SLOVENSKI STANDARD
SIST EN 12496:2013

01-september-2013

Galvanske anode za katodno zaščito v slani vodi in slanem blatu

Galvanic anodes for cathodic protection in seawater and saline mud

Galvanische Anoden für den kathodischen Schutz in Seewasser und salzhaltigem Schlamm

Anodes galvaniques pour la protection cathodique dans l'eau de mer et les boues salines

Ta slovenski standard je istoveten z: EN 12496:2013

ICS:

77.060	Korozija kovin	Corrosion of metals

SIST EN 12496:2013 **en,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12496

June 2013

ICS 77.060

English Version

Galvanic anodes for cathodic protection in seawater and saline mud

Anodes galvaniques pour la protection cathodique dans l'eau de mer et les boues salines

Galvanische Anoden für den kathodischen Schutz in Seewasser und salzhaltigem Schlamm

This European Standard was approved by CEN on 25 April 2013.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 12496:2013: E

Contents

Page

Foreword

This document (EN 12496:2013) has been prepared by Technical Committee CEN/TC 219 “Cathodic protection”, the secretariat of which is held by BSI.

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 2013, and conflicting national standards shall be withdrawn at the latest by December 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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

Introduction

The anticipated performance, including design life, of the cast galvanic anodes for use in sea water and saline mud is determined by their composition and the quality of their manufacture.

This European Standard specifies the minimum requirements for the galvanic anodes quality levels and verification procedures.

1 Scope

This European Standard specifies the minimum requirements and gives recommendations for the chemical composition, the electrochemical properties, the physical tolerances, and the test and inspection procedures for cast galvanic anodes of aluminium, magnesium and zinc based alloys for cathodic protection in sea water and saline mud.

This European Standard is applicable to the majority of galvanic anodes used for seawater and saline mud applications, i.e. cast anodes of trapezoidal, "D", or circular cross section and bracelet type anodes.

The general requirements and recommendations of this European Standard may also be applied to other anode shapes, e.g. half-spherical, button, etc., which are sometimes used for seawater applications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 12473, *General principles of cathodic protection in sea water*

EN ISO 8044, *Corrosion of metals and alloys — Basic terms and definitions (ISO 8044)*

EN ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings (ISO 8501-1)*

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1)*

ISO 10474:1991, *Steel and steel products — Inspection documents*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 8044 and EN 12473 and the following apply.

3.1
acidity
presence of an excess of hydrogen ions over hydroxyl ions (pH <7)

3.2
active surface
surface condition where corrosion occurs

3.3
anode consumption rate
mass consumption rate
amount of anode material consumed for a current output of one ampere during one year

Note 1 to entry: The anode consumption rate is expressed in kilograms per amp year (kg/A.y).

3.4
batch
charge
cast
unit that defines molten metal and identifies the anodes cast from it

3.5
bracelet anode
anode shaped as half- or part-rings to be positioned on tubular items

Note 1 to entry: Two or more part-ring anodes will have to fit together to become a bracelet anode.

3.6
calcareous deposit
layer consisting of a mixture of calcium carbonate and magnesium hydroxide deposited on surfaces being cathodically protected in seawater due to the increased pH adjacent to the protected surface

3.7
cast
see "batch"

3.8
charge
see "batch"

3.9
closed circuit potential
potential measured at the anode when a current is flowing in between the anode and the surface being protected

3.10
cold shut
horizontal surface discontinuity caused by solidification of a portion of a meniscus during the progressive filling of a mould, which is later covered with more solidifying metals as the molten metal level rises

Note 1 to entry: Cold shuts generally occur at corners remote from the point of pour.

3.11
core
see "insert"

3.12
crack
fracture of metal along a path producing a discontinuity similar to a ragged edge

Note 1 to entry: It can occur during the solidification of the anode (hot cracking), during the contraction of the anode after solidification, or under externally applied loads. Hot cracking can be associated with the shrinkage depression that can occur in open-topped moulds.

3.13
current capacity
total amount of electricity that is produced when one kilogram of anode material is consumed

Note 1 to entry: The current capacity is expressed in amp-hours per kilogram (A.h/kg).

3.14
driving voltage
voltage established between the operating potential of a galvanic anode and the protection potential of the structure

Note 1 to entry: This figure is used in the calculation of anode current output from the anode/electrolyte resistance.

3.15
electrochemical properties
properties of potential and current capacity that characterise a galvanic anode and can be assessed by quantitative tests

3.16
flush mounted anode
anode fitted to a structure with one face in contact with or very close to the structure

3.17
free running test
electrochemical test where potential and current are not controlled

3.18
gas hole
blow hole, channel or porosity produced by gas evolution during solidification

Note 1 to entry: Gas holes can indicate contamination of the mould or core prior to casting.

3.19
heat
product that is cast to a planned procedure in one melting operation in one furnace, without significant interruption

Note 1 to entry: If the casting sequence is interrupted, the anodes produced before, between, and after the interruptions constitute "batches".

