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Non-destructive testing (NDT) methods of steel tubes - Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections

钢管无损检测　无缝和焊接钢管表面缺欠的液体渗透检测

(ISO 10893-4:2011, Non-destructive testing of steel tubes - Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections, IDT)

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Non-destructive testing (NDT) methods of steel tubes - Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections

1 Scope

This document specifies the requirements for liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections.

This document applies to the detection of imperfections on all or part of the surface of steel tubes, and also applies to the detection of hollow profiles.

2 Normative references

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

ISO 3059 Non-destructive testing - Penetrant testing and magnetic particle testing - Viewing conditions

ISO 3452-1 Non-destructive testing - Penetrant testing - Part 1: General principles

ISO 3452-2 Non-destructive testing - Penetrant testing - Part 2: Testing of penetrant materials

ISO 9712 Non-destructive testing - Qualification and certification of personnel

NOTE: GB/T 9445-2015 Non-destructive testing - Qualification and certification of personnel (ISO 9712:2012, IDT)

ISO 11484 Steel products - Employer’s qualification system for non-destructive testing (NDT) personnel

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in ISO 3452-1 and ISO 11484 and the following apply.

3.1

tube

A long hollow product with open ends and a cross-section of any shape.

3.2

seamless tube

A hollow tube made by piercing a solid material, which is further hot or cold processed into final dimensions.

3.3

welded tube

A hollow tube made from a strip by crimping and then welding, which may be further hot and cold processed into final dimensions.

3.4

manufacturer

An organization that produces products in accordance with relevant standards and declares that the delivered products comply with relevant standards.

3.5

agreement

The contract signed between the manufacturer and purchaser at the time of inquiry and order.

4 General requirements

4.1 Unless otherwise specified in the product standard or agreed upon between both supplier and purchaser, the liquid penetrant inspection shall be carried out after completion of all the production processes of steel tubes (rolling, heat treating, cold and hot processing, sizing, and straightening, etc.).

4.2 The surface of the steel tube to be inspected shall be clean enough and free of oil, grease, sand, scale or any other foreign matter that may affect the accuracy of the penetrant inspection results. The type of indications and the minimum imperfection dimension that can be detected depend on the specific steel tube manufacturing process and the surface finish.

4.3 The inspection shall be carried out by operators trained and qualified in accordance with ISO 9712, ISO 11484 or equivalent standards and under the supervision of

competent personnel authorized by the manufacturer. In the case of third-party inspection, this item shall be agreed upon between the supplier and purchaser.

The employer shall issue operating authorization certificates in accordance with procedural documents. NDT operations shall be authorized by a level 3 NDT personnel approved by the employer.

NOTE: The definitions of level 1, level 2, and level 3 can be found in the corresponding standards, such as ISO 9712 and ISO 11484.

5 Inspection methods

5.1 General

5.1.1 A liquid penetrant is applied to the surface of the workpiece being inspected and penetrates into the opening imperfections, and excess penetrant is removed; the surface being inspected is dried and a developer is applied. The developer is used to adsorb the penetrant penetrates into the imperfections and provide a high-contrast background for indications. The indication of the penetrant can be a colored indication (visible under white light) or a fluorescent indication (visible under ultraviolet light). For these two penetrant inspection techniques, the following three penetrants can be used:

a) water washable type;

b) post-emulsifying type;

c) solvent removable type.

NOTE: The term “penetrant material” used in this document includes all penetrants, solvents, cleaning agents, developers, etc. used in the inspection process.

5.1.2 For each steel tube to be inspected or each inspection position, it shall select one of three types of penetrating materials for the inspection using colored penetrant technique or fluorescent penetrant technique.

The general principles and verification methods for liquid penetrant inspection as described in ISO 3059, ISO 3452-1, ISO 3452-2 shall be used.

5.2 Detection of imperfections and their classification

The liquid penetrant inspection is an effective means of detecting surface opening imperfections (referred to as “surface imperfections” in this document). Typical surface imperfections that can be detected by this method are cracks, seams, laps, cold shuts, laminations, and porosity.

