DRAFT TANZANIA STANDARD

Polyethylene Terephthalate (PET) Preform-Specification

TANZANIA BUREAU OF STANDARDS

1st Edition

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*The National Environment Management Council (NEMC)
Weights and Measures Agency (WMA)
*College of Natural and Applied Sciences (CoNAS)
National Bureau of Statistics (NBS)
Tanzania Portland Cement Company Limited (TPCC)
Simba Plastics Co Limited

The organizations marked with an asterisk (*) in the above list, together with the following were directly represented on the Technical Committee entrusted with the preparation of this Tanzania Standard:

Industrial Packaging Limited (IPL)
Zanzibar Bureau of Standards (ZBS)
Small Industries Development Organization (SIDO)
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0 National Foreword

The Tanzania Bureau of Standards is the statutory national standards body for Tanzania, established under the Act.No.3 of 1975, amended by Act.No.2 of 2009.

This Tanzania Standard has been adopted by Packaging Technical committee, under the supervision of the General Techniques Standards Divisional Committee (GTDC) and it is in accordance with the procedures of the Bureau.

During the preparation of this standard, reference was made to the following document:

> RS 499-1 Post-consumer polyethylene terephthalate (PET) containers — Specification — Part 1: Food grade PET recyclates, preforms and containers, published by Rwanda Standard Board

Acknowledgement is hereby made for the assistance derived from this source

0.2 Terminology and conventions

The text of the International standard is hereby being recommended for approval without deviation for publication as Tanzania standard.

Some terminology and certain conventions are not identical with those used as Tanzania Standard; attention is drawn to the following:

The comma has been used as decimal marker for metric dimensions. In Tanzania, its current practice is to use a full point on the baseline as decimal marker.

Whenever the words “International Standard” appear, referring to this Finalized Tanzania Standard, they should read as “Tanzania Standard”.

1. Scope

This draft Tanzania standard describes the requirements, sampling and test methods for preforms made from Polyethylene terephthalate (PET) thermoplastic polyester resin.

2. Normative references

The following documents are referred to in the text in such a way that some or all of their content constitute requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2859-1 Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.

ISO 15512 Plastics — Determination of water content.

ISO 1628-5 Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 5: Thermoplastic polyester (TP) homopolymers and copolymers.

ASTM F2013-10 Standard test method for determination of residual acetaldehyde in polyethylene terephthalate bottle polymer using an automated static head-space sampling device and a capillary GC with a flame ionization detector.

ASTM D4754-18 Standard test method for two-sided liquid extraction of plastic materials using FDA migration cell.

EN1186-3:2022 Materials and articles in contact with foodstuffs. Plastics Test methods for overall migration in evaporable simulants.

EN 13130-1:2004 Materials and articles in contact with foodstuffs - Plastics substances subject to limitation - Part 1: Guide to test methods for the specific migration of substances from plastics to foods and food simulants and the determination of substances in plastics and the selection of conditions of exposure to food simulants

3. Terms and definitions

For the purpose of this document, the following terms and definitions shall apply:

3.1
bubble
spherical, internal void of air or other gas trapped within a plastic

3.2
crystallinity
state of molecular structure in some resins which denotes uniformity and compactness of the molecular chains forming the polymer, normally can be attributed to the formation of solid crystals having a definite geometric form

3.3
flash
extra plastic attached to a moulding along the parting line; under most conditions it would be objectionable and must be removed before the parts are acceptable

3.4
gate
In injection and transfer moulding, the orifice through which the melt enters the cavity

3.5
gate nub
small bits of plastic, left on the parts after cutting them from the runners

3.6
intrinsic viscosity
limiting value of the reduced viscosity or the inherent viscosity at infinite dilution of the polymer is a common descriptor of PET flow ability

3.7
perpendicularity
distance between two parallel straight lines (tangents) between which the cut surface profile is inscribed and within the set angle (e.g. 90° in the case of vertical cuts)

3.8
preform
coherent, test tube shaped mass of powdered, granular or fibrous polyethylene terephthalate thermoplastic polyester resin

4 Requirements

4.1 General requirements

4.1.1 The preform shall be manufactured in accordance with good manufacturing practice (GMP) so that, under normal or foreseeable conditions of use, they do not transfer their constituents to food in quantities which could endanger human health; bring about an unacceptable change in the composition.

