
**Vitreous and porcelain enamels —
Glass-lined apparatus for process
plants —**

**Part 5:
Presentation and characterization of
defects**

*Emaux vitrifiés — Appareils émaillés pour les installations
industrielles —*

Partie 5: Présentation et caractérisation des défauts

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 107, *Metallic and other inorganic coatings*, and in collaboration with Technical Committee CEN/TC 262, *Metallic and other inorganic coatings*.

ISO 28721 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings*, in collaboration with ISO Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 28721 consists of the following parts, under the general title *Vitreous and porcelain enamels — Glass-lined apparatus for process plants*:

- *Part 1: Quality requirements for apparatus, components, appliances and accessories*
- *Part 2: Designation and specification of resistance to chemical attack and thermal shock*
- *Part 3: Thermal shock resistance*
- *Part 4: Quality requirements for glass-lined flanged steel pipes and flanged steel fittings*
- *Part 5: Presentation and characterization of defects*

Vitreous and porcelain enamels — Glass-lined apparatus for process plants —

Part 5: Presentation and characterization of defects

1 Scope

This part of ISO 28721 establishes a system for the cataloguing of defects in enamellings for chemical service and vessels. In addition, it describes some types of areas in which defects have been treated and which can easily be confounded with enamelling defects. It serves for a consistent language use concerning the designation and characterization of enamelling defects.

This part of ISO 28721 is limited to detectable defects and does not purport to fully take into consideration all occurring types of defects. It does **not** evaluate enamelling defects; the classification carried out is based on experience and corresponds, as far as possible, to ISO 28721-1.

NOTE Regarding the acceptance of glass lined equipment for use in process engineering, ISO 28721-1 applies.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 28721-1, *Vitreous and porcelain enamels — Glass-lined apparatus for process plants — Part 1: Quality requirements for apparatus, components, appliances and accessories*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

enamelling defect

defect arising during the enamelling of equipment and pipelines to be used in process engineering

3.2

reparable enamelling defect

enamelling defect that can be remedied without thermal post-treatment

EXAMPLE Defect that can be remedied by polishing.

3.3

non-reparable enamelling defect

defect in the enamel coating that renders a component unfit for its respective intended use

3.4

refiring

further enamel firing (also local), with or without another application

3.5

re-enamelling

complete new creation of the enamel coating

4 Enamelling defects

4.1 Colour lines

4.1.1 General

The enamelling defects strain lines (4.1.2), tearings (4.1.3) and pearl lines (4.1.4) are closely related to one another. The causes of their development and their appearances are similar.

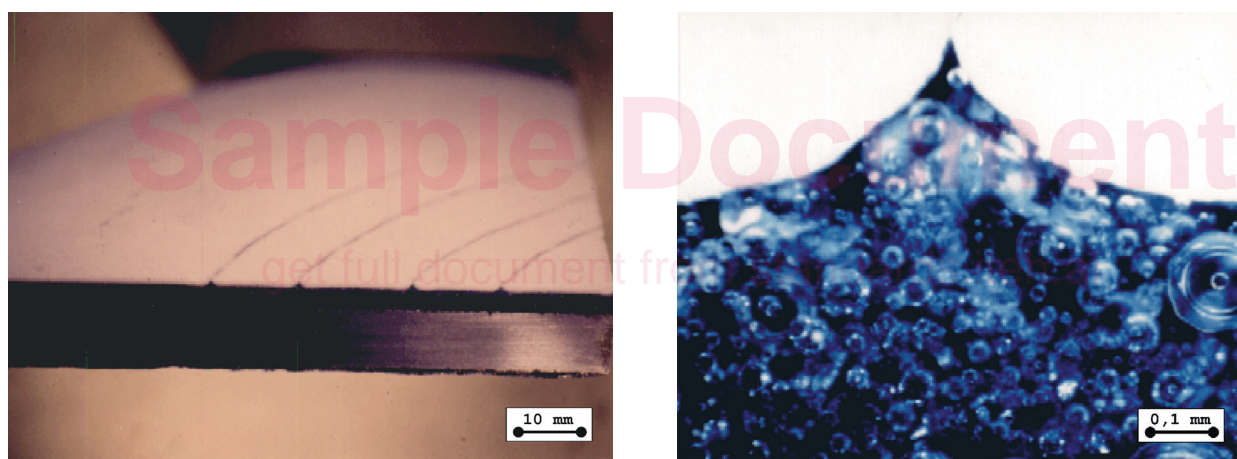
4.1.2 Strain lines

4.1.2.1 Further designations

Merged strain lines, linearly upward fused ground coat and hairlines.

