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Seamless and welded steel tubes for pressure purposes — Ultrasonic testing of tube ends for the detection of laminar imperfections

Tubes en acier soudés et sans soudure pour service sous pression — Contrôle par ultrasons des extrémités de tube pour la détection des dédoublures de laminage

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 11496 was prepared by Technical Committee ISO/TC 17, *Steel*, Sub-Committee SC 19, *Technical delivery conditions for steel tubes for pressure purposes*.

Seamless and welded steel tubes for pressure purposes — Ultrasonic testing of tube ends for the detection of laminar imperfections

1 Scope

1.1 This International Standard specifies requirements for full peripheral ultrasonic testing of the ends of seamless and welded tubes for the detection of laminar imperfections.

It is intended to detect, over a zone at the ends of plain end and bevelled end tubes, laminar imperfections which may interfere with subsequent fabrication operations (e.g. welding, ultrasonic inspection of welds, etc.).

1.2 This International Standard is applicable to the inspection of tubes with an outside diameter greater than 30 mm. No lower limit of thickness is specified, but see note 1.

NOTE 1   For thicknesses less than 5 mm, difficulties can be experienced in detecting laminar imperfections by this method. When such difficulties arise, an agreement between the purchaser and manufacturer is required to determine the testing technique to be adopted.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11484:—[1], *Steel tubes for pressure purposes — Qualification and certification of non-destructive testing (NDT) personnel.*

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1) To be published.

3 General requirements

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

These activities 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 surfaces of the tube end zones to be tested shall be sufficiently free from foreign matter which would interfere with the validity of the test.

4 Method of test

4.1 The tube end zone at both tube ends shall be tested using an ultrasonic pulse echo technique for the detection of laminar imperfections, with ultrasound transmitted in the direction normal to the tube surface.

4.2 During testing, the tubes and/or the transducer assembly shall be moved relative to each other so that the whole of the tube surface is scanned from the outside surface, or the inside surface where appropriate, over a 25 mm or $2a$ wide band (a = wall thickness) with a maximum of 50 mm, whichever is the greater, from the point where the outside surface meets the end face or bevel.

In the case of submerged arc-welded tubes, when the weld reinforcement precludes a test for laminar imperfections close to and over the reinforcement, a 25 mm wide zone on either side of the weld reinforcement shall not be inspected unless the purchaser and manufacturer agree to do so. The

reinforcement is removed by dressing to permit a full peripheral test to be executed.

4.3 The maximum width of each individual transducer, measured parallel to the major axis of the tube, shall be 25 mm.

4.4 The equipment for automatic or semi-automatic testing (when used) shall be capable of differentiating between acceptable and suspect tubes by means of an automatic trigger/alarm level.

NOTE 2   It is stressed that the ultrasonic technique described in this International Standard may not reveal the presence of laminar imperfections which may occur on the plain or bevelled end face. As a result, either liquid penetrant or magnetic particle inspection of the end face is often employed. In the latter case, longitudinal or radial magnetization is used.

5   Reference standards

5.1 The reference standards defined in this International Standard are convenient standards for calibration of non-destructive testing equipment. The dimensions of these standards should not be construed as the minimum size of imperfection detectable by such equipment.

5.2 The ultrasonic equipment shall be calibrated either electronically with a plain tubular test piece (see 7.1.1), or using reference standards comprising flat bottomed round, square or rectangular recesses (see figure 1) machined into the inner surface of a tubular test piece (see 7.1.2).

5.3 The test piece shall have the same nominal diameter, thickness and surface finish as the tube to be tested, and shall have similar acoustic properties (e.g. velocity, attenuation coefficient, etc.).

6   Dimensions of reference standard

6.1 The dimensions of the reference standard, when used, shall be as follows:
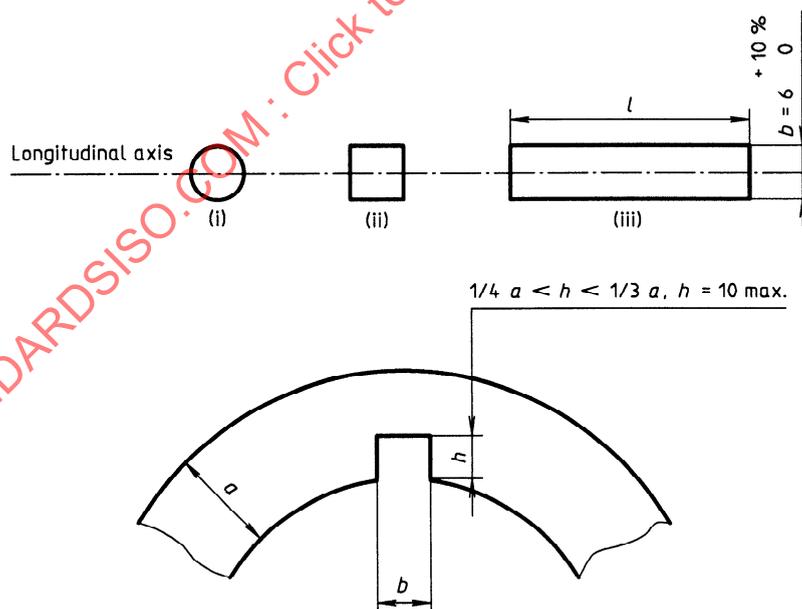
6.1.1   Width (circumferential dimension)

