INTERNATIONAL STANDARD

ISO 25902-1

First edition
2009-02-01

Titanium pipes and tubes — Non-destructive testing —

Part 1: Eddy-current examination

Canalisations et tubes en titane — Essai non destructif —

Partie 1: Contrôle par courants de Foucault

Reference number
ISO 25902-1:2009(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 25902-1 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 11, *Titanium*.

ISO 25902 consists of the following parts, under the general title *Titanium pipes and tubes — Non-destructive testing*:

— *Part 1: Eddy-current examination*

— *Part 2: Ultrasonic examination for the detection of longitudinal flaws*

Titanium pipes and tubes — Non-destructive testing —

Part 1: Eddy-current examination

1 Scope

This part of ISO 25902 specifies a method for the eddy-current examination, hereafter referred to as the "examination", for detecting flaws in titanium seamless tubes and welded tubes, hereafter referred to as the "tubes".

Titanium tubes are now used as steam surface condensers in steam-power plants, anatomic-power plants and desalination plants. Therefore, the quality of titanium tubes is very important and this is why the eddy-current inspection method was established. This method also applies to titanium alloy tubes.

In this part of ISO 25902

— the minimum wall thickness is 0,3 mm,

— the rectangular groove and the drilled hole are permitted as reference standards,

— as the outside diameter of the titanium tube increases, the detected flaw also increases. The limit of the outside diameter of the titanium tube is 38,1 mm.

2 Normative reference

The following referenced document is 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 15548-1, *Non-destructive testing − Equipment for eddy current examination − Part 1: Instrument characteristics and verification*

3 Terms and definitions

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

3.1
straightening mark
circumferentially spiral micro-dimensional variation which is generated by a straightening roll when a tube bend is straightened

3.2
ring mark
circumferential-like micro-dimensional variation which is generated by the stop of a roll when materials are cold rolled

3.3
rough surface
partial variation in roughness on the surface of a tube, which is the residue of a surface-finish trace

3.4
dent
partial variation on the surface of a tube, which is generated by mechanical shock

4 General

4.1 Applicable dimension range

The range of the applicable dimensions of a tube shall be 10 mm to 150 mm outside diameter and 0, 3 mm to 10 mm thickness.

4.2 Summary of examination method

The examination shall be carried out by using an encircling coil (hereafter, referred to as the “test coil”).

4.3 Personnel

This inspection shall be carried out by suitably trained operators and supervised by competent personnel nominated by the manufacturer. In the case of third-party inspection, this shall be agreed between the purchaser and manufacturer.

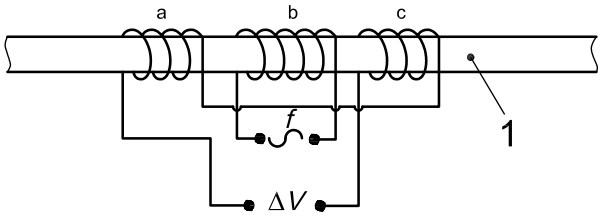
5 Apparatus

5.1 Test apparatus, composed of a flaw detector, a test coil, a tube feed device (including a coil-holding table), and an automatic alarm system or a recorder.

5.2 Eddy-current test instrument, composed of an oscillator, an electric device processing an electric signal, a display for signals resulting from flaws or the like, etc. and shall be as follows. See Figure 1.

a) The type, test frequency, the display system for indication, etc. shall conform to the purpose of the test.

b) The eddy-current test instrument shall operate stably for long periods under fluctuations of 0 °C to 40 °C ambient temperature and ± 15 % supply voltage, and shall be protected against electric noise from the outside.



Key

1 tube

a Secondary 1.

b Primary.

c Secondary 2.

f Frequency.

ΔV Supply voltage.

Figure 1 — Simplified diagram of concentric coil technique

5.3 Test coil, of a self-comparison type.

5.4 Tube feed device, automatic alarm system or recorder, with sufficient performance in flaw-detecting operation and acceptance criteria of the results.

5.5 Verification of apparatus for flaw detection.

The performance of the apparatus for flaw detection shall be verified by periodic examination and, if necessary, in accordance with ISO 15548-1. The apparatus for flaw detection shall have sufficient performance in flaw-detecting operation and judging operation of the results.

6 Reference piece

6.1 Purpose

The reference piece shall be used for setting the sensitivity of the apparatus for flaw detection and examining whether the sensitivity is maintained at a necessary level or not.

