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Resistance welding — Procedure for the evaluation of the life of spot welding electrodes using constant machine settings

Soudage par résistance — Mode opératoire pour l'évaluation de la durée de vie des électrodes utilisées en soudage par points avec des réglages de machines constants

Reference number
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Foreword

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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 8166 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*, 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...".

Contents

Foreword

This document (EN ISO 8166:2003) has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS, in collaboration with Technical Committee 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of an identical text or by endorsement, at the latest by December 2003, and conflicting national standards shall be withdrawn at the latest by December 2003.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

This European Standard enables the electrode life of spot welding electrodes to be determined. This standard does not invalidate procedures for electrode life testing or their qualification documents in current use which complied with the national or international standards or regulations existing at that time, provided the intent of the technical requirement is satisfied and the specified application, its performance and equipment with which it is performed remain unchanged.

When this standard is referenced for contractual purposes, all questions relating to the specification and implementation of welding procedures shall be defined in the design specification at the time of enquiry or at the contract stage.

It has been assumed in this standard that the execution of its provisions is entrusted to appropriately trained, skilled and experienced personnel.

For the quality of welded structures the relevant part of standard EN ISO 14554 should be applicable. The specification of procedures should follow guidelines as in standard prEN ISO 15609-5.

The specified procedure allows the determination of the life of spot welding electrodes i.e. the number of acceptable spot welds which can be made between the need for re-dressing of the electrodes. The test procedure can be used to evaluate the following:

a) the influence of electrode material or electrode shape and dimensions on the electrode life when welding a particular material;

b) the affect of material being welded on the electrode life obtained using a fixed electrode shape and dimensions;

c) the influence of welding conditions on electrode life when using a particular combination of electrode material and shape for the welding of any material type;

d) the influence of welding machine type, electrode cooling on electrode life.

Precise details of the test procedure to be used will depend on which aspect of items a) to d) is to be evaluated relative to the electrode life obtained.

For convenience, a generic test procedure is described in this document which allows assessment of the effect of the material being welded on the electrode life obtained when using precisely defined welding conditions/electrode configurations. These can be modified depending on the particular parameters being investigated.

Recommendations are also given concerning the important parameters which need to be kept constant so as to allow the appropriate comparisons to be made as indicated in a), c) and d) above.

1 Scope

This European Standard specifies a procedure to be used for the evaluation of the life of spot welding electrodes when welding uncoated and coated steels, stainless steels, aluminium and aluminium alloys using constant machine settings which are not changed during the test. The procedure can also be used to establish the electrode life when spot welding other metallic materials.

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 ISO 14273, *Specimen dimensions and procedure for shear testing resistance spot, seam and embossed projection welds (ISO 14273:2000).*

prEN ISO 14329:1999, *Welding — Destructive testing of welds — Failure types and geometric measurements for resistance spot, seam and projection welds (ISO/DIS 14329:1999).*

prEN ISO 15609-5, *Specification and approval of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding (ISO/DIS 15609-5:2000).*

EN ISO 17653, *Destructive tests on welds in metallic materials — Torsion of resistance spot welds (ISO 17653:2003).*

ISO 669:2000, *Resistance welding — Resistance welding equipment — Mechanical and electrical requirements.*

ISO 5182:1991, *Welding — Materials for resistance welding electrodes and ancillary equipment.*

ISO 5184, *Straight resistance spot welding electrodes.*

ISO 5821, *Resistance spot welding electrode caps.*

ISO 5830, *Resistance spot welding — Male electrode caps.*

ISO 10447, *Welding — Peel and chisel testing of resistance spot, projection and seam welds.*

ISO/DIS 14373, *Welding — Resistance spot welds — Procedure for spot welding of uncoated and coated low carbon and high strength steels.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in ISO 669:2000 and prEN ISO 14329:1999 apply.

4 Criteria for the end point of the electrode life test

For the purpose of this procedure for all materials, the electrode life is the number of welds which can be made giving the required weld quality before re-machining of the electrode face is necessary.

The electrode shall be considered to have reached its life when the welds being produced have a weld diameter, as indicated in a peel test, of less than $3{,}5\sqrt{t}$ (where t is the sheet thickness in mm) for three welds in a test sample of five consecutive welds. Peel testing shall be carried out according to ISO 10447. All electrode life tests will be repeated three times to give an indication of the amount of scatter. Both the average value and the range of electrode life shall be quoted. Ring or stuck welds are not acceptable. It should be noted that ring welds occur sooner when welding coated steels.

