



**SLOVENSKI STANDARD**  
**SIST EN 14866:2006**

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

Emails und Emailierungen - Regenerative, emailierte und gepackte Bleche für Luft-Gas- und Gas-Gas-Wärmeaustauscher - Anforderungen  
(Standard.iTeh.ai)

Emaux vitrifiés - Echangeurs thermiques pour réchauffeurs air-gaz et gaz-gaz a empilement de panneaux emailés remplaçables et démontables - Spécifications  
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EUROPEAN STANDARD

EN 14866

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## Vitreous and porcelain enamels - Regenerative, enamelled and packed panels for air-gas and gas-gas heat exchangers - Specifications

Emaux vitrifiés - Echangeurs thermiques pour réchauffeurs air-gaz et gaz-gaz à empilement de panneaux émaillés remplaçables et démontables - Spécifications

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This European Standard was approved by CEN on 14 November 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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## Foreword

This European Standard (EN 14866:2005) has been prepared by Technical Committee CEN/TC 262 “Metallic and other inorganic coatings”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2006, and conflicting national standards shall be withdrawn at the latest by June 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom

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**EN 14866:2005 (E)****1 Scope**

This European Standard specifies the minimum requirements and the functional characteristics of enamel coatings applied by any enamel process, such as: wet dipping, wet flow-coating, wet spraying, wet electrostatic spraying, wet electro deposition or dry powder electrostatic spraying, to profiled steel heat exchanger panels in regenerative heat exchangers, before and after packing in baskets.

NOTE For very severe service conditions, or to obtain extended operation life, more stringent limits may be agreed between customer and supplier.

**2 Normative references**

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10209:1996, *Cold-rolled low carbon steel flat products for vitreous enamelling — Technical delivery conditions*

EN 14483-2:2004, *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*

EN 14863, *Vitreous and porcelain enamels — Determination of the edge covering on enamelled steel plate to be used in heat exchangers*

EN ISO 105-J03, *Textiles — Tests for colour fastness — Part J03: Calculation of colour differences (ISO 105-J03:1995, including Technical Corrigendum 1:1996)*

EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178:1982)*

EN ISO 8289:2001, *Vitreous and porcelain enamels — Low voltage test for detecting and locating defects (ISO 8289:2000)*

ISO 2723, *Vitreous and porcelain enamels for sheet steel — Production of specimens for testing*

ISO 4534, *Vitreous and porcelain enamels — Determination of fluidity behaviour — Fusion flow test*

ISO 7991, *Glass — Determination of coefficient of mean linear thermal expansion*

**3 Terms and definitions**

For the purpose of this European Standard, the following terms and definitions apply.

**3.1****blisters**

localised bubbles under the surface of the fired enamel

**3.2****burn-off**

localised areas of rough black oxide erupting through the enamel coating

**3.3****chipping**

fracturing and detachment of particles from a vitreous enamelled surface

**3.4****copperheads**

small freckle or pimple-like reddish brown spots occurring in ground-coats, or direct-on enamels applied to sheet metals

**3.5****cracking**

laminar interruptions in the fused coating running vertical to the surface

NOTE 1 The laminar interruptions can also occur at different angles.

NOTE 2 Their causes are mainly the result of tensile stresses within the enamel coating.

**3.6****crazing**

fine cracks in the enamel coating

**3.7****fire tool marks****(fire marks)**

small indentations similar in appearance to shallow pinholes

**3.8****fishscaling**

small half-moon shaped defects occurring in the vitreous enamelled surface

NOTE Fishscaling can occur immediately on cooling or after some time has elapsed following firing. These defects originate from super saturation of the substrate with hydrogen (acquired during firing) that suddenly fractures the enamel coating in order to relieve the pressure that has accumulated with time at the enamel-steel interface.

**3.9****spalling**

spontaneous fracturing and detachment of particles of enamel from within the coating layer

NOTE Spalling often occurs on corners, sharp radii, or panel edges; the result of too low enamel coefficient of expansion for the substrate, the external radii and the enamel thickness concerned. Thermal stresses can aggravate the spalling.

**3.10****tearing**

short breaks or cracks in the enamel bisque that have healed during firing

**3.11****air-gas heater**

heat exchangers used to heat up the air needed for combustion in the boiler using the combustion gases from the boiler as the hot fluid

NOTE 1 The maximum temperature of the hot gases entering the heat exchanger is 450 °C with a normal operating temperature from 380 °C to 320 °C.

