	T 805	277	Cylinder Tip
T 802	279	T 831		
T 803	278	T 832		
T 804	278	T 833		

Pressures and Volumes

Peak pressure (bar)	1113.71
Switch over pr. (bar)	1112.71
Cushion (ccm)	2.09

Times (s)

Injection	3.51
Dosage	2.83
Cooling	4.25
Cycle	32.20

Quality Data

TIR @ End Cap (mm)	
Avg.	
Std. Dev.	0.0000
TIR @ Transition (mm)	
Avg.	
Std. Dev.	0.0000
Part Weight (g)	
Avg.	10.1000
Std. Dev.	0.0000

Injection Setups

Request	Date	Project Engineer	Variable
32669 E	9/15/21	Jérôme Larrieu	Plaque C

Machine	Ambient Temp (°C)	Rel. Humidity (%)	Dew Point (°C)	Mold (°C)	Dryer (°C)
#180955 Arburg 370	13.4	98.3	13.1	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	13.50
2	1200.0	5.00	8.00
3	1500.0	3.00	
4			

Plastification	
Dosage (ccm)	18.30
Circum.Speed (m/min)	10.00
Back Pressure (bar)	50.0
Decomp. Flow (ccm/s)	20.0
Decomp. Volume (ccm)	2.0

Switch over Point (ccm)
2.50

	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)	1078.71
Switch over pr. (bar)	1078.71
Cushion (ccm)	1.99

Times (s)

Injection	3.51
Dosage	2.83
Cooling	4.25
Cycle	32.22

Quality Data

TIR @ End Cap (mm)	
Avg.	
Std. Dev.	0.0000
TIR @ Transition (mm)	
Avg.	
Std. Dev.	0.0000
Part Weight (g)	
Avg.	10.1100
Std. Dev.	0.0000