6.2 Materials

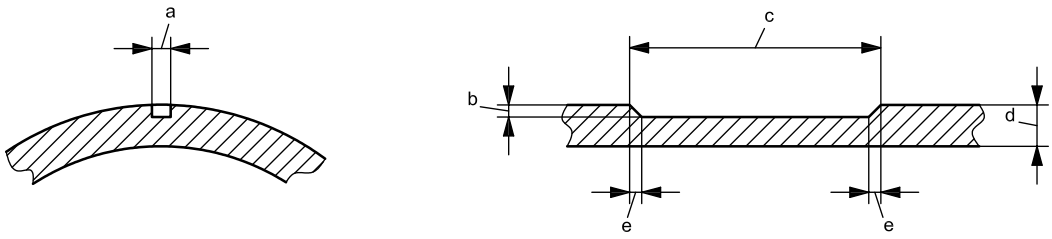
Materials to be used for the reference piece shall have at least the same material quality, nominal dimensions, and surface condition as those of the tubes to be examined.

6.3 Reference standards

6.3.1 Classification and shapes of reference standards

Reference standards used for a reference piece shall be classified as a rectangular groove or a drilled hole, and their shapes shall be as given in Figure 2.

Furthermore, the symbol for the class of a reference standard shall be N for the rectangular groove and D for the drilled hole.



a) Rectangular groove

b) Drilled hole

Key

a Width of groove.
b Depth.
c Length of groove.
d Thickness.
e At most 10 % of length.
f Diameter of drilled hole.

Figure 2 — Classification and shapes of reference standards

6.3.2 Dimensions of reference standards and tolerances thereon

The reference-standard dimensions and tolerances shall be as given in Tables 1 and 2.

Table 1 — Dimensions of rectangular grooves and tolerances thereon

Dimensions in millimetres

Nominal class of rectangular groove	Depth	Tolerance on depth	Length l	Width
N-0,10	0,10	± 0,05	$10 \leqslant l \leqslant 25$	1,0 max.
N-0,20	0,20			
N-0,40	0,40	± 15 % (minimum value ± 0,05)		
N-12,5	12,5 % of thickness			
N-15	15,0 % of thickness			
N-20	20,0 % of thickness			
N-25	25,0 % of thickness			
N-30	30,0 % of thickness			
N-40	40,0 % of thickness			

Table 2 — Size of drilled holes and tolerance thereon

Nominal class of drilled hole	Diameter of hole mm	Tolerance on diameter mm
D-0,8	0,8	± 0,05
D-1,0	1,0	
D-1,2	1,2	
D-1,4	1,4	
D-1,6	1,6	
D-3,2	3,2	± 0,1

6.4 Fabrication of reference standards

The reference standards (notch/drill hole) shall be fabricated as follows:

a) for seamless tubes: formed by electric-discharge machining or mechanical machining;

b) for welded tubes: formed by electric-discharge machining or mechanical machining on the base-metal part of the tube.

6.5 Number and interval of reference standards

The following conditions shall apply.

a) There shall be one or more angular grooves positioned axially on the outer surface of the tube.

b) There shall be three drilled holes in the axial direction of a tube at intervals and each at 120° on the peripheral direction of the tube. The drilled hole shall be opened by vertically piercing the surface of the tube.

c) Each interval of reference standards and each distance from the end of a reference piece shall be such that the signal of the reference standard can be sufficiently separately detected at the speed to be examined.

7 Test method

7.1 Test frequency

The test frequency shall be within the range of 1 kHz to 512 kHz, and a frequency capable of detecting sufficiently the reference standard of a reference piece shall be used.

7.2 Test coil

The test coil shall have a shape, system and dimensions so that reference standards of the reference piece to be used for setting sensitivity can be sufficiently detected.

7.3 Settings

7.3.1 Period for setting flaw-detection sensitivity

The flaw-detection sensitivity shall be set before the start of the examination.

7.3.2 Reference standards for setting flaw-detection sensitivity

For reference standards to be used for setting flaw-detection sensitivity, Table 3 applies to tubes with an outside diameter of at most 38,1 mm and Table 4 applies to tubes with an outside diameter of over 38,1 mm. The division given in the Tables is selected according to the use of a tube, manufacturing method, finishing method and thickness, and either a rectangular groove or a drilled hole shall be used.