Alternative criteria for determining the end of electrode life shall be used as defined in the design specification. These depend on the requirements of the product. Typical examples which can be used when testing uncoated or coated steels include:

a) agreed reduction in tensile shear force of the weld e.g., 30 %. (Shear Testing will be carried out in accordance with EN ISO 14273);

b) agreed criteria using a torsion testing procedure according to EN ISO 17653;

c) agreed criteria based on micro-sections;

d) limits based on aesthetic requirements, e.g. surface indentation or surface marking;

e) agreed criteria based on electrode sticking.

When testing aluminium or aluminium alloys, the following criteria for the end of the electrode life can be used as defined in the design specification. These depend on the requirements of the end product and include:

f) an agreed 30 % reduction in tensile shear force of the weld;

g) agreed criteria using a torsion testing procedure;

h) agreed criteria based on weld nugget porosity or cracking;

i) criteria based on surface cracking;

j) limits based on aesthetic requirements, e.g. surface indentation or surface marking;

k) agreed criteria based on electrode sticking.

5 Machine details

5.1 General

The electrode life is very dependent on the type of spot welding machine or gun used. It is necessary therefore to specify various aspects of machine or gun design. Both electrical and mechanical characteristics of the welding machine and gun shall be specified according to ISO 669.

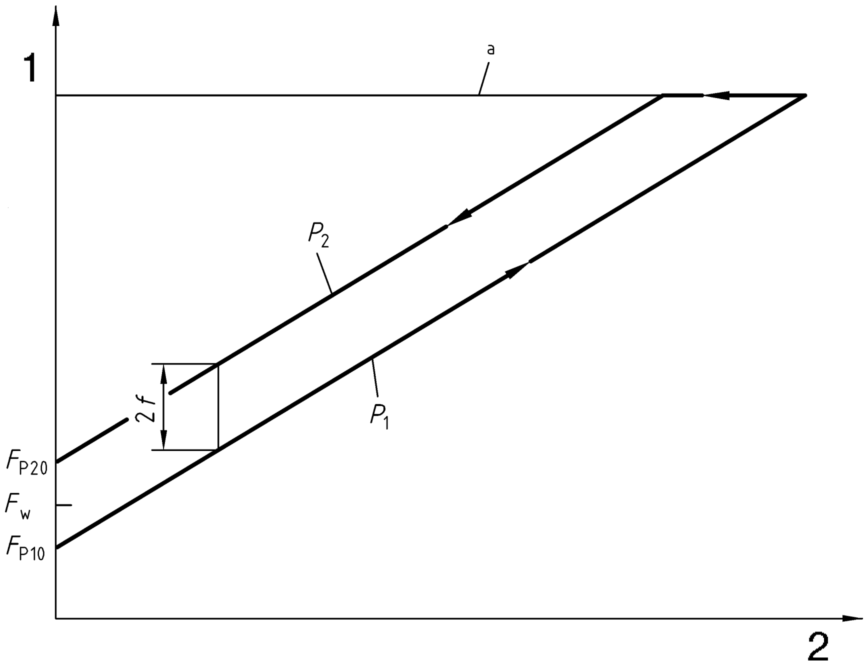
5.2 Machine type

The spot welding machines or guns shall be a conventional 50 Hz or 60 Hz AC type with electrical and mechanical properties specified in ISO 669. If phase shift control is used for the adjustment of the welding current, then the required welding current shall be attained with a phase setting giving not less than 70 % of the full sinusoidal waveform. The phase angle should be measured and recorded whenever possible.

Machines based on DC, or other generated waveform type can be used as defined in the design specification. Special machines may be necessary for spot welding aluminium and aluminium alloys depending on the required weld quality. For best results when welding aluminium and aluminium alloys, machines fitted with a low inertia electrode head assembly with a rapid follow-up action should be used.

5.3 Mechanical characteristics

The mass and static friction properties of the upper movable electrode head assembly shall be determined and recorded. Mass (M) and static friction (f) of the upper movable parts shall be determined from the hysteresis curve of electrode force vs air pressure in the upper cylinder (see Figure 1).



