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Destructive tests on welds in metallic materials — Method for taking samples for delta ferrite measurement

*Essais destructifs des soudures sur matériaux métalliques — Méthode
d'échantillonnage pour la mesure de la ferrite delta*



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Foreword

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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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17655 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

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Foreword

This document (EN ISO 17655:2003) has been prepared by Technical Committee CEN/TC 121, "Welding", the secretariat of which is held by DS, in collaboration with ISO/TC 44 "Welding and allied processes".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2003, and conflicting national standards shall be withdrawn at the latest by September 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

By way of departure from this European Standard, EN ISO 8249 describes methods of manufacturing of primary and secondary standards for calibration of ferrite testing instruments and gives information for determining the ferrite content of all-weld metal under specified and reproducible conditions.

1 Scope

This European Standard specifies the determination of the delta ferrite content of welds, of surfacings with austenitic weld metal, welding being carried out on welding procedure tests and production coupon test plates using any fusion welding process that is suitable for austenitic materials, with or without filler metal including welds made on components.

It is intended that the ferrite number be used exclusively for stating the delta ferrite content of austenitic weld metal as determined by the method described here.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1597-1, *Welding consumables — Test methods — Part 1: Test piece for all-weld metal test specimens in steel, nickel and nickel alloys.*

EN ISO 8249:2000, *Welding - Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals (ISO 8249:2000).*

3 Terms and definitions

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

3.1

all-weld metal

filler metal that has solidified after welding and has not mixed with the parent metal

3.2

weld metal

metal composed of parent metal and/or filler metal or a metal deposited during surfacing

3.3

delta ferrite

body centred modification of iron formed at high temperatures stable at ambient temperature

3.4

primary weld metal standards

samples of carbon steel parent metal covered with non-magnetic layers of different thickness

[EN ISO 8249:2000]

3.5

secondary weld metal standards

calibrated with primary weld metal standards

3.6

ferrite number

measure of the force required to detach a permanent magnet from an austenitic weld metal sample ("tear-off force", for short)

3.7

ferrite percent

percentage of delta ferrite in an austenitic material

4 Symbols and descriptions

Table 1 — Symbols and descriptions

Symbol	Description	Unit
FN	Ferrite number	No.
FP	Ferrite percent	%
δ -ferrite	Delta ferrite	No. or %

5 General

Austenitic weld metal may, as a function of its chemical composition and of the cooling conditions during the welding process, contain a δ -ferrite phase. A certain amount of δ -ferrite may be desirable to increase the resistance of the austenitic weld metal to hot cracking; however, it also reduces corrosion resistance and promotes the formation of a brittle sigma phase at elevated operating temperatures. Knowledge of the δ -ferrite content is thus necessary to allow the weld metal properties to be predicted.

6 Principle

Physical methods of measurement are based on the fact that δ -ferrite is magnetic, whereas austenite, carbides, sigma phase and inclusions are nonmagnetic.

The term „ferrite number“ (FN) is used to designate the δ -ferrite content. In the past, the ferrite number was determined arbitrarily by measuring the attractive force between a permanent magnet of defined strength and size and steel samples with electroplated non-magnetic coatings of different thickness.

Thus, except for low levels of δ -ferrite content (below 10 %), the ferrite number is not necessarily identical with the percentage ferrite content of the weld metal.

7 Designation

The value of ferrite number (FN), as determined in accordance with this standard, shall be designated and reported on the test certificate as follows, which relates to a measured value of 8:

Measurement: 8 FN

8 Procedure

8.1 Location of measurement surface

In the case of all-weld metal, the measurement surface shall be located as described in EN 1597-1. For welds, the measurements shall be taken at the centre of the weld, taking into account the characteristics of the instrument when measuring small welds or thin surfacings consisting of austenitic materials.

8.2 Preparation of measurement surface

The measurement surface shall be bright and smooth and sufficiently flat so as to ensure adequate coupling of the test magnet or test probe. To this effect, the top run shall be smooth, e.g. by grinding and/or filing, in the direction of the weld bead. No unacceptable microstructure changes (e.g. formation of deformation martensite) or temper colours shall be formed during grinding.

