SLOVENSKI STANDARD
SIST EN 14532-2:2005

01-marec-2005

Dodajni materiali za varjenje - Preskusne metode in zahteve po kakovosti - 2. del: Dodatne metode in ocenjevanje skladnosti dodajnih materialov za jeklo, nikelj in nikljeve zlitine

Welding consumables - Test methods and quality requirements - Part 2: Supplementary methods and conformity assessment of consumables for steel, nickel and nickel alloys

Schweißzusätze - Prüfverfahren und Qualitätsanforderungen - Teil 2: Ergänzende Prüfungen und Konformitätsbewertung von Schweißzusätzen für Stahl, Nickel und Nickellegierungen

Produits consommables pour le soudage - Méthodes d'essai et exigences de qualité - Partie 2: Méthodes complémentaires et évaluation de la conformité des produits consommables pour l'acier, le nickel et les alliages de nickel

Ta slovenski standard je istoveten z: **EN 14532-2:2004**

ICS:

25.160.20	Potrošni material pri varjenju	Welding consumables
77.080.20	Jekla	Steels
77.120.40	Nikelj, krom in njune zlitine	Nickel, chromium and their alloys

SIST EN 14532-2:2005 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 14532-2

November 2004

ICS 25.160.20

English version

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 14532-2:2004: E

Contents

Foreword

This document (EN 14532-2:2004) has been prepared by Technical Committee CEN/TC 121 “Welding”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by May 2005, and conflicting national standards shall be withdrawn at the latest by May 2005.

This document consists of the following parts:

EN 14532-1, *Welding consumables — Test methods and quality requirements — Part 1: Primary methods and conformity assessment of consumables for steel, nickel and nickel alloys.*

EN 14532-2, *Welding consumables — Test methods and quality requirements — Part 2: Supplementary methods and conformity assessment of consumables for steel, nickel and nickel alloys.*

EN 14532-3, *Welding consumables — Test methods and quality requirements — Part 3: Conformity assessment of wire electrodes, wires and rods for welding of aluminium alloys.*

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

Introduction

Responsibility for identifying the extent of qualification lies with the manufacturer/supplier on the basis of his assessment of market requirements.

A product that has been qualified in accordance with the primary methods e.g. in EN 14532-1 may need evaluation through one or more supplementary tests for some fields of application.

1 Scope

This document applies to welding consumables for which supplementary qualification is required. It contains the technical requirements to be fulfilled.

These supplementary tests apply for welding consumables, where the primary qualification is available in accordance with EN 14532-1. The supplementary tests can be carried out at any time without the need to repeat the primary tests.

This document describes the testing methods, the amount of testing and the requirements for supplementary qualification of welding consumables.

2 Normative references

The following referenced documents are 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.

EN 876, *Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints.*

EN 1597-1:1997, *Welding consumables — Test methods — Part 1: Test piece for all-weld metal test specimens in steel, nickel and nickel alloys.*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Methods of test at ambient temperature.*

EN 10002-5, *Metallic materials — Tensile testing — Part 5: method of testing at elevated temperature.*

EN 10291, *Metallic materials — Uniaxial creep testing in tension — Method of test.*

EN 14532-1:2004, *Welding consumables — Test methods and quality requirements — Part 1: Primary methods and conformity assessment of consumables for steel, nickel and nickel alloys.*

prEN 14700, *Welding consumables — Welding consumables for hard-facing.*

EN ISO 3690, *Welding and allied processes – Determination of hydrogen content in ferritic arc weld metal (ISO 3690:2000).*

CR ISO 15608:2000, *Welding — Guidelines for a metallic material grouping system (ISO/TR 15608:2000).*

3 Terms and definitions

For the purposes of this document, the terms and definitions of EN 14532-1:2004 apply.

4 Supplementary tests

4.1 General

An overview of supplementary tests is listed in Annex A.

4.2 All-weld metal

All-weld metal test pieces and test specimens shall be prepared in accordance with 6.1.2 of EN 14532–1:2004, and with test piece type 1.3 of EN 1597-1:1997 or Figure D.1 for oxyacetylene welding. Welding shall be carried out in the flat position, except where the consumable is designed exclusively for other position(s). One type of test piece with one consumable size and batch may be selected by the manufacturer, in accordance with the consumables used for primary qualification testing to EN 14532-1.

4.2.1 Post weld heat treatment

4.2.1.1 General

Post weld heat treatment of the all-weld metal - if required by the manufacturer for the particular range of application - shall be applied to the test assembly. If the entire test assembly is too large for the furnace, it may be divided into suitable parts but not into individual test specimens.

Post weld heat treatment conditions shall be stated in the report.

4.2.1.2 Stress relief

For welding consumables for non-alloy, fine grain high strength and creep resisting steels the holding time shall be at least 3 h at the highest stress relief temperature (+0/-20) ºC for the parent material groups (see Annex B) given in the required range of application for the qualification. When qualification is applied for wall thickness over 75 mm the holding time shall be at least 3 h + 1 h/25 mm wall thickness exceeding 75 mm.

NOTE 1 Users may consider longer times to allow for the possibility of repair and multiple heat treatment.