4.1.2 Foreign materials in the preform, inhomogeneous areas, vacuoles, non-molten material, burnt material, and moisture rings shall not be permitted.

4.1.3 All preform visual defects as shown in Annex C shall not be permitted.

4.1.4 Materials

4.1.4.1 The material used for manufacturing preform shall be thermoplastic polyester resin polyethylene terephthalate (PET) having density between 790 to 850 kg/m^3. Any additive, to impart preform may be added to the resin in quantity that does not endanger human health and environment.

4.1.4.2 The Intrinsic Viscosity of polyethylene terephthalate (PET) resins shall be between 0.72 dl/g (low molecular weight resins) and 0.88 dl/g (high molecular weight resins) when tested in accordance with ISO 1628.

4.1.4.3 The thermoplastic polyester resin polyethylene terephthalate (PET) shall be supplied with a humidity content less than 0.2 % or 2000 ppm when tested in accordance with ISO 15512.

4.1.4.4 PET resin, as determined by laboratory method shall start melting at around 215-220 ℃ and complete melting at around 285 ℃, presenting a peak temperature at 290 ℃.

4.2 Specific requirements

4.2.1 Physical chemical requirements

Preforms shall comply with the requirements of Table 1 when tested in accordance with the test methods specified therein.

Table 1 — Physical chemical requirements of PET preforms

S/No.	Parameter		Requirement		Test method
i.	Intrinsic viscosity, minimum (dl/g)		For NCSD	0.72	ISO 1628
ii.			For CSD	0.82	
iii.	Acetaldehyde content, maximum (ppm)		For NCSD	4	ASTM F2013-10
iv.			For CSD	10	
v.	Weight tolerance, g	<30	± 0.3		
		30 to 50	± 0.4		
		>50	± 0.5		
vi.	Gate nub length, maximum, mm		3		
vii.	Perpendicularity, mm		± 0.75		Annex B
viii.	Wall thickness variation, maximum, mm		0.25		Annex A
NOTE: "NCSD"- Non-Carbonated Soft Drink "CSD"- Carbonated Soft Drink					

4.2.2 Specific migration of chemicals

4.2.2.1 Specific migration of compound

The specific migration limit of compound from the polyethylene terephthalate (PET) material shall not exceed the limit specified in Table 2 when determined in accordance with the test method specified therein.

Table 2 — Specific migration limits for compounds used in the manufacture of preform

S/No.	Compound	Specific migration limit, mg/kg of food, max.	Test method
i.	Mono- and diethylene glycol (including the ester of stearic acid with ethylene glycol)	30	ASTM D4754-18
ii.	Terephthalic acid	7.5	
iii.	Isophthalic acid	5	
iv.	Antimony trioxide (calculated as antimony)	0.04	
v.	2-Aminobenzamide (anthranilamide)	0.05	

4.2.2.2 Restrictions on release of inorganic substances

The preform material shall not release contaminants in quantities exceeding their migration limits given in Table 3 when determined in accordance with EN 13130-1:2004.

Table 3 — Specific migration limit of inorganic substances

S/No.	Substance	Specific migration limit mg/kg of food, beverage or food stimulant, max.
i.	Aluminium	1
ii.	Barium	1

iii.	Cobalt	0.05
iv.	Copper	5
v.	Iron	48
vi.	Lithium	0.6
vii.	Manganese	0.6
viii.	Zinc	10

4.2.2.3 Restrictions on release of hazardous substances

The preform material shall not release contaminants in quantities exceeding their migration limits given in Table 4 when determined in accordance with the test method specified therein.