The length of the measurement surface shall be 40 mm, with a minimum width of 5 mm. The measurement surface shall not exhibit any weld bead starts and end craters and shall be free from foreign matter, such as lubricants, dirt or magnetic particles.

8.3 Instruments

Suitable instrument shall be used to determine the ferrite number, taking into account their range of application as specified by the manufacturer.

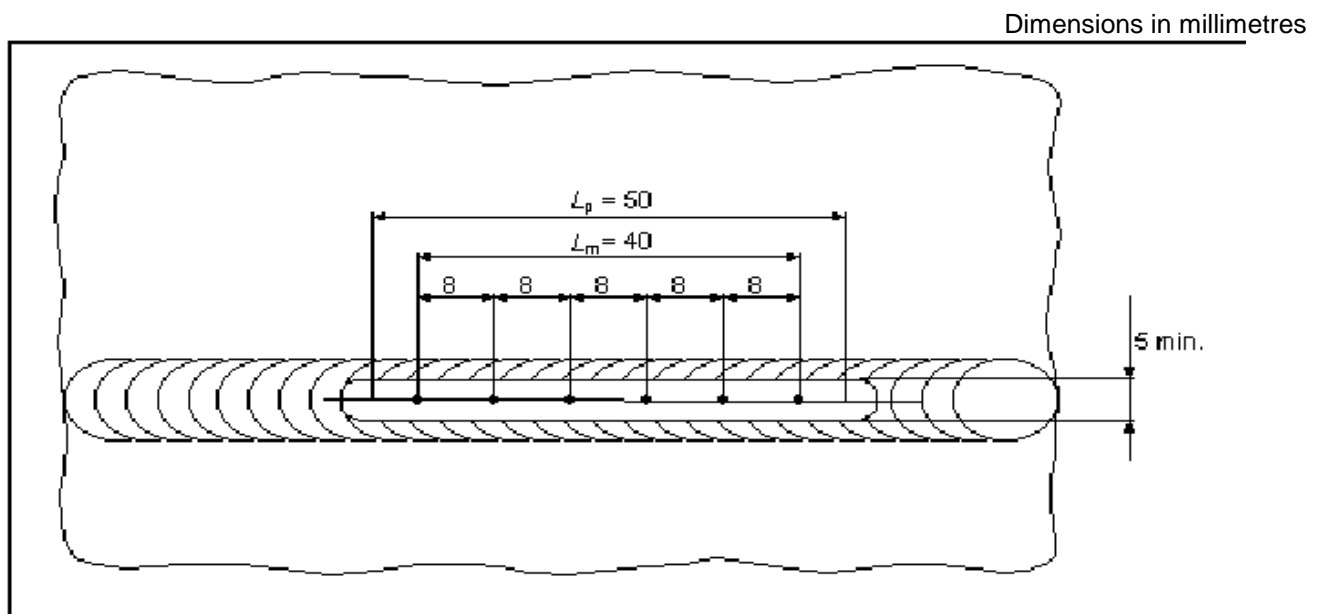
8.4 Calibration

Prior to use, the instruments shall be calibrated with the aid of secondary weld metal standards according to EN ISO 8249. The secondary weld metal standard and the specified measuring range shall be selected to suit the ferrite number to be determined.

8.5 Procedure

Since δ -ferrite is not uniformly distributed in the material, the result obtained for one and the same weld metal may vary from measuring point to measuring point. Thus, measurement shall be carried out at six points equally spaced along the centre line of the measurement surface (see Figure 1).

The ferrite number is the arithmetical average value from 6 single measurements, rounded to the next whole number. Testing shall be carried out at ambient temperature. The gauging surface shall not be exposed to impacts or vibrations during measuring.



Key

L_p = length of test surface

L_m = length of measurement surface

Figure 1 — Measurement surface with measuring points

9 Test report

The test report shall include a reference to this standard and provide the following information:

- a) reference to weld metal designation;
- b) information on whether measurement was made on a weld procedure or production component;
- c) location of measurement surface on the component;
- d) instrument used;
- e) ferrite number of secondary weld metal standard and measuring range used;
- f) ferrite number determined;
- g) any deviations from this standard.

Bibliography

EN ISO 6847, *Welding consumables - Deposition of a weld metal pad for chemical analysis (ISO 6847:2000)*

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