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Seamless and welded steel tubes for pressure purposes — Magnetic particle inspection of the tube body for the detection of surface imperfections

Tubes en acier sans soudure et soudés pour service sous pression — Contrôle par magnétoscopie du corps des tubes pour la détection des imperfections de surface

Reference number
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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.

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.

International Standard ISO 13665 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes*.

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Seamless and welded steel tubes for pressure purposes — Magnetic particle inspection of the tube body for the detection of surface imperfections

1 Scope

1.1 This International Standard specifies requirements for magnetic particle inspection of the tube body of seamless and welded steel tubes for pressure purposes, for the detection of surface imperfections, according to four different acceptance levels.

It is intended that this International Standard be used to detect surface imperfections on all or part of the outer surface of tubes, excluding the end/bevel face, as may be required by the relevant products standards. However, it may be applied to the inside surface over a limited length from the ends of tubes, dependent on the tube diameter, by agreement between the purchaser and manufacturer.

1.2 In addition, this International Standard may be used, as appropriate, to locate the position of external surface imperfections detected by another non-destructive testing method, for example, ultrasonics, prior to dressing of the tube surface, and to ensure complete removal of the imperfection after dressing is complete.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9934-1:—[1], *Non-destructive testing — Magnetic particle testing — Part 1: General principles.*

ISO 11484:1994, *Steel tubes for pressure purposes — Qualification and certification of non-destructive testing (NDT) personnel.*

3 General requirements

3.1 The magnetic particle inspection covered by this International Standard is usually carried out on tubes after completion of all the primary production process operations.

This inspection shall be carried out by personnel certificated in accordance with ISO 11484, as nominated by the manufacturer. In the case of third-party inspection, this shall be agreed between the purchaser and manufacturer.

3.2 The surface of the tube to be tested shall be sufficiently clean and free from oil, grease and other foreign matter which could interfere with the correct interpretation of indications obtained from the magnetic particle inspection of the tube.

3.3 It is emphasized that the type of indications obtained, as well as the minimum dimension of the surface imperfections to be detected, are dependent upon the specific tube manufacturing process and the tube surface finish.

1) To be published.

4 Method of test

4.1 The entire outer surface of each tube or part of it, as required, shall be inspected using the magnetic particle method, for the detection of longitudinal and/or transverse surface imperfections, using a.c. or d.c. magnetization and dry powder, black or fluorescent ink, as appropriate to the magnetic particle technique adopted, generally in accordance with the requirements given in ISO 9934-1.

4.2 During the production testing of tubes, magnetization shall be applied in the circumferential direction for the detection of longitudinal surface imperfections or in the direction parallel to the major axis of the tube for the detection of transverse surface imperfections. The dry powder or black ink shall be applied simultaneously, as appropriate, to reveal the presence of surface imperfections, using an illumination of not less than 350 lx.

In cases where there is insufficient sensitivity due, for example, either to poor contrast between the dry powder or black ink and the surface of the tube to be inspected, or as a result of the magnetization technique adopted, the tube surface shall, prior to inspection, be coated with a white background paint to aid contrast. Alternatively, fluorescent ink shall be used and the inspection carried out in a darkened area using a UV-A radiation source, with a background white light level not exceeding 20 lx and a black light intensity of at least 8 W/m^2.

The use of residual magnetism, i.e. application of magnetic particles after initial tube magnetization, is only permitted after prior agreement between the purchaser and manufacturer.

4.3 The magnetization methods applicable to the magnetic particle inspection of tubes are described in 4.3.1 to 4.3.4.

4.3.1 Method A — Current flow method

In this method, current derived from a d.c., a.c., full or half-wave rectified a.c. external power source is passed between two contact areas on the surface of the tube. This method is intended for the detection of imperfections which lie generally parallel to the direction of current flow.

4.3.2 Method B — Threaded bar/cable method

In this method, current (as in Method A) is passed through a rigid bar or flexible cable placed within the tube bore and approximately concentric with it. This method is intended (as in Method A) for the detection of imperfections which lie generally parallel to the direction of current flow through the threaded bar/cable.

4.3.3 Method C — Encircling coil method

In this method, a rigid or semi-rigid current-carrying coil is placed around the tube and the surface of the tube within the influence of the coil is magnetized in the direction parallel to the major axis of the tube, favouring the detection of generally transverse imperfections.

4.3.4 Method D — Magnetic flow method

In this method, the tube, or part of it, forms part of the magnetic circuit of an electromagnet which carries current from an external power source (as in Method A). This method favours the detection of imperfections lying at right angles to an imaginary line adjoining the pole pieces of the electromagnet.

4.4 It is emphasized that it is outwith the scope of this International Standard to specify the levels of magnetization required, and current levels required to achieve such levels of magnetization, to reveal the presence of unacceptable surface imperfections.

NOTE 1 This is due to the wide variety of magnetic particle techniques available and permitted for this purpose.

However, in all cases the magnetization requirements together with the use of magnetic inks and powders given in ISO 9934-1 shall apply.

4.5 During the production testing of tubes, the level of magnetization achieved using the adopted technique and equipment shall be checked at regular intervals, not exceeding 4 h, for example using a penetrameter or magnetic field-strength meter, as appropriate.