4.1.2.2 Description

Strain lines are lines that are always dark and running parallel, or concentrically in the usually blue or white glass cover coat (see Figure 1). In a severe case of strain lines, a number of bubbles or blisters in a single line can appear, forming a pearl line (4.1.4).



a) White cover coat with macroscopically detectable strain lines

b) Lateral view, white cover coat exploring leapt up dark ground coat

Figure 1 — Strain lines

4.1.2.3 Origin and causes

Strain lines arise during enamelling due to thermally or mechanically induced stress in the component. When heating up, the ground coat and the covering bisque cracks open. During firing, parts of the ground coat penetrate into the cover coat.

Possible causes are the following:

- a wrong combination of steel/ground coat/cover coat;
- weld seam made from non-suitable filler material;
- mixing zones in the weld metal;
- non-adapted temperature control during enamelling of constructively unfavourable components, e.g. components showing mass accumulation;

— plastic deformation of the component during enamelling.

4.1.2.4 Classification

Non-reparable enamelling defect.

4.1.2.5 Suggestions for defect treatment

Re-enamelling, taking into consideration the causes mentioned in [4.1.2.3](#).

4.1.3 Tearings

4.1.3.1 Further designations

Hairlines.

4.1.3.2 Description

Tearings are mostly dark lines, running parallel or concentrically in the cover coat, i.e. lines that are always dark in blue enamel and either dark or light and transparent in white enamel. In contradiction to pearl lines (see [4.1.4](#)), the lines do not show large blisters and are closely related to strain lines (see [4.1.2](#)). Unlike strain lines, however, these lines are recessed (see [Figure 2](#)).

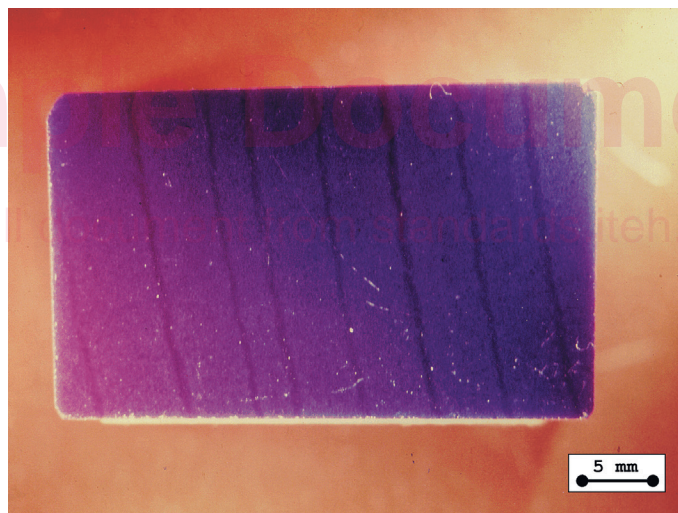


Figure 2 — Tearings

4.1.3.3 Origin and causes

Tearings arise during enamelling due to thermally or mechanically induced stress in the component. When heating up, the enamel bisque and/or the enamel coating crack(s) open. These cracks merge again during firing. If only the cover coat is affected, dark lines appear. If the crack runs through to the metal surface, blisters in the form of pearl lines also (see [4.1.4](#)) arise along the crack (for causes, see [4.1.2.3](#)).

4.1.3.4 Classification

Non-reparable enamelling defect. As, without carrying out destructive testing, it cannot be determined whether parts of the ground coat leap up, toleration is generally not possible for safety reasons.

4.1.3.5 Suggestions for defect treatment

Re-enamelling, taking into consideration the causes mentioned in [4.1.3.3](#).