Key

1 Electrode force F
2 Air pressure in cylinder P

a Nominal electrode force

f Force included by static friction

f_0 Force included by static friction at zero air pressure

F_{P10} Electrode force at zero air pressure in case of increasing air pressure

F_{P20} Electrode force at zero air pressure in case of decreasing air pressure

F_W Weight of upper movable head

g Constant of gravitation

M Mass of upper movable head

$$F_W + f = F_{P20}$$

$$F_W - f = F_{P10}$$

$$F_{P20} - F_{P10} = 2\,f$$

$$F_{P10} + F_{P20} = 2\,F_W$$

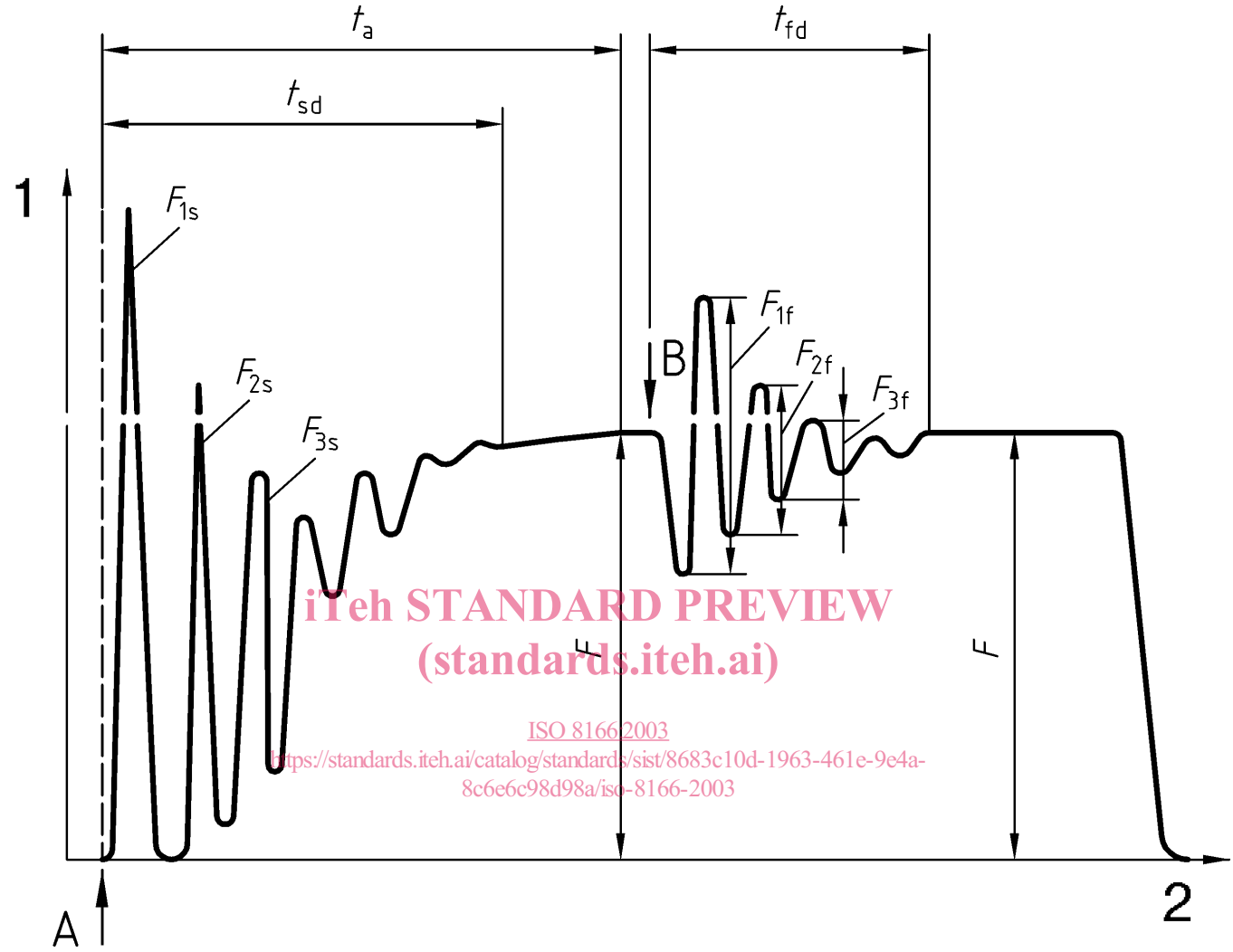
$$M = \frac{F_W}{g}$$

$$F_W = \frac{F_{P10} + F_{P20}}{2}$$

$$f_0 = \frac{F_{P20} - F_{P10}}{2}$$

Figure 1 — Mass M and static friction f of the upper movable electrode head assembly determined by hysteresis curve for electrode force vs cylinder air pressure

The impact characteristics of the electrode head assembly shall be determined as specified in ISO 669 from a force-time curve (see Figure 2) determined using an accelerometer or a load cell fitted to the electrode head assembly.



Key

1 Electrode force F
2 Time t

A	Moment of electrode contact
B	Start of electrode follow up
t_a	Force rise time
t_{fd}	Decay time during follow up
t_{sd}	Decay time after electrode contact
F	Electrode force
F_{1s} to F_{3s}	Force oscillations during follow up
F_{1f} to F_{3f}	Force oscillations after electrode contact

Figure 2 — Dynamic behaviour of a spot welding machine (schematic)

Any deviation from these requirements, arising because of machine design or instrumentation shall be defined in the design specification prior to carrying out the test.