5 Evaluation of indications

5.1 It is stressed that the magnetic particle inspection method does not make it possible to determine the nature, shape, orientation and more particularly the depth of surface imperfections revealed as indications. The dimensions and extent of magnetic particle "build-up" of indications do not directly represent the actual dimensions of the surface imperfection causing the indication. For these rea-

sons, the classification/evaluation of magnetic particle indications shall be as follows:

a) linear indications — indications where the length of the indication is equal to or more than three times the width of the indication;

b) rounded indications — indications which are circular or elliptical in shape, where the length of the indication is less than three times the width of the indication;

c) accumulated indications — indications which are linear or rounded and are aligned or clustered with a separation of not more than the length of the smallest indication;

d) non-relevant indications — indications of a similar shape/form which may result from localized surface irregularities to a particular tube-making process, for example, machining marks, scratches, sizing/straightening marks etc.

5.2 Evaluation of indications shall be carried out using the naked eye without any means of image magnification.

5.3 The minimum dimension of indications to be considered during the evaluation shall be as given in table 1, in relation to the acceptance level specified.

Table 1 — Minimum dimension of indications to be considered for evaluation

Acceptance level	Diameter D or length L of the smallest indication to be considered mm
M1	1,5
M2	2,0
M3	3,0
M4	5,0

5.4 Only relevant indications with their major dimension in excess of that given in table 1 shall be taken into account when determining the incidence of such indications, according to the appropriate acceptance level. Non-relevant indications are not to be considered during evaluation.

5.5 Relevant indications obtained by magnetic particle inspection in accordance with this International Standard shall be evaluated and classified as follows.

a) For general testing of tube surfaces, either of the entire surface or a localized area, an imaginary frame aperture of 100 mm × 150 mm shall be placed over the area with the highest incidence of relevant indications. The indications shall be classified with regard to the type, number and dimensions of the indications within the frame, according to the appropriate acceptance level given in table 2.

b) For testing the weld seam of welded tube, an imaginary frame aperture of 50 mm × 150 mm, with the weld centred on the 50 mm dimension of the frame aperture, shall be placed over the area with the highest incidence of relevant indications. The indications shall be classified with regard to the type, number and dimensions of the indications within the frame, according to the appropriate acceptance level given in table 3.

c) For calculating the cumulative length of accumulated indications, the length along the major axis of linear and rounded indications shall be used and in cases where the separation between two adjacent indications is less than the length or the diameter of the larger of the two indications, the indications shall be considered as one and the sum of the individual lengths or diameters plus the separation shall be used to calculate the overall length.

6 Acceptance

6.1 Tubes or parts of tubes not showing indications in excess of those permitted by the corresponding acceptance level shall be deemed to have passed the test.

6.2 Tubes or parts of tubes showing indications in excess of those permitted by the corresponding acceptance level shall be designated suspect.

6.3 For suspect tubes, one or more of the following actions shall be taken.

a) The suspect area shall be explored by dressing using an acceptable method and, after checking that the remaining thickness is within the tolerance limits, the suspect area shall be retested as previously specified to ensure that each imperfection giving rise to the original indications has been completely removed.

The tube shall then be deemed to have passed the test.

b) The suspect area shall be cropped off. The manufacturer shall ensure to the satisfaction of the purchaser that all of the suspect area has been removed.

c) The tube shall be deemed not to have passed the test.

Table 2 — Tube surface: maximum permissible number of indications and dimensions (diameter or length) within a frame aperture of 100 mm × 150 mm

Acceptance level	Tube thickness mm	Type of indications					
		Rounded		Linear		Accumulated	
		Number	Dimension mm	Number	Dimension mm	Number	Dimension mm
M1	⩽ 16	5	3,0	3	1,5	1	4,0
	> 16 ⩽ 50	5	3,0	3	3,0	1	6,0
	> 50	5	3,0	3	5,0	1	10,0
M2	⩽ 16	8	4,0	4	3,0	1	6,0
	> 16 ⩽ 50	8	4,0	4	6,0	1	12,0
	> 50	8	4,0	4	10,0	1	20,0
M3	⩽ 16	10	6,0	5	6,0	1	10,0
	> 16 ⩽ 50	10	6,0	5	9,0	1	18,0
	> 50	10	6,0	5	15,0	1	30,0
M4	⩽ 16	12	10,0	6	10,0	1	18,0
	> 16 ⩽ 50	12	10,0	6	18,0	1	27,0
	> 50	12	10,0	6	30,0	1	45,0

Table 3 — Weld seam: maximum permissible number of indications and dimensions (diameter or length) within a frame aperture of 150 mm × 50 mm (width centred on the weld seam)

Acceptance level	Tube thickness mm	Type of indications					
		Rounded		Linear		Accumulated	
		Number	Dimension mm	Number	Dimension mm	Number	Dimension mm
M1	⩽ 16	1	3,0	1	1,5	1	4,0
	> 16	1	3,0	1	3,0	1	6,0
M2	⩽ 16	2	4,0	2	3,0	1	6,0
	> 16	2	4,0	2	6,0	1	12,0
M3	⩽ 16	3	6,0	3	6,0	1	10,0
	> 16	3	6,0	3	9,0	1	18,0
M4	⩽ 16	4	10,0	4	10,0	1	18,0
	> 16	4	10,0	4	18,0	1	27,0