3.20
insert
core form over which the anode is cast and which is used to connect the anode to the structure requiring protection

3.21
ladle sample
specimen taken from a molten metal stream

3.22
mass consumption rate
see “anode consumption rate”

3.23
non-metallic inclusions
particles of oxides and other refractory materials entrapped in liquid metal during the melting or casting sequences

3.24
passive surface
condition of low surface activity or resistance to corrosion of a metal, as a result of protective film formation

3.25
pit
localised corrosion resulting in pits, i.e. cavities extending from the surface into the metal

3.26
polarisation
change in the potential of an electrode as the result of current flow to or from that electrode

3.27
shrinkage depressions
natural concave surfaces produced when liquid metal is allowed to solidify in a container without the provision of extra liquid metal to compensate for the reduction in volume that occurs during the liquid-solid transformation

Note 1 to entry: The term also applies to the concave surfaces produced when liquid metal is solidified in a closed mould in such a manner that the area is not "fed" by the liquid metal provided by the mould design.

3.28
stand-off anode
anode which is offset a certain distance from the object on which it is positioned

3.29
surface lap
discontinuity caused by solidification of the meniscus of a partially cast anode as a result of interrupted flow of the casting stream

Note 1 to entry: The solidified meniscus is covered with metal when the flow resumes. Cold laps can occur along the length of an anode.

3.30
surface morphology
description of the features or structure of the anode surface

3.31
undercutting
cutting away metal from below, e.g. caused by pitting corrosion or inter-granular corrosion

4 Galvanic anode materials and their properties

4.1 General

Alloys used for galvanic anodes in seawater or saline mud shall be based on aluminium (Al), magnesium (Mg) and zinc (Zn). The performance, and therefore the suitability of a particular alloy for a specific application, will depend on the composition and characteristics of both the alloy and the electrolyte, temperature of operation and the anode current density.

The properties of an anode alloy may be obtained from the performance data in the given environmental conditions. The performance data shall include the current capacity in amp-hours per kilogram (A.h/kg), and the closed circuit potential of a working anode measured against a standard reference electrode.

Alloys shall be ordered either in compliance with a generic alloy composition, where required performance properties have been previously established or to meet a specific performance characteristic. In the latter case, the supplier should be required to provide confirmation of performance as demonstrated against defined test procedures (see 5.4).

4.2 Anode alloy composition

The chemical composition of any alloy used for galvanic anodes shall be specified by the supplier and the corresponding electrochemical properties shall be determined and documented.

The supplier shall provide supporting evidence for ensuring chemical composition according to 5.2.

The performance of an alloy is dependent on the specific alloy composition, resulting in variations in activation, resistance to passivation, current capacity and consumption morphology. In particular, some elements are known to have a detrimental effect on the anode performance and their content is normally subject to strict control.

The most common galvanic anode compositions for aluminium, magnesium and zinc based anode alloys are given in Annex B.

The required range of alloying elements will vary significantly, the tolerance on the composition changes with the range. For example, zinc content in aluminium based alloys can range from 2 % to 6 % (tolerance ± 0,5 %), while indium content will typically be 0,01 % to 0,05 % (tolerance ± 0,005 %).

4.3 Electrochemical properties

4.3.1 General

The performance of a galvanic anode material (alloy) is dependent on its actual chemical composition and homogeneity, current density and the environmental conditions in which it is exposed.

Since the method of cathodic protection is electrochemical in nature, the anode material's electrochemical properties shall be determined under the expected environmental operating conditions. These may include:

— potential;

— current capacity;

— anode consumption rate.

In addition, anode surface morphology affects the efficiency and shall also be determined.

These properties of the anode material shall be determined by appropriate tests (see 5.4).

Annex C describes the test methods that are most often used.

4.3.2 Potential

The selected anode alloy shall have a closed circuit potential more negative than the protection potential required for cathodic protection. The anode alloy operating potential shall be stable with time to ensure long-term performance and shall be documented by long-term testing for the particular operating environment.

Where long-term performance data relating to anode operating potential are not available for a specific alloy/environmental combination, additional tests should be carried out to determine the effect of current density, temperature and time on the operating potential in the particular environment and the various operating conditions of the anode.

Anode alloys will polarise, i.e. change potential, when current is passed. It is the potential of a working anode, i.e. the closed circuit potential, that is important. The potential of an anode material will also vary with the surrounding environment. The potential may change with time even when exposed to constant conditions due to corrosion products being formed on the anode surface and due to variations in the current demand.

The anode operating potential is generally more negative than -1,00 V measured with a Ag/AgCl/seawater reference electrode. However, where a low driving voltage is required either special anode compositions (with operating potential of -0,85 V vs. Ag/AgCl/seawater reference electrode) or anodes with a voltage controller (such as diode or resistive bond) between the anode and the structure can be used.

4.3.3 Current capacity

The current capacity for a galvanic anode alloy is expressed in ampere.hours per kilogram (A.h/kg) and is the total amount of electricity (A.h) that is produced in practice when one kilogram of the anode material is consumed for a given operating condition. The practical current capacity is different for anode materials exposed to different environmental conditions such as hot and cold seawater, seabed mud, etc.