CORROSION AND THE PROTECTION OF METALS

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Contents

Summary

An overview is given of the nature of corrosion, its causes, and its prevention in metal structures and equipment, generally made of steel, used in the water supply industry. The conditions where corrosion might be expected are listed, and protection methods such as preemptive surface preparation and regular maintenance are dealt with.

Cathodic protection, paints and coatings, and insulation against galvanic corrosion are the main counteractive measures usually applied. Specialist advice is generally to be sought for dealing with complex cases such as saltwater immersion, atmospheric spray, and contact with acidic soil moisture.

1. Introduction

In the field of water supply, conditions can be encountered that are highly corrosive to metals, typically steel, stainless steel, cast iron, aluminum, zinc, and brass as employed in dams, pumping stations, and hydraulic control structures. The life expectancy of equipment used in the main fields of application for water supply and purification, and also waterpower, will depend on the quality of protection against corrosion and the adequacy of the maintenance policy that is applied.

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The establishment of sustainable water supply projects involves the need to apply sound corrosion protection principles, along with other precautionary measures, to ensure the reliable delivery of water into the near future (see *Aging of Plastics; Degradation of Concrete; Aging and Rehabilitation of Appurtenant Structures to Dams; The Protection Against Deterioration of Materials in the Ocean*).

2. Corrosion Principles

Corrosion is associated with the conversion of a metal to a metallic compound, also called an electrochemical reaction, due to the chemical change accompanied by the passage of small electrical currents. Metals corrode, yielding their corrosion products, which are chemically more stable than the metals themselves, which are physically weaker and subjected to excessive wear and tear.

Three main natural environmental circumstances affect the rate of corrosion, namely, atmosphere, water, and soil. Corrosion encountered in coastal and inland situations, arid and humid conditions, or in other situations or climatic conditions can vary considerably from the expected norms.

Industrial pollution could have an aggravating effect, especially when arising in humid coastal climates. Generally accepted environmental circumstances are linked to corrosion: acid rain, salt air, wind and weather extremes, and abrasion. Suitable precautions are required to meet needs in various zones and for typical parameters.

The following atmospheric effects influence the corrosion rate:

- Relative humidity and the duration of wet conditions. Serious corrosion of steel occurs when the relative humidity in the atmosphere is above 70%.
- Atmospheric contamination from sea-salt nuclei and industrial pollutants
- Wind distribution of corrosive agents
- Solar radiation, which attacks organic coatings and, together with water vapor atmospheric pollution by sulfur dioxide, forms an acid that corrodes metal
- The following are effects of water and soil on the corrodability of certain metals:
- The tendency of some metals to corrode in the presence of water depends on corrosive factors present in the water, such as acidity, dissolved oxygen, and solutes.
- The main corrosive agents in soil are high electrical conductivity (which is a measure of salts present in the soil), oxygen content, pH differential, and sulfate-reducing bacteria.
- The general classification of soil conditions, such as wetness (damp, saturated, or marshy), dryness, and aerobic or anaerobic states, helps to identify corrosive agents.

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Biographical Sketch

Ron Chantler holds the degrees B.Sc. (Hons.) in mechanical engineering (Manchester) and in electrical engineering (University of the Witwatersrand, Johannesburg), and he is a chartered engineer (UK) and professional engineer (RSA). His professional experience includes 5 years as design engineer on nuclear power plants in the UK and 35 years as professional engineer (mechanical and electrical) with the Department of Water Affairs, South Africa. Publications include the proceedings of a conference on early flood warning measures, reports on flowmetering, and guidelines for equipping dams with floodgates.

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