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Cathodic Protection to Control External Corrosion of Concrete Pressure Pipelines and Mortar-Coated Steel Pipelines for Water or Waste Water Service

ABSTRACT

Furnishes guidelines that provide corrosion control personnel, owners, operators, designers, manufacturers, and contractors information on corrosion control of prestressed concrete cylinder pipe (PCCP) and mortar-coated steel pipelines for water or waste water service through the application of cathodic protection. The guidelines presented are applicable to new or existing buried pipelines with or without a supplemental coating.

KEYWORDS

Cathodic protection, concrete, PCCP, pipeline, water, waste water, TG 019.

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Foreword

The purpose of this standard practice is to furnish guidelines that provide corrosion control personnel, owners, operators, designers, manufacturers, and contractors with information on controlling external corrosion of embedded steel in concrete pressure pipelines and mortar-coated steel pipelines for water or waste water service through the application of cathodic protection (CP). The guidelines presented are applicable to new or existing buried pipelines with or without a supplemental coating.

The provisions of this standard should be applied under the direction of competent persons who are qualified to engage in the practice of corrosion control on buried or submerged metallic pipelines. Such persons may be licensed professional engineers or persons recognized as Corrosion Specialists or CP Specialists by NACE. The professional experience of such persons should include suitable experience in CP of prestressed concrete structures, if protection of that type of structure is being planned.

This standard was originally prepared in 2000 by NACE Task Group T-10A-28, a component of Unit Committee T-10A on Cathodic Protection. To provide the necessary expertise on all aspects of the subject and to receive input from all interested parties, Task Group T-10A-28 was composed of corrosion consultants, consulting engineers, architect-engineers, CP engineers, researchers, pipeline owners, and representatives from both industry and government. The standard was reaffirmed in 2004 by Specific Technology Group (STG) 05, “Cathodic/Anodic Protection” and revised in 2008 and 2014 by Task Group (TG) 019, “Mortar-Coated Pipes: Cathodic Protection Criteria.” It was reaffirmed with editorial changes in 2019 by TG 019. This standard is issued by NACE under the auspices of STG 05.

In NACE standards, the terms ***shall, must, should,*** and ***may*** are used in accordance with the definitions of these terms in the NACE Publications Style Manual. The terms ***shall*** and ***must*** are used to state a requirement, and are considered mandatory. The term ***should*** is used to state something good and is recommended, but is not considered mandatory. The term ***may*** is used to state something considered optional.

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Figures

Section 1: General

1.1 Introduction

1.1.1 Concrete and steel are considered compatible materials because they have similar coefficients of thermal expansion and because concrete usually provides steel with excellent corrosion protection. Because of the high alkalinity of portland cement, a stable, corrosion-mitigating, passive oxide film forms on the surface of the encased steel. If this film does not form or is weakened or destroyed, corrosion can occur.

1.1.2 The protective oxide film formed on steel encased in concrete does not form or will be destroyed if the concrete does not fully encase the steel, the alkalinity of the concrete is lost by reaction with aggressive gases or liquids, or excessive amounts of chloride or other aggressive ions are present. If one or more of these conditions exists and moisture and oxygen are in contact with the steel, corrosion can occur.

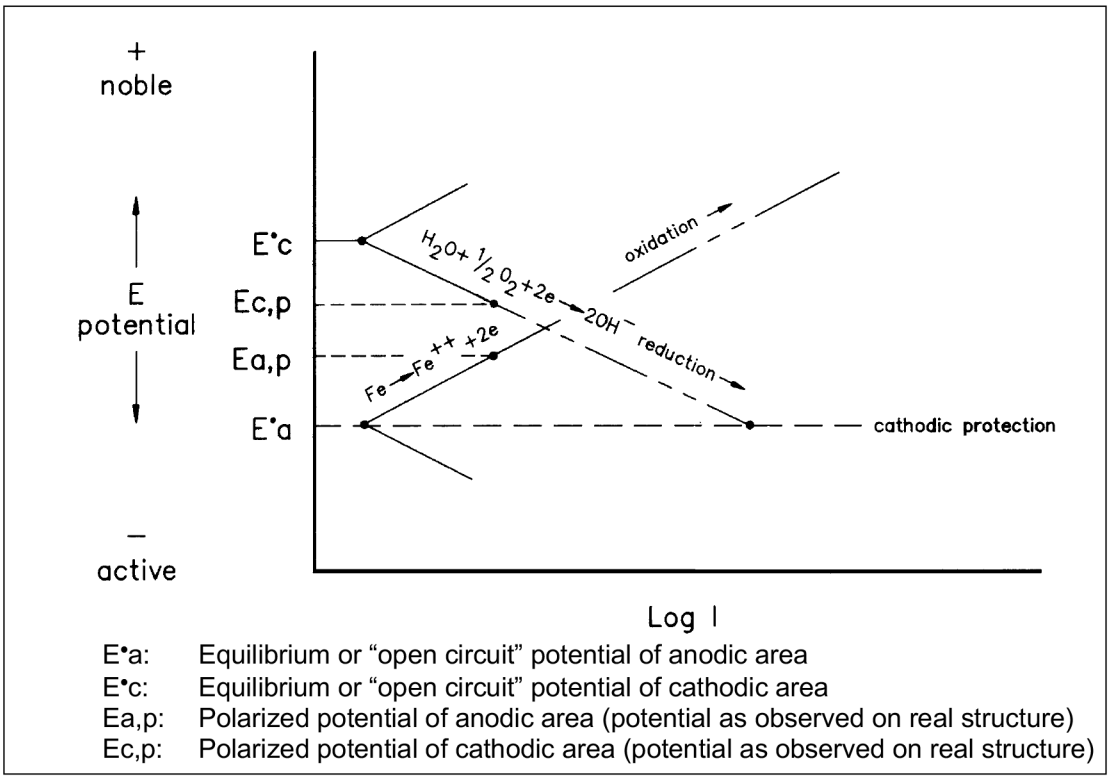
1.1.3 Corrosion occurs because of the formation of an electrochemical cell. An electrochemical cell consists of four components: an anode, at which oxidation occurs; a cathode, at which reduction occurs; a metallic path through which electrical current passes as a flow of electrons; and an electrolyte (concrete pore solution) through which electrical current passes as a flow of ions in an aqueous medium. If any one of the four elements of the electrochemical cell is eliminated, corrosion is prevented.

1.1.4 Within the electrochemical cell, the location of relative anodic and cathodic areas can be determined through potential (voltage) measurements. This is accomplished by measuring the potential between a metal immersed or embedded in an electrolyte and a stable reference electrode. This technique may also be used to assess the effectiveness of CP.

1.2 Cathodic Protection (CP)

1.2.1 The basic principles of corrosion can be used to understand the theory of CP. CP is defined as a technique to reduce the corrosion of a metal surface by making that surface the cathode of an electrochemical cell (see Figure 1).

1.2.2 If corrosion of steel is found in a concrete pressure pipeline or a mortar-coated steel pipeline, CP may be used to control further corrosion. However, CP does not replace lost steel or return corroded steel to its original cross-section.



E•a: Equilibrium or "open circuit" potential of anodic area
E•c: Equilibrium or "open circuit" potential of cathodic area
Ea,p: Polarized potential of anodic area (potential as observed on real structure)
Ec,p: Polarized potential of cathodic area (potential as observed on real structure)

Figure 1: Polarization Diagram[1]