Table 4 — Specific migration limit of hazardous substances

Hazardous substances	mg/kg of food, beverage or food stimulant, max	Test method
Lead	0.1%	EN1186-3:2022
Hexavalent chromium	0.1%	
Mercury	0.1%	
Cadmium	0.01%	
Polybrominated biphenyls (PBB)	0.1%	
Polybrominated diphenyl ethers (PBDE)	0.1%	

5 Packaging and marking

5.1 Packaging

The preforms shall be packaged in suitable packaging materials that maintain their integrity, prevent the ingress of dust, moisture and other foreign matters during transportation and storage.

5.2 Marking

5.2.1 The preform shall be legibly and indelibly marked with mould number.

5.2.2 The following information shall be legibly and indelibly marked on the packaging, or in accompanying documents:

a) name, trade mark or other means of identification of the manufacturer;
b) batch number;
c) date of manufacture;
d) words “for food contact” or symbol for food contact material;
e) words “PET” or symbol indicating that it is made from PET material;
f) expiry date;
g) product type, i.e., weight of the preform.

6 Sampling

The sampling criteria shall be in accordance with ISO 2859-1.

Annex A

(normative)

Measurement of wall thickness

A.1 Apparatus
A suitable instrument, e.g. micrometer, Vernier calliper, non-contact instrument, etc. having a measurement accuracy of 0,02 mm.

A.2 Procedure
Cut the preform body horizontally into upper, middle, and lower equal sections. Measure the wall thickness at four places, 90° apart and offset from the parting line, in each section. Take average of four readings and report as wall thickness at upper, middle, and lower.

A.2.1 Micrometer method
Measure the wall thickness with a micrometer or screw gauge fitted with ball point tip**.**

A.2.2 Dial calliper gauge method
Measure the wall thickness with the help of dial calliper fitted with spherical anvils. Care shall be taken to avoid movement of the container during measurement as this can affect the reading obtained.

A.2.3 Non-contact instrument method
Measure the wall thickness according to the manufacturer's instructions.

A.3 Results
The wall thickness is recorded as the mean of the four readings each for upper, middle, and lower sections

Annex B

(normative)

Measurement of perpendicularity

B.1 General
The perpendicularity test verifies that the body of a preform is perpendicular to the finish surface. The perpendicularity test is designed to ensure that preform stand upright in an orientation that is completely perpendicular to the bearing surface on which they stand.

B.2 Test equipment
Perpendicularity gauge assembly or Digital perpendicularity tester or equivalent.

B.3 Sample quantities
To be determined by end users' specifications and risk analysis.

B.4 Procedure

B.4.1 Using randomly selected sample preforms as a source, select a sub-group of perpendicularity samples.

B.4.2 Place the sample in the measuring apparatus. Be sure that the base of each preform is held securely in the support fixture.

B.4.3 Adjust the dial indicator contact so that it rests on the locking ring of the preform finish. Set the dial indicator on "0."

B.4.4 Rotate the preform through at least 360° and note the maximum and minimum deviation on the gauge on either side of vertical. Set the zero mark of the gauge at that position.

B.4.5 Repeat steps 3 and 4 for remaining samples.

B.4.6 Record all measurements

Annex C

(normative)

Common preform visual defects with their possible solutions

Defects can reduce the speed and cost-efficiency of the entire product development process, and can potentially shorten product life spans if left unchecked. Preform visual defects can be caused by a host of reasons, including poor design, production process mistakes, quality control failures, and more. As such, it is important to take a proactive approach to risk mitigation throughout the product development process so as to reduce the chances of preform defects. There are many visual defects that are encountered by the producers at very initial stage of production of preforms. Some of the common defects and their possible solutions are as shown in Table 5.

