SLOVENSKI STANDARD
SIST EN 12502-3:2005

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Protikorozijska zaġļ ita kovinskih materialov - Navodilo za ocenjevanje verjetnosti nastanka korozije v porazdeljeni vodi in skladiġļ nih sistemih - 3. del: Vplivni dejavniki za vroļ e pocinkane ģelezove materiale

Protection of metallic materials against corrosion - Guidance on the assessment of corrosion likelihood in water distribution and storage systems - Part 3: Influencing factors for hot dip galvanised ferrous materials

Korrosionsschutz metallischer Werkstoffe - Hinweise zur Abschätzung der Korrosionswahrscheinlichkeit in Wasserverteilungs- und -speichersystemen - Teil 3: Einflussfaktoren für schmelztauchverzinkte Eisenwerkstoffe

Protection des matériaux métalliques contre la corrosion - Recommandations pour l'évaluation du risque de corrosion dans les installations de distribution et de stockage d'eau - Partie 3 : Facteurs a considérer pour les métaux ferreux galvanisés a chaud

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23.040.99	Drugi sestavni deli za cevovode	Other pipeline components
77.060	Korozija kovin	Corrosion of metals
91.140.60	Sistemi za oskrbo z vodo	Water supply systems

SIST EN 12502-3:2005 **en**

EUROPEAN STANDARD

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English version

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This European Standard was approved by CEN on 22 November 2004.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of 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.

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Contents

Foreword

This document (EN 12502-3:2004) has been prepared by Technical Committee CEN/TC 262 “Metallic and other inorganic coatings”, 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 June 2005, and conflicting national standards shall be withdrawn at the latest by June 2005.

This standard is in five parts:

*Part 1: Genera*l;

Part 2: Influencing factors for copper and copper alloys;

Part 3: Influencing factors for hot dip galvanized ferrous material;

Part 4: Influencing factors for stainless steels;

Part 5: Influencing factors for cast iron, unalloyed and low alloyed steels.

Together these five parts constitute a package of interrelated European Standards with a common date of withdrawal (dow) of 2005-06.

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

This document results mainly from investigations into and experience gained of the corrosion of hot dip galvanized ferrous materials, used as steel tubes and cast iron fittings (galvanized products), in drinking water distribution systems in buildings. However, it can be applied analogously to other water systems.

The corrosion likelihood of galvanized products depends on the formation of a corrosion product layer, which begins to form as soon as the galvanized surface comes in contact with water. The more this layer prevents ionic and electronic exchanges between the metal and water, the more protective it will be and the higher the durability of the galvanized products.

Drinking water systems with galvanized products, although showing visible corrosion effects, are, in general, resistant to corrosion damage in normal use. However, there are conditions under which they will sustain corrosion damage.

As a result of the complex interactions between the various influencing factors, the extent of corrosion can only be expressed in terms of likelihood. This document is a guidance document and does not set explicit rules for the use of hot dip galvanized ferrous materials in water systems. It can be used to minimize the likelihood of corrosion damages occurring by:

— assisting in designing, installing and operating systems from an anti-corrosion point of view;

— evaluating the need for additional corrosion protection methods for a new or existing system;

— assisting in failure analysis, when failures occur in order to prevent repeat failures occurring.

However, a corrosion expert, or at least a person with technical training and experience in the corrosion field is required to give an accurate assessment of corrosion likelihood or failure analysis.

1 Scope

This document gives a review of influencing factors of the corrosion likelihood of hot dip galvanized steel and cast iron, used as tubes, tanks and equipment, unalloyed and low alloy ferrous materials in water distribution and storage systems as defined in EN 12502-1.

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 ISO 8044:1999, *Corrosion of metals and alloys — Basic terms and definitions (ISO 8044:1999)*.

EN 12502-1:2004, *Protection of metallic materials against corrosion — Guidance on the assessment of corrosion likelihood in water distribution and storage systems — Part 1: General*.

