



TRIFUSION® PLUS

Glass Coating Quality Standard

SCOPE

This Standard specifies the quality requirements for the TRIFUSION® PLUS process for glass coating by vitreous enamelling of panels intended for use in the construction of storage tanks for uses such as the storage or treatment of industrial effluent, where a wider variability of liquor concentrations exists and the more aggressive environment demands a superior quality.

This Standard applies to the enamelling elements of the TRIFUSION® PLUS process, however, the quality criteria in Section 3.2 should apply to the tank as built. The TRIFUSION® PLUS glass coating has been developed with reference to International Standard specifications for glass coatings on bolted steel panels and conforms to EN ISO 28765:2022^[1].

DEFINITIONS

For the purposes of this Standard, the following definitions shall apply.

Glass coating: Any inorganic silica coating, commonly also referred to as vitreous enamel, bonded to a metallic substrate by the TRIFUSION® PLUS process at temperatures sufficient to cause glass melting and chemical bonding to the steel substrate so as to form a composite glass/steel panel referred to as Glass-Fused-to-Steel.

Supplier: Any company supplying Permastore with any materials for use in the TRIFUSION® PLUS process.

Defect: Any void, break, crack, discontinuity, blister, foreign inclusion, or contamination of the glass coating.

Discontinuity Free: Any glass coating which does not allow an electric current to pass through to the steel substrate when testing using the specified instrument operated in accordance with Section 3.2.2 of this Standard.

1. GENERAL

The inspection procedures specified in this Standard and the TRIFUSION® PLUS enamelling process shall be carried out under Permastore's quality management system certified to EN ISO 9001:2015^[2].

2. RAW MATERIALS

The steel used shall have a specification as agreed between Permastore and the steel supplier having due regard to the requirements of the enamelling process.

All other raw materials used in the production of the glass coated panels shall be inspected on receipt at Permastore's premises to ensure that they meet Permastore's specifications.

Where Permastore is not able to inspect raw material against any aspect of Permastore's specification or the specification according to Clause 3.1.1 (for example, chemical composition of steels, flow bead tests of glass etc.), Permastore shall require the supplier to carry out such inspections at the supplier's premises and provide Permastore with authorised copies of certificates for such inspections and record conformity of the raw materials in accordance with the Quality Specification, and make certified copies of those records available.

3. QUALITY

3.1 Glass Coating

Glass coated test samples shall be regularly tested to ensure that the properties of the glass coating meet the requirements of this Standard and Permastore's specification.

3.1.1 Quality Specification

Tests shall be carried out to ensure that the glass coating on the contact enamel surface meets the chemical resistance and physical properties specifications set out in Table 1.

TABLE 1 – CHEMICAL RESISTANCE AND PHYSICAL PROPERTIES

	TEST STANDARD	QUALITY SPECIFICATION	MINIMUM TEST FREQUENCY
CHEMICAL RESISTANCE (Inside Surface)			
Citric acid at room temperature	EN ISO 28706-1:2011 ^[3] Clause 9	Class AA	Monthly
Boiling citric acid	EN ISO 28706-2:2017 ^[4] Clause 11	Maximum weight loss 0.75g/m ² after 2.5 hours	Annually
Boiling distilled or demineralized water Liquid phase - Vapour phase -	EN ISO 28706-2:2017 Clause 14	Maximum weight loss 1.5g/m ² after 48 hours 5g/m ² after 48 hours	Annually
Hot sodium hydroxide	EN ISO 28706-4:2016 ^[5] Clause 9	Maximum weight loss 6g/m ² after 24 hours	Annually
Sulphuric acid at room temperature	EN ISO 28706-1:2011 Clause 10	Class AA	Monthly
Hydrochloric acid at room temperature	EN ISO 28706-1:2011 Clause 11	Class AA	Monthly
Boiling hydrochloric acid Vapour phase	EN ISO 28706-2:2017 Clause 13	Maximum weight loss 7g/m ² after 7 days	Annually
Standard detergent solutions	EN ISO 28706-3:2018 ^[6] Clause 10	Maximum weight loss 2.5g/m ² after 24 hours	Annually
PHYSICAL PROPERTIES (Inside Surface)			
Impact	ISO 4532:1991 ^[7] 40N force	Maximum cracking 2mm after 24 hours	Monthly
Adherence level	EN 10209:2013 Annex C ^[8]	Class 2	Monthly
Resistance to abrasion	EN ISO 6370-2:2021 ^[9]	Relative amount of wear <0.9	Annually
Resistance to thermal shock	EN ISO 28763:2019 Annex A ^[10]	No Damage	Annually
Scratch hardness	EN ISO 6769:2022 ^[11]	Mohs 5	Monthly

3.2 Finished Panels

Finished panels shall be inspected following the enamelling process, prior to packing and despatch from Permastore’s premises. Permastore shall carry out inspections on both the inside and the outside surfaces. In cases where both the inside and the outside surfaces of the panel are in contact with the stored liquid both surfaces shall be treated as inside surfaces for the purposes of this Standard.