Table 5 — Common types of preform visual defects with their possible solutions

S/N	Type of visual defect	Description	Possible solutions
1.	Black specks (Contamination)	Black particles that occur randomly in the preform	1. Check the thermocouples on the hot runner, extruder and dryer. 2. Check the dryer condition. 3. Check the resin quality. 4. Reduce the extruder temperature. 5. Reduce the hot runner manifold temperature. 6. Reduce the hot runner manifold temperature. 7. Reduce the screw speed and the back pressure. 8. Check the injection time, and adjust the speed if necessary. 9. Reduce the temperature during the extruder standby.
2.	Bubbles	Bubble(s) in any part of the preform	1. Increase the extruder temperature. 2. Increase the screw speed and the back pressure. 3. Check the residence time and the temperature of the dryer. 4. Decrease the decompression by decreasing the pullback stroke and the pullback dwell time. 5. Make sure that the resin flow of the feeding zone is constant
3.	Burn marks	Black marks and streaks in the gate area	1. Check all the temperature readings. 2. Check the thermocouples on the extruder and the hot runner. 3. Decrease the extruder temperature.

			4. Decrease the hot runner manifold temperature. 5. Decrease the hot runner nozzle temperature. 6. Check the water cooling temperature and the flow. 7. Decrease the screw speed and the back pressure. 8. Decrease the injection speed. 9. Decrease the temperature during extruder standby.
4.	Colour streaks	Colour streaks in the preform body	1. Make sure that the colour feeder is dosing colour correctly. 2. Make sure that no clogging has occurred. 3. Increase the transfer cushion by increasing the extruder position. 4. Increase the screw speed and the back pressure. 5. Increase the extruder temperature. 6. Make sure that the colour mixer rotates continuously
5.	Degradation (Yellow preforms)	An abnormal yellow tint or discoloration throughout the entire preform	Check the resin dryer for proper operation: airflow, hopper residence time, and temperature (resin dependent). 2. Reduce the temperature of the hot runner. 3. Reduce the machine temperature settings. 4. Reduce the shear heat by reducing the screw speed, back pressure, and/or transfer/ injection rate. 5. Minimize heat up times during start-ups. 6. Purge the barrel and shooting pot prior to start-up. Make sure that all discoloured resin is flushed out. 7. During system shutdowns, purge the extruder barrel and shooting pot completely, and immediately reduce machine heats. 8. During system shutdowns, immediately turn off the hot runner nozzle heats. Then turn off the manifold heats, and keep the chilled water flowing through the mould until the hot runner manifold temperature dropped below 100°C.

			9. Check the resin supply for degradation such as discoloration and reduced IV. 10. Make sure that the regrind supply is not overdried, discoloured. or sticking to virgin resin pellets.
6.	Flash	A thin plastic protrusion (flash) at the parting lines	1. Reduce the shot size. 2. Increase the injection time. 3. Increase the transition point. 4. Make sure that there is no debris in the mould. 5. Reduce the hold pressure. 6. Reduce the injection speed to reduce the injection pressure. 7. Check the stack / mould alignment. 8. Check for part interference during closing (e.g., tonnage block, leader pin, taper lock, and bolt.). 9. Check for any part damage (e.g., taper wear). 10. Increase the clamp force. (Do not exceed the maximum allowable clamp tonnage.) 11. Modify the extruder temperature according to the PET characteristics. 12. Check for parting line damage (if the mould has been flashed).
7.	Gate crystallinity	White crystalline formations appearing in the preform gate area. Commonly found throughout the entire wall cross section, in the interior wall section, close to the core cap surface, and as a streak extending from the gate area into the preform body.	1. Increase the temperatures of the hot runner nozzles. 2. Optimize the dry cycle time of the machine. 3. Decrease the temperatures of the hot runner nozzles. 4. Make sure that the temperature, flow, and pressure of the mould chilled-water supply are proper. 5. Make sure that the water channels of the mould gate insert are free of contamination and blockages. 6. Make sure that the hot runner nozzle heater does not touch the gate insert. 7. Reduce the injection fill rate in order to reduce the melt shear heat in the gate seal / gate passage. 8. Make sure that the preform in the robot take-out tube contacts the spherical base insert.

