Introduction to Control Corrosion in line with ISO 12944 latest edition 2018

A global paint solutions company, established in Norway in 1926.

Regional Laboratories
- 200 people working in R&D
- R&D investment: USD 34 million per year

Central Lab
- Sandefjord, Norway
- Regional Labs: Dubai, UAE; K.L., Malaysia; Pusan, South Korea; Zhangjiagang, China

Introduction to Control Corrosion in line with ISO 12944 latest release 2018
Did you know?

5 metric tons of steel is degenerated every second worldwide.
The 40% of all produced steel is used to replace corroded steel.

Corrosion affects precision equipment...
...to infrastructures.

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Definition of corrosion

Corrosion is a chemical reaction between a metal and its surrounding environment under the formation of corrosion products.

Production and degradation of steel

Reaction between the material and the surrounding environment takes place.

The presence of water, humidity, and Oxygen is a prerequisite for corrosion of steel.

Corrosion Mechanism

Galvanic cell - a battery
Corrosion

Single piece of metal showing the anodic and cathodic sites. Corrosion occurs at the anodic sites. If the steel was all cathodic corrosion would stop. A piece of steel has thousands of anodic and cathodic sites. It is, however, unusual to find them uniform as various factors such as contaminants will cause different types of corrosion rates on a single piece of metal.

Pre requisites for Corrosion of Steel

- **A Cathode**: The noble metal / alloy (or part of metal)
- **An Anode**: The less noble metal / alloy
- **An electrical connection** between the two metals.
- **An electrolyte**: Conducting electrical current (by electrons)

Parameters influencing the corrosion speed

- Humidity
- Temperature
- Concentration of salts
- Amount of air pollution, including acid rain, soot and dust particles

How coatings protect the substrate?

Water

Paint with glass or aluminium flakes

Steel

Barrier effect

Inhibitive Primer

1st Coat

2nd Coat

Steel

Moisture Absorption

Ionisation of Inhibitor

Reaction with Steel Surface

Passive layer form

Inhibition

Galvanic effect

Inorganic Zinc Primer

2nd Organic Topcoat

Good adhesion prevents coating undercut

Moisture allows Zinc to ionize, cathodically protecting the steel.

ISO 12944: CPD

Unique – Internationally recognized
Defines Corrosion Environments
Lifetime Expectancy
Recognised Worldwide

ISO 12944 concerns structures made of carbon steel of not less than 3 mm thickness, which are designed using an approved strength calculation.
Classification of Environments

Atmospheric:
- C1: Very low
- C2: Low
- C3: Medium
- C4: High
- C5: Very high

Immersion:
- Im1: Fresh Water
- Im2: Sea or Brackish Water
- Im3: Soil
- Im4: Sea or Brackish Water with CP

C5: Extreme corrosivity

ISO 12944 – 2 Classification of environments

C1 - C5

Climatic conditions

ISO 12944 – 2 Classification of environments

C1 - C5

Climatic conditions

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Climatic conditions

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Climatic conditions
ISO 12944 – 2
Classification of environments

Exterior

C3

- Exposure to salt water
- Industrial environments
- Marine corrosion

C4

- Exterior in temperate climate
- Exposure to salt water
- Marine corrosion

C5

- Exterior in tropical climate
- Exposure to salt water
- Marine corrosion

CX

- Splash Zone
- Tidal Zone
- Combination of C5 & Imm4

Environments examples:

ISO 12944-3 design consideration

Table 2 - Categories of water and soil

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imm</td>
<td>Immersion exposure</td>
</tr>
<tr>
<td>Spl</td>
<td>Splashing zone</td>
</tr>
<tr>
<td>Tid</td>
<td>Tidal zone</td>
</tr>
</tbody>
</table>

ISO 12944-3 for offshore and related structures

Cover by ISO 12944-9
Pre-surface condition

- Visual inspection should be conducted on all steel items prior to surface preparation.
- This will determine the level of pre-preparation requirements such as grinding, filling etc.

ISO 12944-4 surface preparation

- It is very important for the life of a coating system.
- Substrate must be free from oil, grease, salt, soil and any foreign material prior to surface preparation.
- Minimum Sa2½ for all systems.

Application of paint by combination of tools

- Some areas are difficult to reach with a spray gun.
- Start with the paint brush.
- Then, use the back roller.
- Finally, apply the remaining areas with the spray gun.

ISO 12944-5: 2007 protective paint systems

7.4 Durability

The durability of a protective paint system depends on several parameters, such as:
- the type of paint system;
- the design of the structure;
- the condition of the substrate before preparation;
- the surface preparation grade;
- the quality of the surface preparation work;
- the condition of any joints, edges and welds before preparation;
- the standard of the application work;
- the conditions during application;
- the exposure conditions after application.