NOTE 2 Air-gas heat exchangers in which gas fluid from DENOx installations pass through should be considered as Gas-gas heaters for the purpose of this European Standard

**EN 14866:2005 (E)****3.12****gas-gas heater**

heat exchangers used in the de-sulphuration plants to reheat the gases treated in the scrubber to obtain the proper draft in the stack

NOTE 1 The hot fluids are the untreated gases going to the scrubber.

NOTE 2 The maximum temperature of the hot gases entering the heat exchanger is 200 °C with a normal operating temperature from 160 °C to 120 °C.

**4 Steel substrates****4.1 Delivery**

The steel for enamelling shall conform to the requirements of EN 10209 and shall be delivered with a certificate in accordance with 3.1 of EN 10204:2004.

**4.2 Analysis**

The chemical composition shall be determined by a ladle analysis and shall conform to the requirements of EN 10209:1996, Table 2. On request of the enameller, other elements as mentioned in Table 2 shall be agreed with the steel manufacturer. For the grades DCO3ED and DCO4ED the carbon content of the product shall be determined and shall conform to EN 10209:1996, Table 2.

**4.3 Hydrogen permeability**

The hydrogen permeability shall have a minimum TH value of 100, calculated in accordance with EN 10209:1996, B.1.8, Equation (1), or shall give the result of a minimum of 8 min in accordance with EN 10209:1996, B.1, calculation in accordance with B.1.8 Equation (2).

In the absence of a certificate, from the steel supplier, confirming the above minimum hydrogen permeability and with prior agreement between the customer and the supplier the fish-scale resistance shall then be determined as described in 4.4.

The hydrogen permeability method is not acceptable for the steel grades DCO6EK and DCO6ED (see EN 10209:1996, Table 2). For these grades, the fish scale test described in 4.4 shall be used.

**4.4 Fish scale test**

The fish scale test shall be carried out in accordance with EN 10209:1996, B.2, method B.2. The test sheet (150 mm × coil width) shall be pre-treated without a nickel dip. The front and back shall be coated with enamel prepared in accordance with the supplier's milling formula and applied to produce a fired thickness of 100 µm to 130 µm. After drying, the coated test sheet shall be fired for 5 min at 820 °C. The test sheet shall then be subjected to thermal treatment at 60 °C to 80 °C for 24 h and then inspected for fish scales. No fish scales are allowed.

**4.5 Pickling speed**

If required by the enameller, the pickling speed shall be determined in accordance with EN 10209:1996, Annex C and shall be agreed with the steel manufacturer.



## 5 Enamel frit(s)

### 5.1 Delivery

Enamel frit(s) shall be ordered by the enameller with a certificate conforming to the requirements of 3.1 of EN 10204:2004, including the results for the items given under 5.5 and 5.7.

The tests 5.4 and 5.6 shall be carried out whenever there is a change in the frit or a change in the milling formula.

NOTE When taking delivery of "ready to use" enamel, enamel slip or enamel powder the enameller can ask for additional requirements for the application properties in the certificate.

Any other requirements and the test recipes shall be determined by consultation between enameller (and/or customer) and frit manufacturer.

### 5.2 Coefficient of expansion

If required by the enameller, the coefficient of expansion shall be determined in accordance with the house test of the manufacturer of the enamel frit (base material for "ready to use", enamel slip or powder enamel), or in accordance with ISO 7991.

### 5.3 Fusion flow

If required by the enameller, the fusion flow shall be determined in accordance with the house test of the manufacturer of the enamel frit (base material for ready to use, enamel slip or powder enamel), or in accordance with ISO 4534.

### 5.4 Boiling water vapour resistance

If required by the enameller, the water vapour resistance shall be determined in accordance with EN 14483-2:2004, Clause 13

When determined in accordance with EN 14483-2:2004, Clause 13, the enamel coating shall have a maximum mass loss as given in Table 1.

**Table 1 — Maximum mass loss**

Heater type	Mass loss max.
Air-gas	20 g/m <sup>2</sup> /48 h
Gas-gas	6 g/m <sup>2</sup> /48 h

### 5.5 Acid resistance

The boiling sulphuric acid resistance shall be determined in accordance with EN 14483-2:2004, Clause 11.

### 5.6 Thermal shock resistance

If required by the enameller, the thermal shock resistance shall be determined in accordance with Annex A at a test temperature of 350 °C

After testing five times at the test temperature, the test specimens shall show no damage.