			9. Increase the preform cooling time. 10. Open the valve gates earlier prior to injection. 11. Increase the valve-gate open time after hold (preform gate quality permitting). 12. Reduce the hold pressure. 13. Increase the decompression by increasing the pullback stroke. 14. Increase the decompression by increasing the pullback dwell time. 15. Make sure that the hot runner nozzles and gate area are free of contamination and blockages. 16. Make sure that the valve pin is opening correctly
8.	Gate depressions	The outer surface of the preform gate / dome has indentations that are usually in a circular pattern. They may be smooth or wrinkled in appearance.	1. Check the flow rate and the temperature of the cooling water. 2. Increase the preform cooling time. 3. Decrease the hold time. 4. Increase the transition point.
9.	Gate flaking	A portion of the gate vestige that remains trapped between the gate insert land and the valve pin is injected into the cavity in the next cycle. It appears as a torn crystalline vestige or a flake moulded into the dome wall section of the preform.	1. Examine the hot runner valve pin and the gate insert for wear, and replace if necessary. 2. Examine the gate seal insulator and the gate seal for deformation and wear, and replace if necessary. 3. Increase the temperatures of the hot runner nozzles to melt the preform gate vestige to enable easier separation and correct valve gate shut off. 4. Decrease the hold pressure in order to decrease the cooling rate and melt pressure in the gate well area. 5. Increase the decompression by increasing the pullback stroke and/or the pullback dwell time to decrease the cooling rate and the melt pressure in the gate well area. 6. Adjust the valve-pin close-delay timer.
10.	Gate void (Pin hole)	A small hole on the gate nub or just below the gate nub	1. Check the flow and temperature of the cooling water. 2. Examine the valve pin, gate insert, nozzle, and gate seal insulator for wear and damage.

			3. Reduce the mould break. 4. Increase the last hold pressure/time to favour cooling. 5. Decrease or increase the temperature of the hot runner nozzles. 6. Increase the cooling time. 7. Decrease the pullback stroke and pullback dwell time to prevent melt draw away. 8. Reduce the valve-pin close delay. 9. Increase the hot runner manifold temperature to favour the valve pin closing. 10. Check all the temperature readings and correct if necessary. 11. Check the compressed air of the valve gate.
11.	Haze	A cloudy white appearance in the preform body. It can be circumferential white streaks or localized cloudiness in thick wall sections of the preform.	1. Make sure that the dryer is operating correctly. 2. Make sure that the moisture level at the machine extruder throat is less than 50 ppm. 3. Make sure that the temperature (resin dependent), airflow, dewpoint, and hopper residence time of the resin dryer are correct. 4. Make sure that the dryer is operating correctly. 5. Make sure that the temperature (resin dependent), airflow, and hopper residence time of the resin dryer are correct. 6. Check for preferential resin-flow channelling in the hopper. 7. Increase the screw back pressure. 8. Check for resin bridging in the extruder feed zone. If necessary, clear the bridging and reduce the temperature of the extruder feed zone. 9. Increase extruder temperatures. 10. Increase the back pressure to increase the shear heating. 11. Increase the screw speed to increase the shear heating 12. Increase the screw back position in order to increase the screw cushion. (Generally the screw cushion is 10–20 mm.)

