ECOFUSION®

Glass Coating Quality Standard

SCOPE

This Standard specifies the quality requirements for the ECOFUSION® process for glass coating by vitreous enamelling of panels intended for use in the construction of tanks for uses such as storage of moist whole grain or a mixture consisting wholly or mainly of excreta produced by livestock of a consistency that allows it to be pumped or discharged by gravity at any stage in the handling process.

This Standard applies to the enamelling elements of the ECOFUSION® process, however, the quality criteria in Section 3.2 should apply to the tank as built. The ECOFUSION® glass coating has been developed with reference to International standard specifications for glass coatings on bolted steel panels for the construction of agricultural tanks for the storage of animal slurry above ground on farms, such as BS 7793-1:1995[1], and also conforms to EN ISO 28765:2016[2].

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 ECOFUSION® process at temperatures sufficient to cause glass melting and chemical bonding to the 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 ECOFUSION® 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 ECOFUSION® enamelling process shall be carried out under Permastore's quality management system certified to EN ISO 9001:2015[3].

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 suppliers 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 property 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[4] Clause 9	Class A+	Monthly
Boiling citric acid	EN ISO 28706-2:2017[5] Clause 11	Maximum weight loss 4g/m^2 after 2.5 hours	Annually
Boiling distilled or demineralized water Liquid phase	EN ISO 28706-2:2017 Clause 14	Maximum weight loss 5g/m^2 after 48 hours	Annually
Hot sodium hydroxide	EN ISO 28706-4:2016[6] Clause 9	Maximum weight loss 7g/m^2 after 24 hours	Annually
PHYSICAL PROPERTIES (Inside Surface)			
Impact	ISO 4532:1991[7] 20N force	Maximum cracking 2mm after 24 hours	Monthly
Adherence level	EN 10209:2013 Annex C[8]	Class 2	Monthly
Scratch hardness	EN 15771:2010[9]	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.

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 1 mm (0.04") shall be rejected. Any panel having more than three visible defects per m^2 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 low voltage wet swab tester approved by Permastore for this purpose and used in accordance with Method A of EN ISO 8289-1:2020[10] and Clause 3.2.2.1. Inspection shall be carried out using a sampling procedure complying with ISO 2859-1:1999[11]. Inspection shall be conducted in accordance with BS 7793-1:1995 and only panels that meet the criteria shall be accepted.

3.2.2.1 The tester shall have an accuracy of ±1% and a test voltage of 9 volts shall be used. The tester shall have a valid calibration record.

3.2.3 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[12]. Inspection shall be carried out using a sampling procedure complying with ISO 2859-1:1999.

The thickness of the glass on the inside surface of every panel shall be maintained in the range from 180µm to 360µm (7.1mils to 14.2mils). 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 this range 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 liquid 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] **BS 7793-1:1995**

Vitreous enamel coatings for use on bolted steel panels - Part 1: Specification for coatings on bolted steel panels for use in agricultural slurry tanks.

[2] **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.

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

Quality management systems. Requirements.

[4] **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.

[5] **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.

[6] **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.

[7] **ISO 4532:1991**

Vitreous and porcelain enamels - 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 15771:2010**

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

[10] **EN ISO 8289-1:2020**

Vitreous and porcelain enamels - Low voltage test for detecting and locating defects - Part 1: Swab test for non-profiled surfaces.

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

Sampling procedure for inspection by attributes - Part 1: sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.

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

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