3 Terms, definitions, and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 8044:1999 and EN 12502-1:2004 apply.

3.2 Symbols

$c(HCO_3^-)$	Concentration of hydrogen carbonate ions in mmol/l
$c(Cl^-)$	Concentration of chloride ions in mmol/l
$c(SO_4^{2-})$	Concentration of sulphate ions in mmol/l
$c(NO_3^-)$	Concentration of nitrate ions in mmol/l
$c(Ca^{2+})$	Concentration of calcium ions in mmol/l

4 Types of corrosion

4.1 General

Internal corrosion of galvanized products in water distribution and storage systems generally leads to the build-up of layers formed by corrosion products, which might or might not be protective. Because a metal coating produced by hot dip galvanizing is not a homogeneous layer consisting of zinc alone, but a structured system of zinc and various zinc-iron alloy phases, after some time the corrosion products will also contain iron compounds. Because of the greater solubility of the zinc compounds, the layers end up consisting of iron corrosion products (rust). In the case of non-protective layers, corrosion can lead to the impairment of the function of the system (lack of serviceability because of corrosion damage).

The most common types of corrosion are described in EN 12502-1:2004, Clause 4.

The types of corrosion considered for galvanized products are the following:

— uniform corrosion;

— pitting corrosion;

— selective corrosion;

— bimetallic corrosion.

The various possibilities are shown schematically in Tables 1 and 2.

Table 1 — Uniform corrosion and its consequences

	Low rate uniform corrosion	High rate uniform corrosion	
Corrosion effects on zinc coating	Formation of a protective layer on residual zinc coating, which remains during full service life.	Complete loss of zinc coating.	
Corrosion effects on the base metal	None	Uniform attack, low mass loss; protective rust layer	Non-uniform attack, pits, tubercles
Possible corrosion damage (during projected service life)	None	Initially high concentration of metal ions in water	Reduction in free pipe bore size

Table 2 — Localized corrosion and its consequences

	Pitting corrosion	Selective corrosion
Corrosion effects on the coating	Localized loss of coating	Intergranular attack leading to complete loss of the zinc phase
Corrosion effects on the base metal	Pits and tubercles	Non-uniform general corrosion
Possible corrosion damage (during projected service life)	Reduction of free pipe bore size, contamination of water by iron corrosion products, blockage of system components, wall perforation	Initial release of solid zinc corrosion products into water, contamination of water by iron corrosion products

For each type of corrosion, the following influencing factors (described in EN 12502-1:2004, Table 1 and Clause 5) are considered:

— characteristics of the metallic material;

— characteristics of the water;

— design and construction;

— commissioning and pressure testing;

— operating conditions.

To assess the influence of the characteristics of the water, data as described in EN 12502-1 are necessary. Therefore, the composition of the water fed into the respective installations is relevant. However, temporary variations of the water composition need to be considered. Therefore, in addition to a detailed analysis of the water, information about its variations is necessary.

4.2 Uniform corrosion

4.2.1 General

Experience shows that corrosion damage to galvanized products because of uniform corrosion can only occur if the corrosion velocity is extremely high and there is no possibility of stable protecting rust layers being formed. Uniform corrosion can manifest itself in different ways (see Table 1).

Uniform corrosion leads to the formation of layers consisting of zinc hydroxycarbonates, which, depending on the carbonic acid species concentration, can offer the product greater or lesser degrees of protection.

If the corrosion rate is sufficiently low, no complete loss of the zinc layer will occur during the projected service life. Protective layers will form on the remaining zinc phase of the metal coating.

At a higher corrosion rate, the metal coating will be completely removed during the projected service life. The concentration of iron corrosion products in the surface layer increases during the corrosion of the zinc-iron alloy phases. Further corrosion processes eventually result in the formation of a surface layer consisting predominantly of aged iron corrosion products, which provide lasting corrosion protection.

If the corrosion rate of the coating is too high, or the concentration of the components forming the carbonic acid system too low to allow the formation of a protective layer, the base metal will be non-uniformly attacked after the consumption of the metal coating. The consequence can be contamination of the water by iron corrosion products, encrustation and clogging of the pipes or wall penetration by pitting corrosion.

Although zinc corrosion products are only sparingly soluble, zinc ions are released into water.

The concentration of zinc ions because of dissolution of corrosion products will depend on:

— the concentration of the carbonic acid species in the water;

— the duration of stagnation of water in pipes;

— the age of the installation;

— the dilution caused by mixing with fresh water;

— the method of sampling.

The quantity of loosely adherent zinc corrosion products that can be removed from the tube walls will depend on:

— the duration of low water velocity;

— the extent of sudden turbulent flow.