ISO 12944-5: 2018 protective paint systems

Step No. 2

Durability: Coating system life expectancy to the first major maintenance
- low (L) up to 7 years
- medium (M) 7 years to 15 years
- high (H) 15 years to 25 years
- very high (VH) more than 25 years

The durability range is not a "guarantee time". Durability is a technical consideration that can help the owner set up a maintenance program.

A guarantee time is the subject of clauses in the contract and is not within the scope of this part of ISO 12944. There are no rules that link the two periods of time.
Rust grade evaluation

According to ISO 12944-5 first major maintenance would normally need to be carried out for reasons of corrosion protection once coating have reached R03 (1% rust intensity).

ISO 12944–5: 2018 protective paint systems

8.4 Guidelines for selecting the appropriate paint system

— Determine the corrosivity category of the environment (macroclimate) where the structure will be located, as described in ISO 12944-2.
— Establish whether special conditions (microclimate) exist which can result in a higher corrosivity category (see ISO 12944-2).
— Search in Annexes B to E for the relevant table. Annex B establishes a set of minimum requirements for protective systems in the various corrosivity and immersion categories and durability.
— Identify in the table paint systems with the required durability.
— Consult the paint manufacturer in order to confirm the choice and to determine what commercially available paint system(s) correspond to the paint system selected.

Minimum requirements for protective systems

Table A.1 — for hot dip galvanized steel

<table>
<thead>
<tr>
<th>MNOC (minimum number of coats)</th>
<th>NDFT (Nominal Dry Film Thickness)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK &amp; AY are not recommended for C4 vh &amp; C5 h &amp; vh.</td>
<td></td>
</tr>
</tbody>
</table>

For C4 vh & C5 h & vh, increased DFT might be necessary.
If unprotected steelwork destined for corrosivity category C1 is initially transported, stored temporarily or assembled in an exposed situation (for example, a C4/C5 coastal environment), corrosion will commence due to air-borne contaminants/salts and will continue even when the steelwork is moved to its final category C1 location. To avoid this problem, the steelwork should either be protected during site storage or given a suitable primer coat. The dry film thickness should be appropriate for the expected storage time and the severity of the storage environment.
• Durability increased with NDFT
• AK, AY are not recommended for C5
• Zinc primers give higher durability at relatively lower NDFT

C5

• Durability increased with NDFT
• EP, PUR, can save NDFT for similar durability compared to AK, AY
• No special pigments i.e. Zn or others in the primer since galvanizing gives cathodic protection to the steel

C6

D1

• Durability increased with NDFT
• Metalizing gives excellent corrosion protection alone, by duplex system expected durability is h or vh
• 2 coats since a sealer is required for porous metalizing

E1

F2

• For C4 vh and C5 h it is an option to use Test regime 1 or 2
• For C5 vh, use only test regime 2
ISO 12944 part 9

72h UV and Condensation
4h exposure to UV at 60 °C (UVA 340)
4h exposure to condensation at 50 °C
72h Salt Spray
24h exposure to low temperature -20°C
25 cycles, 4200h

ISO 12944-6 laboratory testing

Part 7 : Execution and supervision of paint work

This part looks at the execution of the painting project and includes:

• Supply and storage of coatings.
• Site & weather conditions.
• Method of application Brush, Roller, Spray.
• Inspection and control during painting

ISO 12944-8:2007 development of specifications for new work and maintenance

How to develop a specification for new work.
All relevant parameters shall be taken into consideration, for example:

– required durability;
– environmental conditions and special stresses;
– surface preparation;
– different generic types of paint;
– number and types of coats (priming coat(s), intermediate coat(s) and top coat(s));
– methods of application and application requirements;
– place of application (shop or site);
– scaffolding requirements;
– requirements regarding (future) maintenance (if any);
– health and safety requirements;
– environmental protection requirements.

ISO 12944–9: for offshore and related structures

(replaces ISO 20340)

Type of environment:
The structure may be divided into different zones based on the type of environment each zone is exposed to:

— one zone corresponds to the area exposed to atmospheric category CX (offshore);
— another zone corresponds to the area that is permanently immersed in sea water, i.e. category Im4;
— two further zones correspond to the tidal and splash zones which are a combination of category CX (offshore) and Im4:
— the tidal zone is the area in which the water level changes because of natural or artificial effects, thus giving rise to increased corrosion due to the combined effect of cyclic exposure to water and the atmosphere;
— the splash zone is the area wetted by wave and spray action which can give rise to exceptionally high-corrosion stresses, especially with sea water.