Table 3 — Reference standards for setting flaw-detection sensitivity (38,1 mm max. outside diameter)

Division	Application				Classification of reference standards to be used	
	Use	Manufacturing method	Finishing method	Thickness t mm	Nominal of rectangular groove	Nominal of drilled hole
EA	For heat exchanger	Welded tube	As-welded or cold drawing	$0,3 \leqslant t < 0,8$	N-0,10	D-0,8
				$0,8 \leqslant t < 3$	N-12,5	
EB		Seamless tube	Cold drawing	$1 \leqslant t < 1,3$	N-0,20	D-1,0
				$1,3 \leqslant t < 5$	N-15	
EC	For piping	Welded tube	As-welded or cold drawing	$1 \leqslant t \leqslant 10$	N-20	D-1,2
ED		Seamless tube	Cold drawing	$1 \leqslant t \leqslant 10$	N-25	D-1,4
EE			Hot extrusion	$3 \leqslant t \leqslant 10$	N-30	D-1,6
	For heat exchanger and for piping		Cold rolling	$1 \leqslant t < 1,3$	N-0,40	
				$1,3 \leqslant t \leqslant 10$	N-30	

Table 4 — Reference standards for setting flaw-detection sensitivity (over 38,1 mm outside diameter)

Division	Application				Classification of reference standards to be used	
	Use	Manufacturing method	Finishing method	Thickness t mm	Nominal of rectangular groove	Nominal of drilled hole
EF	For heat exchanger	Welded tube	As-welded or cold drawing	$0,3 \leqslant t < 1,3$	N-0,20	D-1,0
				$1,3 \leqslant t < 3$	N-15	
EG		Seamless tube	Cold drawing	$1 \leqslant t < 5$	N-20	D-1,2
EH	For piping	Welded tube	As-welded or cold drawing	$1 \leqslant t \leqslant 10$	N-25	D-1,4
EI		Seamless tube	Cold drawing	$1 \leqslant t \leqslant 10$	N-30	D-1,6
EJ	For heat exchanger and for piping		Hot extrusion	$3 \leqslant t \leqslant 10$	N-40	D-3,2
			Cold rolling	$1 \leqslant t \leqslant 10$		

7.3.3 Adjustment of eddy-current test instrument

The sensitivity, phase, etc. of an eddy-current test instrument shall be adjusted with the reference piece of the division selected from Table 3 or Table 4.

The sensitivity of the eddy-current test instrument shall be adjusted so that the indication by the reference standard of the reference piece becomes almost 50 % of the scale range of the recorder, indicator, etc.

The display, automatic alarm system, or recorder of the eddy-current test instrument shall be adjusted so that the indication by reference standards falls within a normal operation range during the travelling state of the reference piece.

7.3.4 Adjustment of tube feed device

The tube feed device shall be regulated so that dispersion of the signal of the reference standard is detected within a range of ± 15 % when the test coil is passed at a speed to be examined by varying the position of the reference standard of a reference piece at each 90° for a rectangular groove, or with the reference standard formed at each 120° on the periphery of the tube of the reference piece for a drilled hole.

7.4 Confirmation of sensitivity of eddy-current test instrument

It shall be confirmed at least every 4 h that the sensitivity of the eddy-current test instrument is suitably maintained when examining the end of each operation, when the examination is interrupted and when the examination is continuously performed. Where an abnormality of the apparatus is discovered during the eddy-current test instrument examination, readjustment is performed and all tubes examined during the abnormal period shall be re-examined.

8 Acceptance criteria

The tube shall be accepted in the case where a signal equal to or greater than the signal from the reference standard of a reference piece is not detected. Although the signal is equal to or greater than the signal from the reference standard of the reference piece, when the flaw is caused by the following and therefore judged harmless, the tube under test may be regarded as accepted.

a) straightening mark;

b) ring mark;

c) rough surface;

d) dent;

e) other similar flaw.

9 Test report

The following items shall be stated in the test report:

a) date of examination;

b) name of inspection personnel;

c) symbol for grade and tube;

d) dimensions of tube;

e) name of apparatus for eddy-current test instrument;

f) reference standards;

g) test coil;

h) test frequency;

i) method for flaw detection, conditions for flaw detection (tube feed speed, working sensitivity, phase, etc.);

j) results of the examination.

ICS 77.040.20; 77.150.50

Price based on 8 pages