Control of Corrosion under Thermal Insulation and Fireproofing Materials—A Systems Approach

This NACE International standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he or she has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this NACE International standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by Letters Patent, or as indemnifying or protecting anyone against liability for infringement of Letters Patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. NACE International assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE International interpretations issued by NACE International in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this NACE International standard are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This NACE International standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this standard. Users of this NACE International standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: NACE International standards are subject to periodic review, and may be revised or withdrawn at any time in accordance with NACE technical committee procedures. NACE International requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication and subsequently from the date of each reaffirmation or revision. The user is cautioned to obtain the latest edition. Purchasers of NACE International standards may receive current information on all standards and other NACE International publications by contacting the NACE International FirstService Department, 15835 Park Ten Place, Houston, TX 77084-5145 (telephone +1 281-228-6200).

ABSTRACT
Provides current technology and industry practices for mitigating corrosion under thermal insulation and fireproofing materials. Adopts a systems approach. Contains sections on corrosion mechanisms, mechanical design, protective coatings, insulation materials, and inspection and maintenance.

KEYWORDS
carbon steels, coatings, corrosion control, fireproofing materials, insulation, protective coatings, steels, thermal insulation, TG 325.

©2017 NACE International, 15835 Park Ten Place, Suite 200, Houston TX 77084, USA. All rights reserved. Reproduction, republication or redistribution of this standard in any form without the express written permission of the publisher is prohibited. Contact NACE International by means of our website www.nace.org, email FirstService@nace.org, or (phone) 281-228-6223 for reprints of this standard.
Foreword

This NACE standard practice provides the current technology and industry practices for mitigating corrosion under thermal insulation and fireproofing materials, a problem termed corrosion under insulation (CUI) in this standard. Because this corrosion problem has many facets and impacts several technologies, a systems approach has been adopted. This standard is intended for use by corrosion-control personnel and others concerned with corrosion under insulation and/or fireproofing of equipment.

This standard is organized into sections by function. Each section was written by specialists in that subject. These specialists are industry representatives from firms producing, specifying, designing, and/or using thermal insulation and fireproofing products on refinery and petrochemical equipment.

Control of Corrosion under Thermal Insulation and Fireproofing Materials—A Systems Approach

1. General ................................................................. 4
2. Corrosion Mechanisms .................................................. 5
3. Mechanical Design .................................................... 12
4. Protective Coatings ..................................................... 16
5. Insulation, Fireproofing, and Accessory Materials .............. 20
6. Inspection and Maintenance .......................................... 25

References .................................................................. 32
Bibliography ............................................................. 33

Figures and Tables
Figure 1: Effect of Temperature on Steel Corrosion in Water .......... 6
Figure 2: Typical Vessel Attachments Where Water May Bypass Insulation .... 13
Figure 3: Attachment to Piping Where Water May Bypass Insulation .......... 13
Figure 4: Vessel Insulation Support Ring—the Problem (a) and the Solution (b) .. 14
Figure 5: Vertical Vessel Bottom Support Ring Minimizing Water Accumulation ... 14
Figure 6: Vessel-Stiffening Ring Insulation Detail ........................................ 14
Figure 7: Center Nozzle at Top Head of Vessel ........................................ 15
Figure 8: Common Nameplate Insulation Detail ........................................ 15
Figure 9: Seal-Welded Cap on Insulation for Personnel Protection ............... 15
Figure 10: Double-Pipe Heat Exchanger Insulation Penetrated by C-Channel Support ................................................................. 15
Figure 11: Protrusions Through Jacketing .............................................. 16
Figure 12: Pipe Supports Without Protrusions ........................................ 16
Figure 13: Cold Service Pipe Support Without Continuous Vapor Barrier ........ 16
Figure 14: Cold Service Pipe Support with Continuous Vapor Barrier .......... 17
Figure 15: Pipe Insulation Penetrated by Column Fireproofing .................... 17
Table 1: Typical Protective Coating Systems for Austenitic and Duplex Stainless Steels Under Thermal Insulation ............................................. 18
Table 2: Typical Protective Coating Systems for Carbon Steels Under Thermal Insulation and Fireproofing ............................................................. 19
Section 1: General

1.1 Corrosion under insulation (CUI) has been occurring for as long as hot or cold equipment has been insulated for thermal protection, energy conservation, or process stabilization. The destructive results and nature of the corrosion mechanism were not mentioned in the literature until the 1950s. As more problems have been experienced, concern and interest have built around this subject. Many articles and symposium papers have been published since 1983 as interest and activity in CUI have increased. The increased activity was driven largely by many occurrences of severe CUI resulting in major equipment outages, production losses, and unexpected maintenance costs in refineries, gas plants, and chemical plants.

1.2 To correct these problems, companies have developed their own criteria and approaches to the prevention of CUI. When comparing the various approaches, it is evident that there are many similarities, some differences, some new ideas, and some old ideas that have stood the test of performance. This standard incorporates the experience of many companies throughout the oil, gas, and chemical industries.

1.3 The first ASTM standard relevant to CUI was ASTM C692, adopted in 1971 and originally titled "Evaluating the Influence of Wicking Type Thermal Insulations on the Stress Corrosion Cracking Tendency of Austenitic Stainless Steels."

1.4 A symposium was held jointly by NACE, ASTM, and Materials Technology Institute (MTI) on this subject with speakers from industries worldwide in October 1983. The papers were published in 1985 as ASTM Publication STP 880.

1.5 The first NACE state-of-the-art report on CUI was written in 1989 by Task Group T-6H-31 and issued as NACE Publication 6H189. NACE Task Group T-5A-30 was organized shortly thereafter to serve as a forum for further discussion regarding CUI. In addition to reviews of the corrosion mechanisms, perspectives on such CUI topics as methods for mitigation, insulation materials, and inspection were often exchanged. While corrosion engineers were becoming knowledgeable about CUI, ASTM Committee C16 on Thermal Insulation was preparing standards for testing insulation with a propensity to cause chloride stress corrosion cracking (SCC) of austenitic stainless steel. These two groups interacted but proceeded to develop their standards and information separately.

1.6 In this standard, the term equipment includes all objects in a facility with external metal surfaces that are insulated or fireproofed and subject to corrosion.

1.7 In previous editions of this standard, carbon steel and austenitic stainless steels were the primary metals addressed. Because of their increased usage in applications where CUI is a concern, duplex stainless steels have been more explicitly addressed in this revision.

1.8 Although most of the attention has been focused on corrosion under thermal insulation, fireproofing materials also function, at least in part, as insulation applied to protect equipment during a potential fire. Other fire protection mechanisms initiated as endothermic reactions within the fireproofing material during a fire are not covered in this standard. Corrosion mechanisms, the root cause of failure, and corrosion prevention may be the same for corrosion under fireproofing as for corrosion under insulation.