

QUALITY STANDARD FOR

TRIFUSION® PLUS

GLASS COATINGS

FOR USE IN

INDUSTRIAL LIQUID STORAGE TANKS

1. 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 5.2 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⁽¹⁾.

2. DEFINITIONS

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

Glass coating: Any coating, commonly also referred to as vitreous enamel, based on silica Glass-Fused-to-Steel sheets 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.

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

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

Discontinuity: Any defect which allows an electric current to pass through the glass coating when testing using the specified instrument operated in accordance with Section 5.2.2 of this Standard.

3. GENERAL

The inspection procedures specified in this Standard and the TRIFUSION® PLUS enamelling process shall be carried

out under quality management systems accredited to ISO 9001⁽²⁾.

4. RAW MATERIALS

4.1 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.

4.2 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.

4.3 Where Permastore is not able to inspect raw material against any aspect of Permastore's specification or the specification according to Clause 5.1.1 (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.

5. QUALITY

5.1 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.

5.1.1 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.

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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 28706-2:2011 ⁽⁴⁾ Clause 10 | Maximum weight loss 0.75g/m ² after 2½ hours | Annually |
| Boiling distilled or demineralized water Liquid phase - Vapour phase - | EN ISO 28706-2:2011 Clause 13 | 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 28706-2:2011 Clause 12 | Maximum weight loss 7g/m ² after 7 days | Annually |
| Standard detergent solutions | EN ISO 28706-3:2011 ⁽⁶⁾ Clause 9 | Maximum weight loss 2.5g/m ² in 24 hours | Annually |
| PHYSICAL PROPERTIES (Inside Surface) | | | |
| Impact | ISO 4532 ⁽⁷⁾ , 40N force. | Maximum cracking 2mm after 24 hours | Monthly |
| Adherence level | EN 10209: Annex C ⁽⁸⁾ | Class 2 | Monthly |
| Resistance to abrasion | ISO 6370-2 ⁽⁹⁾ | Maximum weight loss 45g/m ² | Annually |
| Resistance to thermal shock | EN ISO 28763:Annex A ⁽¹⁰⁾ | No Damage | Annually |
| Scratch hardness | EN 15771 ⁽¹¹⁾ | Mohs 5 | Monthly |

5.2 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.

5.2.1 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.

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5.2.2 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⁽¹²⁾ and Clause 5.2.2.1. Inspection shall be carried out on every panel and any panel having any discontinuities shall be rejected.

5.2.2.1 The tester shall have an accuracy of $\pm 1\%$ and a test voltage of 1500 volts shall be used. The tester shall have a valid calibration record.

5.2.3 Inspection of the Glass Thickness

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

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

5.2.4 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: Part 1. Panels of a colour outside these limits shall be rejected.

6. 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.

7. GUIDANCE NOTES FOR INSTALLATION AND USE

7.1 Care in Handling

Recommendations for the correct methods of handling outside the

enamelling premises are given in the *Permastore Construction Guide*.

7.2 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*.

7.3 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.

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8. REFERENCES

1. EN ISO 28765:2016

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. ISO 9001

Quality management systems - Requirements for design, manufacture and installation of vitreous enamelled tanks and silos for storage and processing of liquid and dry product and associated equipment.

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 28706-2:2011

Vitreous and porcelain enamels – Determination of resistance to chemical corrosion – Part 2: Determination of resistance to chemical corrosion by boiling acids, neutral 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 28706-3:2011

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.

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. ISO 6370-2:2011

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

10. EN ISO 28763:2011

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

11. EN 15771:2010

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 2178:1995

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

14. ISO 2859:1999

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