			13. Make sure that the pressure, flow, and temperature of the water cooling system are correct. 14. Make sure that the mould cooling channels are free from contamination and blockages. 15. Increase the cooling time.
12.	Knit line (Weld line)	A microscopic groove that forms when two flow fronts converge but do not bond together, which creates a minute indentation along the interface at this boundary. Usually is observed where the melt paths join around a thread vent blade up to the top sealing surface of a neck finish.	1. Increase the injection speed. 2. Increase the injection pressure. 3. Increase the hold speed. 4. Increase the hold pressure. 5. Increase the temperature of the mould chilled water. (Note: This may affect the preform quality and moulding cycle time.) 6. Clean the mould neck ring and the locking ring vents. 7. Make sure that the mould vent size agrees with the drawing dimensions. 8. Make sure that the ambient dew point in the moulding area is less than the temperature of the mould chilled water. 9. Increase the temperature of the mould chilled water to more than the ambient dew point in the moulding area to prevent condensation. (Note: This may affect the preform quality and moulding cycle time.) 10. Examine the mould cavity plate at the cavity and gate inserts for water leaks, and repair if necessary. 11. Examine the locking rings, nick rings, and neck ring slides of the mould core side for water leaks, and repair if necessary. 12. Examine the hose and fitting connections on the supply and return manifold and the neck ring slides for water leaks, and repair if necessary. 13. Make sure that the moulding surfaces are free of contamination: mould spray residue, flash particles, and others.
13.	Long gate vestige	An elongated gate on a preform that appears as a melt protrusion	1. Check for foreign matter in the nozzle. 2. Check the valve pin for damage.

			3. Check the piston seals of the valve pin for damage. 4. Make sure that the air pressure of the valve gate is correct, and clean the filter. 5. Check the gate seal insulator for damage. 6. Decrease the hold pressure / time to decrease the cooling rate and the melt pressure in the gate well area. 7. Increase the pullback stroke and the pullback dwell time to reduce the pressure in the preform. 8. Increase the hot runner manifold temperature to favour the valve pin closing. 9. Increase or decrease the temperature of the hot runner nozzles.
14.	Malformed top-sealing surface	The top sealing surface of the preform is not fully formed. This is usually seen as a glossy sink on or adjacent to the top sealing surface.	1. Make sure that the mould neck ring and the locking ring vents are clean. 2. Make sure that the sizes of the mould vents agree with the drawing dimensions. 3. Set the clamp tonnage to the minimum permitted by the process.
15.	Moisture marks	Circumferential rings appear on the inner and/or outer surfaces of the preform. The rings are usually seen as clear ridges having an elliptical shape.	1. Make sure that the ambient dew point in the moulding area is less than the temperature of the mould chilled water. 2. Increase the temperature of the mould chilled water to more than the ambient dew point in the moulding area to prevent condensation. (Note: This may affect the preform quality and moulding cycle time.) 3. Examine the mould cavity plate at the cavity and gate inserts for water leaks, and repair if necessary. 4. Examine the locking rings, nick rings, and neck ring slides of the mould core side for water leaks, and repair if necessary. 5. Examine the hose and fitting connections on the supply and return manifold and the neck ring slides for water leaks, and repair if necessary.
16.	Parting line indentation	A circumferential indent on the outer diameter of the preform	1. Decrease the hold pressure. 2. Increase the injection transition position.

		at the neck ring / cavity parting line because of deformation when opening the mould.	3. Decrease the shot size. 4. Increase the pullback stroke to increase the decompression. 5. Increase the pullback dwell time to increase the decompression. 6. Extend the valve-gate open timer after hold. 7. Increase the preform cooling time. 8. Make sure that the flow, pressure, and temperature of the water-cooling system are correct. 9. Make sure that the mould cooling channels are free of contamination and blockages.
17.	Peeling	A torn section on the external surface of the preform, starting from the gate nub extending outward toward the hemispherical area. The torn section sticks on the moulding surface of the gate insert and can remain for several cycles.	1. Check the gate insert, gate seal insulator, valve pin, and gate seals for any wear or damage and replace if necessary. 2. Check the clearance between the valve pin and the gate insert. 3. Check for an oval gate hole. 4. Make sure that the water cooling and the flow are correct. 5. Check the water channel for contamination. 6. Decrease the cooling rate at the preform tip. 7. Decrease the hold pressure/time to decrease the cooling rate and the melt pressure in the gate well area. 8. Increase the hot runner nozzle temperature to increase the melt in the gate well area. 9. Increase the decompression to decrease the cooling rate in the gate well area. 10. Increase the cooling time to increase the dome solidification and break the gate vestige during mould opening. 11. Make sure that the pressure of the compressed air of the valve gate is not below 7.6 bar (110 psi).
18.	Pulled gate vestige	An elongated gate on a preform that appears as a stretched crystalline vestige	1. Check the flow and temperature of the cooling water. 2. Decrease the mould break to zero.