The test assembly shall be cooled in the furnace to a temperature 300 °C or lower. Subsequent cooling may be carried out in still air.

For stress relief or tempering, heating/cooling rates above 300 ºC shall not exceed 100 °C/h.

NOTE 2 Welding consumables for austenitic and austenitic-ferritic stainless steels and austenitic welding consumables used for dissimilar welds and overlays are not normally subject to stress relief.

4.2.1.3 Normalising

When qualification is specifically required for a weld metal that will be normalised, the holding time shall be ½ h at the highest normalising temperature (+0/-30) °C for the parent material groups (see Annex B) mentioned in the required range of application for the qualification. The test assembly shall be cooled within 3 h to a temperature of 300 °C (+0/-20)°C. Subsequent cooling may be carried out in still air. If tempering is to be applied, it shall be as described in 4.2.1.5.

4.2.1.4 Quenching

When qualification is specifically required for a weld metal that will be quenched and tempered, quenching of the test assembly shall be carried out as required for the parent material groups (see Annex B) mentioned in the required range of qualification.

4.2.1.5 Tempering

When tempering is applied after either normalising or quenching, the holding time shall be 1 h/25 mm wall thickness at the highest tempering temperature (+0/-20) °C for the parent material groups (see Annex B) mentioned in the required range of application for the qualification. The test assembly shall be cooled in the furnace to a temperature of 300 °C or lower. Subsequent cooling may be carried out in still air.

4.2.1.6 Solution heat treatment

The holding time shall be ½ h at the lowest solution heat treatment temperature (+30/-0) °C for the parent metal groups (see Annex B) mentioned in the required range of qualification. Higher temperatures may be used if required by the welding consumable but shall be within the temperature range recommended for the parent metal. In this case the lowest temperature qualified shall be that used for the test. The test assembly shall be cooled in still air or otherwise if required.

4.2.2 Tensile tests

4.2.2.1 General

Where appropriate, consumables shall be qualified for high temperature application either by high temperature tensile testing in accordance with 4.2.2.3 for maximum application temperatures within the ranges defined in Table 1, or by creep rupture testing in accordance with 4.2.3 for higher application temperatures.

4.2.2.2 Tensile tests at room temperature

Two tensile tests at room temperature (23 ± 5) °C shall be carried out for each heat treatment condition. This can be reduced to one test if the manufacturer can document results of at least two previous tests.

4.2.2.3 Tensile tests at elevated temperature

Two tensile tests shall be carried out at the maximum application temperature, within the range defined in Table 1, for which qualification is required.

Table 1 — Requirements for tensile tests at elevated temperature

Consumable type	Group according to CR ISO 15608:2000 [a]	Application temperature range
Ferritic and martensitic steels	1, 3, 4, 5, 6	350 °C to 500 °C
Austenitic stainless steels	8	400 °C to 500 °C
Nickel alloys	41 to 48	400 °C to 550 °C
[a] Explanation of the material groups see Annex G.		

4.2.2.4 Conditions for test specimens and testing

The all-weld metal tensile test specimens of ferritic welding consumables may be exposed to a temperature not exceeding 250 ºC for a period not exceeding 16 h for hydrogen removal prior to testing, alternatively a temperature not exceeding 105 ºC for a time not to exceed 48 h may be used.

Tensile test specimens shall be of 10 mm diameter in accordance with EN 876. For all-weld metal, the test should be carried out in accordance with EN 10002-1 or EN 10002-5 and the tensile strength, lower yield strength or proof strength, elongation after fracture (A_5) and reduction of area shall be determined.

For all groups of welding consumables, tested at all temperatures, the 0,2 % proof strength shall be determined, except in the case of consumables for non alloy and fine grain steels tested at room temperature (23 ± 5) ºC when the lower yield strength shall be determined.

The requirements at room temperature and at elevated temperatures are given in Annex C, depending on the material groups according to CR ISO 15608:2000, for which the consumable is intended to be verified.

For verification of strength at elevated temperatures with welding consumables for oxy-acetylene welding the test assembly should be prepared in accordance with Annex D.

In case of welding consumables for parent metals not mentioned in Annex C the requirements shall be defined by the manufacturer based upon the applicable parent metal properties.

4.2.3 Creep rupture tests

4.2.3.1 General

Where required by the manufacturer for application at temperatures within the creep range, that is, above the temperature range defined in Table 1, short term creep rupture testing shall be carried out in accordance with EN 10291 on the all-weld metal, or when this is not practicable, on the welded joint as specified in 4.3.4.

Whereas long term creep test data may be required by application standards for high temperature design purposes, short term product check test data are only suitable for the conformity evaluation of welding consumables. This can provide general confirmation that a consumable is suitable for application within the creep range. However, the short term check test data cannot reliably be extrapolated to the longer term, and do not provide an acceptable basis for high temperature design or component life assessment.

The manufacturer shall specify a reference parent material, being that which the consumable most closely matches in chemical composition, and/or that which the consumable is principally designed to weld. This shall be a material with established reference creep rupture data. This should be as provided in Annex E or ECCC-Document (see Bibliography), or newly submitted reference data of comparable scope extending to at least 30 000 hours test duration[1)]. Conformity evaluation of welding consumables by creep rupture testing is not required when no such reference creep rupture data exist on the parent material.

