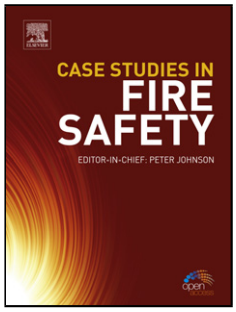

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Author: Roman Kodým Dalimil Šnita Vlastimil Fíla Karel Bouzek Milan Kouřil

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<AT>Investigation of Processes Occurring at Cathodically Protected Underground Installations: Experimental Study of pH Alteration and Mathematical Modeling of Oxygen Transport in Soil

Roman Kodým[a*] , Dalimil Šnita[b], Vlastimil Fíla[a], Karel Bouzek[a] and Milan Kouřil[c]
(*Author's name order: given name, family name)*
<AU><PA>*Corresponding author##Email##kodymr@vscht.cz##/Email##.
<AFF>[a]Department of Inorganic Technology, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic
<AFF>[b]Department of Chemical Engineering; University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic
<AFF>[c]Department of Metals and Corrosion Engineering; University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic

<ABS-Head><ABS-HEAD>Graphical abstract
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<ABS-P><xps:span class="xps_Image">fx1</xps:span>
<ABS-HEAD>Highlights► Processes occurring at cathodically protected underground steel pipe studied ► In-field test of soil pH change in vicinity of cathodically polarized steel pipe ► Mathematical modelling of two-phase oxygen transport in the soil towards buried pipe ► Cathodic protection current solely due oxygen reduction calculated

<ABS-HEAD>Abstract

<ABS-P>A detailed analysis of the complex processes occurring at the surface of cathodically protected underground metal installations is presented. In the first part an alteration of soil pH in vicinity of cathodically polarized buried specimen of carbon-steel pipe is investigated experimentally. In the second part a stationary two-phase oxygen transport to a defect in the protective coating of an underground pipe is studied by mathematical modeling and protection current solely given by oxygen reduction are calculated. This information is crucial to an evaluation of subsequent processes taking place at a protected metal surface, which is part of a follow-up study.
<KWD>Abbreviations: 3DMG, three–dimensional model geometry; 3D, 2D, 1D, three–, two–, one–dimensional; CP, cathodic protection; CSE, Copper – copper sulfate reference electrode; OCDR, oxygen concentration drop region; SSMG, spherical symmetrical model geometry; SCE, Saturated calomel reference electrode; SHE, Standard hydrogen electrode

<KWD>Keywords: Cathodic protection; Field polarization test; Underground metal installation; Mathematical modeling; Two-phase oxygen transport

<H1>1 Introduction
Today metallic underground installations (*pipelines, storage tanks etc.*) are an important part of the existing infrastructures. To mitigate the corrosion processes and thus reduce the related risks, such metallic structures are coated. However, if the protective coating breaks down or delaminates locally, cathodic protection (CP) takes over [1-3].
CP is primarily based on cathodic polarization of the metal surface towards more cathodic potential than the free corrosion potential to reduce the corrosion rate. The main possible depolarization reactions in a neutral or alkaline environment are the hydrogen evolution reaction (HER) and the oxygen reduction reaction (ORR) according to Reactions (1) and (2), respectively [1].