			3. Increase the mould opening speed. 4. Increase the last hold pressure to favour cooling. 5. Decrease the hot-runner nozzle temperature. 6. Increase the cooling time. 7. Decrease the pullback stroke and pullback dwell time to prevent melt draw away.
19.	Preform buckling	The preform body collapses during ejection, usually at the thickest and hottest part of the wall section.	1. Make sure that the flow, pressure, and temperature of the water-cooling system are correct. 2. Make sure that the mould cooling channels are free of contamination and blockages. 3. Increase the cooling time. 4. Increase the hold pressure. 5. Increase the hold time. 6. Decrease the machine temperatures. 7. Decrease the hot runner temperatures. 8. Decrease the hold pressure. 9. Make sure that the ambient dew point in the moulding area is less than the temperature of the mould chilled water. 10. Increase the temperature of the mould chilled water to more than the ambient dew point in the moulding area to prevent condensation. (Note: This may affect the preform quality and the moulding cycle time.)
20.	Short shot	A not fully filled preform from a completed injection cycle. It is usually seen as an underdeveloped thread section in the preform neck area and a decreased preform weight.	1. Increase the shot size. 2. Decrease the transition position. 3. Increase the hold time. 4. Increase the hold pressure. 5. Increase the injection speed. 6. Increase the injection pressure. 7. Increase the melt temperature to reduce the melt viscosity. 8. Make sure that the resin and preform have a correct IV. 9. Increase the hot runner manifold temperatures. 10. Increase the hot-runner nozzle temperatures. 11. Increase the machine temperatures. 12. Examine the hot runner gate seal for contamination, and clean if necessary.

			13. Examine the valve pin for damage, and replace if necessary. 14. Examine the valve-pin piston seals for damage, and replace if necessary. 15. Increase the hot runner manifold temperature to allow increased valve pin movement. 16. Make sure that the air pressure of the valve pin is correct. 17. Examine the air mufflers of the valve gate for blockages, and clean or replace if necessary. 18. Clean the mould vents. 19. Make sure that the sizes of the mould vents agree with the drawing dimensions.
21.	Sink marks	Sink marks are depressions on the internal and/or external preform surfaces.	1. Check the mould cooling temperature and the flow. 2. Check the valve pin motion. 3. Make sure that the compressed air of the valve gate is sufficient. 4. Check the temperature and the residence time of the resin. 5. Check the robot and the iChill alignment. 6. Increase the hold time / pressure. 7. Increase the cooling time. 8. Reduce the injection speed. 9. Maintain a cushion of 5-8 mm on the plunger. 10. Decrease the transition point. 11. Reduce the extruder temperature.
22.	Splay marks	Flow disturbances on the surface of the preform that appear as longitudinal or hooked, silvery white streaks flowing away from the gate	1. Make sure that the dryer is operating correctly. 2. Decrease the hot-runner nozzle temperatures. 3. Decrease the hot-runner manifold temperatures. 4. Decrease the machine temperatures. 5. Decrease the screw speed, back pressure, and/or transfer/injection rate to decrease the shear heating in the extruder. 6. Keep the hot runner heat-up time to a minimum. 7. Make sure that all discoloured resin is purged from the barrel and the shooting pot