A consumable is to be qualified by reference to a single specified reference parent material. Its application to weld other parent materials, dissimilar joints, etc., is the responsibility of the user.

4.2.3.2 Legacy creep rupture data

The manufacturer may, at his option, put forward legacy creep rupture test data in the public domain from previous tests on all-weld metal specimens from a consumable of matching type, as defined in 4.2.3.3, to that which is to be evaluated. When legacy data, which shall be required to meet the creep rupture testing specifications of this document, are made available, testing shall not be required on the actual consumable to be evaluated. Legacy data may alternatively be deemed to have been provided if there is documented evidence that the legacy consumable has performed satisfactorily in application at temperatures within the creep range, under pressure or dynamic loading, for at least 30 000 hours operation.

4.2.3.3 Matching consumables

When legacy data are provided, the evaluated consumable shall be required to match the legacy consumable in terms of its type designation within the appropriate classification Standard, and/or the all-weld metal chemical composition scatter band, product form (e.g. metal-arc welding with covered electrode, process 111), and flux or coating type (e.g. basic / rutile / cellulosic). The evaluated consumable shall not be required to match the legacy consumable in terms of the distribution of chemical constituents between wire, flux and/or coating, chemical additions to the consumable which do not affect the composition of the weld deposit, or the exact chemical composition limits specified for each alloying or creep strengthening element, provided that the chemical composition ranges specified are substantially overlapping. Responsibility for declaring that the evaluated consumable matches a legacy consumable shall rest with the manufacturer of the evaluated consumable.

Tungsten inert gas welding consumables may be qualified on the basis of the all-weld metal chemical analysis. The composition shall be within the range of the all-weld metal of a covered electrode or gas shielded metal arc welding consumable subjected to creep rupture testing.

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1) Other recognised public domain sources of parent material mean creep rupture data may alternatively be used as reference data subject to technical review. The source of reference data should be given on the test certificate.

4.2.3.4 Testing conditions

Creep rupture testing shall normally[2] be carried out using a test assembly as specified in EN 1597-1. The minimum gauge diameter shall be 8 mm, except for legacy test data.

NOTE Gauge diameters of at least 10 mm are recommended to limit data scatter.

The test specimen axis shall be aligned with the direction of welding.

Constant load creep rupture testing shall be carried out at a selected fixed temperature within the range (T to T+100) °C, where T is the maximum application temperature for which qualification is required. At least four tests to rupture shall be obtained. At least one of these shall record a rupture life in excess of 1 000 hours, and at least one shall record a rupture life between 50 hours and 250 hours. Data points recording a rupture life below 50 hours shall be discarded. At least one of the tests to failure shall be carried out at an applied stress lower than the 10 000 hour mean data creep strength of the reference parent material at the specified maximum application temperature, as given in Annex E or other suitable parent material reference data source[3].

4.2.3.5 Requirements

The test data shall be analysed using a best-fit linear regression between the logarithm of the test life and the logarithm of the applied stress. The 1 000 hour creep rupture strength of the all-weld metal at the test temperature shall thereby be calculated, expressed as a percentage of the mean data 1 000 hour creep rupture strength of the reference parent material given by Annex E or other suitable parent material reference data source, and recorded on the test certificate. Its value shall be assessed by comparison with the scatter band of the parent material, defined as a range from 80 % to 120 % of the mean parent material rupture strength. If the value falls outside the scatter band of the parent material, a cautionary note shall be recorded on the test certificate. The individual creep rupture values shall also be shown as a table in the test certificate.

The extrapolated 10 000 hour creep rupture strength of the all-weld metal at the test temperature shall similarly be calculated and expressed as a percentage of the mean data 10 000 hour creep rupture strength of the reference parent material. If this value falls below 80 %, it shall be recorded on the test certificate, with a cautionary note that the results may indicate a potentially adverse long term trend. In this case, a repeat creep rupture test series may be undertaken, including alternative test conditions and / or longer test durations. If the repeat tests are successful, the cautionary note may be deleted.

4.2.4 Embrittlement tests

If the intended service temperature for stainless steel welding consumables is > 450 °C and the ferrite content > 10 FN (see EN 14532-1), or for nickel based welding consumables if the intended service temperature is > 550 °C, embrittlement tests shall be carried out.

This shall be checked on the basis of an impact energy / time curve at different post weld ageing temperatures. Temperatures shall be fixed in accordance with the range of application for the parent metal to be welded. Test specimens in accordance with EN 14532-1 shall be used.

[2] The manufacturer may alternatively opt to use a notched bar test specimen geometry when the reference parent material creep rupture data, and legacy all-weld metal creep rupture data when provided, have been obtained using a similar notched bar test specimen geometry.

[3] The test temperature should be selected by the manufacturer to enable the realistic test stress condition to be achieved. Annex E may be used for guidance. Typically, a test temperature exceeding the maximum application temperature by 30 °C to 50°C may be required.