6 mm $^{+10}_{0}$ %

6.1.2   Recess depth

Between 1/4 and 1/2 of the nominal tube thickness.

6.2 The reference standard dimensions and shape shall be verified by a suitable technique.

Dimensions in millimetres

l = length of rectangular recess (only restriction: $l > 6$)

b = width of rectangular recess

h = depth of rectangular recess

a = wall thickness of tube

Figure 1 — Reference recess forms

7 Equipment calibration and checking

7.1 The equipment shall be calibrated statically using either electronic means in accordance with 7.1.1 or a reference standard in accordance with 7.1.2.

7.1.1 Calibration using an electronic technique

With the transducer assembly positioned on the tubular test piece, the full amplitude of the first back wall echo minus 6 dB shall be used to set the trigger/alarm level of the equipment.

At the start of the production testing run, the manufacturer shall demonstrate that, at the set sensitivity, the equipment will detect, under static conditions, the reference recess as given in 5.2 and figure 1. If not, the necessary adjustment in sensitivity shall be made prior to the testing of production tubes.

In certain circumstances for manual ultrasonic testing, the test sensitivity shall be established with DAC curves as supplied by the transducer manufacturer or DAC curves as prepared by the tube manufacturer using, in both cases, the 5 mm flat bottom hole curve.

7.1.2 Calibration using a reference standard

Under static conditions, with the transducer or each transducer in turn centrally located over the reference recess, the full signal amplitude of the signal obtained from the reference recess shall be used to set the trigger/alarm level of the equipment.

7.2 During the production testing of tubes, the relative rotational and translational speeds together with the equipment pulse repetition frequency, shall be chosen to provide full surface coverage of the end zone at both ends of each tube.

7.3 The calibration of the equipment shall be checked at regular intervals during the production testing of tubes of the same diameter, thickness and grade.

The frequency of checking the calibration shall be at least every 4 h or once every ten production tubes tested, whichever is the longer time period, but also whenever there is an equipment operator changeover and at the start and end of the production run.

NOTE 3   In cases where a production testing run is continuous from one shift period to the next, the 4 h maximum period may be extended by agreement between the purchaser and manufacturer.

7.4 The equipment shall be recalibrated following any system adjustments or whenever the specified nominal tube diameter, wall thickness or grade of steel is changed.

7.5 If on checking during production testing the calibration requirements are not satisfied, even after increasing the test sensitivity by 3 dB to allow for system drift, then all tubes tested since the previous check shall be retested after the equipment has been recalibrated.

Retesting shall be necessary even after a drop in test sensitivity of more than 3 dB since the previous calibration, provided that suitable recordings from individually identifiable tubes are available which permit accurate classification into suspect and acceptable categories.

8 Acceptance

8.1 Any tube not producing a trigger/alarm condition shall be deemed to have passed this test.

8.2 Any tube producing a trigger/alarm condition shall be designated suspect, or at the manufacturer's option, may be retested as specified above.

8.3 If, on retesting, no trigger/alarm condition is obtained, the tube shall be deemed to have passed this test. Tubes producing a trigger/alarm condition shall be designated suspect.

8.4 For suspect tubes, the manufacturer may either reject the tube or crop off the suspect area. In the latter case, the manufacturer shall ensure to the satisfaction of the purchaser that all the suspect area has been removed, and subject the end zone of the remaining length to a repeat test as specified above.

9 Test report

When specified, the manufacturer shall submit to the purchaser a test report that includes, at least, the following information:

a) reference to this International Standard;

b) date of test report;

c) acceptance level;

d) statement of conformity;

e) material designation by grade and size;

f) type and details of inspection technique;

g) description of the reference standard;

h) equipment calibration and method used.

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