			before start-up. 8. Examine the hot-runner gate seal for damage that could create hang-up spots for the melt. 9. Examine the gate seal insulator and gate insert area for damage that could create hang-up spots for the melt. 10. Increase the screw back pressure. 11. Examine the resin supply for degradation, and replace if necessary. 12. Examine the extruder feed zone for plastic bridging. If necessary, clear the bridging, and reduce the temperature of the extruder feed zone. 13. Decrease the pullback stroke and/or pullback dwell time to decrease the decompression
23.	Stringing	Hair-like strands that protrude from the gate nub	1. Check the flow and temperature of the cooling water. 2. Increase the preform cooling time. 3. Decrease the hold time. 4. Make sure that the hot runner heat settings are correct.
24.	Surface blemishes (Scratches)	Random marks that appear as elliptical blemishes, scratches, and irregular impressions, or recurring marks that appear as longitudinal scratches or irregularities on the surface of the preform	1. Keep to a minimum the handling and transferring of preforms after robot ejection. 2. Keep to a minimum the distance the preforms fall from the robot to the conveyor. 3. Decrease the robot ejection force. 4. Increase the preform cooling time to reduce the preform surface temperature and sensitivity to damage. 5. Make sure that the flow, pressure, and temperature of the water cooling system are correct. 6. Make sure that the mould cooling channels are free of contamination and blockages. 7. Make sure that the cooling channels of the takeout plate tube of the robot are free of contamination and blockages. 8. Increase the cooling time. 9. Increase the cooling dwell time in the robot takeout plate.

			10. Examine the moulding surfaces for damage, and repair or replace if necessary. 11. Examine the moulding surfaces for contamination, and clean if necessary. 12. Examine the moulding surfaces for contamination, and clean if necessary. 13. Make sure that the mould core half and the cavity half are aligned. 14. Examine the level of the mould core and cavity halves, and adjust the machine level and/or platen parallelism if necessary. 15. Examine the robot takeout tubes for surface damage, and repair if necessary. 16. Examine the robot takeout tubes for interference when the preforms are ejected, and align if necessary
25.	Unmelts	Resin pellets in the preform body that are fully or partially unmelted	1. Make sure that the airflow, hopper residence time, and temperature (resin dependent) of the dryer are correct. 2. Examine the hopper for preferential resin-flow channeling. 3. Examine the hopper in feed hose for irregularities. 4. Examine the resin for any discoloration (degradation). 5. Do a DSC analysis of the unmelted pellets in the preform body to measure the melting point and the crystallinity level. 6. Compare the size and uniformity of the pellets with the manufacturer's specifications. 7. Increase the screw back pressure. 8. Examine the extruder feed zone for plastic bridging, and remove any bridging that you find. 9. Reduce the temperature of the extruder feed zone, if necessary. 10. Increase the extruder temperatures. 11. Increase the back pressure to increase the shear heating. 12. Increase the screw speed to increase the shear heating. 13. Increase the screw back position to increase the screw

				cushion. (The screw cushion is generally, 10–20 mm.)
26.	White spot in the neck finish	White spot in tamper-proof band	A crystalline spot that appears in the tamper-proof band	1. Increase the injection rate. 2. Decrease the injection transition position. 3. Increase the first hold-pressure zone. 4. Increase the machine temperature. 5. Increase the hot runner temperatures. 6. Increase the hot-runner nozzle temperatures. 7. Increase the back pressure and/or the screw speed to increase the extruder shear heating. 8. Clean the mould vents. 9. Make sure that the sizes of the mould vents agree with the drawing dimensions.
		White spot in the support ring	A crystalline spot that appears in the support ring	1. Decrease the injection fill rate. 2. Clean the mould vents. 3. Make sure that the sizes of the mould vents agree with the drawing dimensions. 4. Decrease the melt temperature to keep the vent clogging to a minimum.

Bibliography

[1] ISO 472:2013 Plastics — Vocabulary

[2] MS 250:2021 Plastics – Post-consumer polyethylene terephthalate (PET) bottle – Specifications for food grade PET recyclates and preforms

[3] ISO 13106, Plastics — Blow-moulded polypropylene containers for packaging of liquid foodstuffs

[4] ISO 22000, Food safety management systems — Requirements for any organization in the food chain