The liquid penetrant inspection cannot determine the nature, shape, and dimensions of imperfections. The dimensions of the penetrant indication do not directly represent the

d) the penetrant should be applied by brushing or spraying. For local inspection of steel tubes, dipping or flooding is not efficient, but can be used.

e) the penetration time shall not be less than the time recommended by the penetrant system manufacturer, usually 3 min ~ 30 min.

f) when removing excess water washable penetrant or post-emulsifying penetrant, it shall be flushed with water at a pressure of about 200 kPa (2 bar) under appropriate black light conditions. The maximum pressure is 350 kPa (3.5 bar). The temperature of the water used for flushing shall be lower than 40 ℃. Use a white wipes and clean, dry impurity-free material as much as possible to wipe away excess solvent removable penetrant, until most traces of the penetrant are removed. Use a clean, lint-free material slightly moistened with detergent to gently wipe the surface, until all traces of excess penetrant are removed from the surface of the workpiece being inspected. It is prohibited to rinse the surface with solvent after using the penetrant and before developing.

g) dry the washed surface, use a clean and dry white stain-free material to assist in wiping, or dry the surface with hot air at a pressure lower than 200 kPa (2 bar) and a temperature lower than 70 °C. Drying is usually by natural evaporation after solvent removal, so no other drying techniques are required. The temperature of the steel tube shall not exceed 50 °C, unless otherwise agreed upon between the purchaser and manufacturer.

h) the wet developer shall be applied by spraying, to ensure that the area being inspected is completely covered with a thin and uniform developer film; the dry-powder developer shall be applied either by immersing the part being inspected into a powder spray cabinet with dry-powder developer, or by spraying dry-powder developer through a powder bulb or a powder spray gun (conventional or electrostatic), to ensure that the powder is evenly sprayed on the surface of the test piece being inspected.

i) the development time is calculated from the time after the wet developer is dry or the dry developer is applied. Under normal circumstances, the development time is equal to the penetration time, usually 5 min ~ 30 min. If the indication size does not change, the development time is allowed to exceed 30 min.

j) the inspection of the areas being inspected is carried out after 5.3 i), and it shall be ensured that there is enough penetrant in the imperfection to be adsorbed to the surface of the workpiece by the developer. If agreed upon between the two parties, a contrast agent can be applied during observation. During fluorescent penetrant inspection, the inspection shall be carried out in a dark area where the visible illumination does not exceed 20 lx, and UV-A ultraviolet radiation is used to make the ultraviolet illumination of the area being inspected on the surface of the workpiece to be not less than 10 W/m^2. During colored penetrant inspection, the

the distance between adjacent indications is less than the length of the larger of the two indications, the two adjacent indications are regarded as one indication, and the indication length shall be the sum of the length of each indication and the length of the spacing.

7 Acceptance

7.1 Any steel tubes showing no indications of exceeding the acceptance level shall be deemed to have passed this inspection.

7.2 Any steel tubes showing indications of exceeding the acceptance level shall be deemed suspect.

7.3 According to the requirements of the product standard, suspect items shall be disposed of according to one or more of the following methods:

a) use grinding or other effective methods to treat suspect areas of the steel tube. After checking whether the remaining thickness is within the tolerance range, the steel tube shall be re-inspected according to the above requirements. If no indication greater than or equal to the acceptance level is found, the steel tube shall be deemed to have passed the inspection. If there is another agreement between the purchaser and the manufacturer, the suspect area shall be re-inspected using other non-destructive testing techniques and methods to confirm whether it meets the acceptance conditions.

b) crop off the suspect area.

c) the steel tube is deemed to have failed the re-inspection.

8 Test report

If specified, the manufacturer shall provide the purchaser with a test report containing at least the following contents:

a) serial number of this document;

b) statement of conformity;

c) any deviation from the provisions of the procedural documents, according to the agreement or other agreement;

d) steel grade and specifications of the product;

e) type and details of inspection technique;

f) description of the imperfection acceptance level of the reference standard;

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