3.2.1 Inspection of the Outside Surface

The outside surface of all panels shall be inspected visually under good daylight or equivalent lighting for defects in the glass coating. Any panel having visible defects larger than 1mm (0.04”) shall be rejected. Any panel having more than three visible defects per m² of the total panel area shall be rejected. All visible defects on the outside surface of accepted panels shall be repaired using a repair material approved by Permastore for this purpose and applied according to the repair material manufacturer's instructions.

3.2.2 Inspection of the Inside Surface

The inside panel surface shall be inspected using a high voltage tester approved by Permastore for this purpose and used in accordance with Test A of EN ISO 2746:2015^[12] and Clause 3.2.2.1. Inspection shall be carried out on every panel and only panels that are discontinuity free are accepted.

3.2.2.1 The tester shall have an accuracy of ±1% and a test voltage of 1500 volts shall be used. The tester shall have a valid calibration record.

3.2.3 Inspection of the Glass Thickness

The thickness of the glass shall be measured using an approved instrument suitable for a measurement range of 0-500µm (0-19.7mils) and used in accordance with EN ISO 2178:2016^[13]. Inspection shall be carried out using a sampling procedure complying with ISO 2859-1:1999^[14].

The thickness of the glass on the inside surface of every panel shall be maintained in the range from 340µm to 500µm (13.4mils to 19.7mils). The thickness of the glass on the outside surface of every panel shall be maintained in the range from 160µm to 500µm (6.3mils to 19.7mils). Panels having a glass thickness outside these ranges shall be rejected.

3.2.4 Inspection of Glass Colour

The outside panel surface shall be inspected using a colour comparator instrument and the colour checked against standard limits set by Permastore. Inspection shall be carried out using a sampling procedure complying with ISO 2859-1:1999. Panels of a colour outside these limits shall be rejected.

4. HANDLING AND PACKING

Prior to storage or packing panel edges shall be protected using a material approved by Permastore for this purpose and applied according to the edge protection material manufacturer's instructions. All panels shall be packed using a suitable membrane between the panels.

5. GUIDANCE NOTES FOR INSTALLATION AND USE

5.1 Care in Handling

Recommendations for the correct methods of handling outside the enamelling premises are given in the Permastore Construction Guide latest revision.

5.2 Inspection at the Construction Site

During tank installation, the use of an approved low voltage wet swab tester on the inside panel surface is recommended. Permastore can advise on the use of the low voltage wet swab test equipment. Guidance is also given in the Permastore Construction Guide latest revision.

5.3 Change of Use

Owners and users of industrial storage tanks should be aware that changes in the use or structure of a tank can result in dramatic changes to the operating environment and affect the coating and design limitations of the tank. Permastore will offer advice on request.

REFERENCES

[1] **EN ISO 28765:2022**

Vitreous and porcelain enamels - Design of vitreous enamel coated bolted steel tanks for the storage or treatment of water or municipal or industrial effluents and sludges.

[2] **EN ISO 9001:2015**

Quality management systems. Requirements.

[3] **EN ISO 28706-1:2011**

Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 1: Determination of resistance to chemical corrosion by acids at room temperature.

[4] **EN ISO 28706-2:2017**

Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 2: Determination of resistance to chemical corrosion by boiling acids, boiling neutral liquids, alkaline liquids and/or their vapours.



[5] **EN ISO 28706-4:2016**

Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 4: Determination of resistance to chemical corrosion by alkaline liquids using a cylindrical vessel.

[6] **EN ISO 28706-3:2018**

Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 3: Determination of resistance to chemical corrosion by alkaline liquids using a hexagonal vessel or a tetragonal glass bottle.

[7] **ISO 4532:1991**

Determination of the resistance of enamelled articles to impact - Pistol test.

[8] **EN 10209:2013 Annex C**

Cold-rolled low carbon steel flat products for vitreous enamelling - Technical delivery conditions.

[9] **EN ISO 6370-2:2021**

Vitreous and porcelain enamels - Determination of resistance to abrasion - Part 2: Loss in mass after sub-surface abrasion.

[10] **EN ISO 28763:2019 Annex A**

Vitreous and porcelain enamels - Regenerative, enamelled and packed panels for air-gas and gas-gas heat exchangers - specifications.

[11] **EN ISO 6769:2022**

Vitreous and porcelain enamels - Determination of surface scratch hardness according to the Mohs scale.

[12] **EN ISO 2746:2015**

Vitreous and porcelain enamels - High voltage test.

[13] **EN ISO 2178:2016**

Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method.

[14] **ISO 2859-1:1999**

Sampling procedure for inspection by attributes - Part 1: Sampling schemes indexed by Acceptance quality limits (AQL) for lot-by-lot inspection.